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NUREG-1437
Supplement 2
Second Renewal

Site-Specific Environmental Impact Statement for License Renewal of Nuclear Plants

Supplement 2, Second Renewal

Regarding Subsequent License Renewal for Oconee Nuclear Station Units 1, 2, and 3

Draft Report for Comment

Office of Nuclear Material Safety and Safeguards

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Site-Specific Environmental Impact Statement for License Renewal of Nuclear Plants

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Regarding Subsequent License Renewal for Oconee Nuclear Station Units 1, 2, and 3

Draft Report for Comment

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Office of Nuclear Material Safety and Safeguards

Proposed Action	Issuance of renewed facility operating licenses DPR-38, DPR-47, and DPR-55 for Oconee Nuclear Station, Units 1, 2, and 3, in Seneca, South Carolina
Type of Statement	Draft Site-Specific Environmental Impact Statement
Agency Contact	Lance Rakovan U.S. Nuclear Regulatory Commission (NRC) Office of Nuclear Material Safety and Safeguards Mail Stop T-4B72 Washington, DC 20555-0001 Email: Lance.Rakovan@nrc.gov

Comments:

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Responsible Agency: U.S. Nuclear Regulatory Commission, Office of Nuclear Material Safety and Safeguards.

Title: Site-Specific Environmental Impact Statement for Subsequent License Renewal of Oconee Nuclear Station, Units 1, 2, and 3 Second Renewal, Draft Report for Comment.

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ABSTRACT

The U.S. Nuclear Regulatory Commission (NRC) staff prepared this site-specific environmental impact statement (EIS) as part of its environmental review of the Duke Energy Carolinas, LLC (Duke Energy) request to renew the operating licenses for Oconee Nuclear Station, Units 1, 2, and 3 (Oconee Station) for an additional 20 years. This EIS includes the site-specific evaluation of the environmental impacts of the proposed action, Oconee Station subsequent license renewal (SLR), and alternatives to SLR. As alternatives, the NRC considered: (1) new nuclear (advanced light-water reactor facility located at Duke Energy's W.S. Lee Nuclear Station site combined with a small modular reactor located at the Oconee Station site); (2) a natural gas-fired power plant (natural gas-fired combined-cycle facility located at the Oconee Station site); (3) a combination of solar photovoltaic, offshore wind, small modular reactors, and demand-side management, and (4) no action.

This EIS considers information contained in Duke Energy's November 7, 2022, submittal (Agencywide Documents Access and Management System Accession No. ML21158A193; Duke Energy 2021-TN8897), which supplements its June 7, 2021, SLR application (Duke Energy 2021-TN8897). Previously, in August 2021, the NRC conducted a scoping period and published a scoping summary report (NRC 2022-TN8905). In February 2022, the Commission issued two memoranda and orders, Commission Legal Issuance (CLI)-22-02 and CLI-22-03 (NRC 2022-TN8182 and NRC 2022-TN8272), concerning SLR environmental reviews. In CLI-22-02, the Commission found that the License Renewal Generic Environmental Impact Statement (LR GEIS) did not cover the SLR period and that 10 CFR 51.53(c)(3) (TN250) does not apply to SLR applicants and, therefore, the NRC staff may not exclusively rely on the 2013 LR GEIS and Table B–1 for the evaluation of Category 1 issues. In CLI-22-03, notably, the Commission determined that the NRC staff must address these impacts on a site-specific basis in site-specific EISs.

The NRC staff prepared this site-specific EIS in accordance with CLI-22-03 (NRC 2022-TN8272), that references CLI-22-02 (NRC 2022-TN8182). This EIS considers the impacts of all SLR issues applicable to Oconee Station SLR on a site-specific basis.

Based on the evaluation of environmental impacts in this EIS, the NRC staff's preliminary recommendation is that the adverse environmental impacts of SLR for Oconee Station are not so great that preserving the option of SLR for energy-planning decisionmakers would be unreasonable. The NRC staff based its preliminary recommendation on the following:

- Duke Energy's environmental report, as supplemented
- consultation with Federal, State, Tribal, and local governmental agencies
- the NRC staff's independent environmental review
- the consideration of public comments received during the scoping processes

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

Background

By letter dated June 7, 2021 (Duke Energy 2021-TN8897), Duke Energy Carolinas, LLC (Duke Energy), submitted an application requesting subsequent license renewal (SLR) for the Oconee Nuclear Station, Units 1, 2, and 3 (Oconee Station) operating licenses to the U.S. Nuclear Regulatory Commission (NRC). Duke Energy subsequently supplemented its application on November 11, 2021 (Duke Energy 2021-TN8898). The Oconee Station Unit 1 renewed facility operating license (DPR-38) expires at midnight on February 6, 2033; the renewed facility operating license for Unit 2 (DPR-47) expires at midnight on October 6, 2033; and the renewed facility operating license for Unit 3 (DPR-55) expires at midnight on July 19, 2034. In its application, Duke Energy requested renewed facility operating licenses for a period of 20 years beyond these expiration dates (i.e., to February 6, 2053, for Oconee Station Unit 1, to October 6, 2053, for Oconee Station Unit 2, and to July 19, 2054, for Oconee Station Unit 3).

The NRC's environmental protection regulations in Title 10 of the *Code of Federal Regulations* (10 CFR) Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions," (TN250) implement the National Environmental Policy Act of 1969, as amended (42 U.S.C. 4321 et seq.; TN661). This Act is commonly referred to as National Environmental Policy Act (NEPA). The regulations at 10 CFR Part 51 require the NRC to prepare an environmental impact statement (EIS) before deciding whether to issue an operating license or a renewed operating license for a nuclear power plant. Pursuant to these regulations, NRC staff began to perform an environmental review of Duke Energy's SLR application and published a scoping summary report in January 2022 (NRC 2022-TN8905).

On February 24, 2022, the Commission issued three memoranda and orders that addressed SLR proceedings for five operating nuclear power plants. Two of these orders, Commission Legal Issuance (CLI)-22-02 (NRC 2022-TN8182) and CLI-22-03 (NRC 2022-TN8272), are relevant to the Oconee Station SLR environmental review. In the orders, the Commission concluded that the License Renewal Generic Environmental Impact Statement (LR GEIS), which the NRC staff relies on, in part, to meet its obligations under 10 CFR Part 51 (TN250) and NEPA, did not consider the impacts from operation during the SLR period.

As discussed in CLI-22-03 (NRC 2022-TN8272), the Commission directed the NRC staff to review and update the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*, Revision 1, Final Report (NUREG–1437; NRC 2013-TN2654; LR GEIS) so that it covers nuclear power plant operation during the SLR period. The Commission stated that the most efficient way to proceed would be for the NRC staff to review and update the LR GEIS and then take appropriate action with respect to pending SLR applications to ensure that the environmental impacts for the period of SLR are considered. Alternatively, the Commission allowed that SLR applicants could submit a revised environmental report providing information on environmental impacts during the SLR period. In such a submittal, SLR applicants must evaluate the impacts of those environmental issues dispositioned in the LR GEIS and Table B-1 in Appendix B to Subpart A of 10 CFR Part 51 (TN250) as generic (Category 1) issues. The NRC staff would then address the impacts of these issues during the SLR period in site-specific EISs.

Consistent with CLI-22-03, on November 7, 2022, Duke Energy submitted a supplemental environmental report of the impacts of continued operations of Oconee Station during the SLR period (Duke Energy 2022-TN8899). That report, which supplemented the environmental report included in Duke Energy's original SLR application, addressed, on a site-specific basis, each environmental issue previously dispositioned as a Category 1 issue in the environmental report. Duke Energy also performed a review to identify any new, materially significant information relevant to the applicable Category 2 issues addressed in its June 7, 2021, application, and determined that there was no new and significant information identified since the SLR application was submitted. The NRC staff then resumed its environmental review of Duke Energy's SLR supplemented application, conducted a second environmental scoping period, and published a second scoping summary report in February 2024 (NRC 2024-TN9478).

The NRC staff prepared this site-specific EIS in accordance with CLI-22-03 (NRC 2022-TN8272), that references CLI-22-02 (NRC 2022-TN8182). This EIS considers the impacts of subsequent license renewal issues applicable to Oconee Station SLR on a site-specific basis. This EIS considers information in Duke Energy's environmental report, as supplemented; consultation with Federal, State, Tribal, and local governmental agencies; the NRC staff's independent environmental review; and the consideration of public comments received during the scoping processes.

Proposed Action

Duke Energy initiated the proposed Federal action (whether to renew the Oconee Station operating licenses) by submitting an SLR application. The current Oconee Station operating licenses are set to expire at midnight on February 6, 2033, for Unit 1 (DPR-38); on October 6, 2033, for Unit 2 (DPR-47); and on July 19, 2034, for Unit 3 (DPR-55). The NRC's Federal action is to determine whether to renew the Oconee Station operating licenses for an additional 20 years. If the NRC renews the operating licenses, Duke Energy would be authorized to operate Oconee Station Unit 1 until February 6, 2053, Unit 2 until October 6, 2053, and Unit 3 until July 19, 2054.

Purpose and Need for Proposed Federal Action

The purpose and need for the proposed Federal action (renewal of the Oconee Station operating licenses) is to provide an option that allows for power generation capability beyond the term of the current renewed nuclear power plant operating licenses to meet future system generating needs, as such needs may be determined by energy-planning decisionmakers, such as State regulators, utility owners, and Federal agencies (other than the NRC). This definition of purpose and need reflects the NRC's recognition that, absent findings in the safety review required by the Atomic Energy Act of 1954, as amended, or in the NEPA environmental analysis that would lead the NRC to reject an SLR application, the NRC has no role in the energy-planning decisions as to whether a particular nuclear power plant should continue to operate.

Environmental Impacts of Subsequent License Renewal

This site-specific EIS evaluates the potential environmental impacts of the proposed action and reasonable alternatives to that action. The environmental impacts of the proposed action and reasonable alternatives are designated as SMALL, MODERATE, or LARGE, which represent three established significance levels for potential impacts, presented in a footnote of Table B–1 in Appendix B to Subpart A of 10 CFR Part 51 (TN250), and defined as follows:

SMALL: Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource.

MODERATE: Environmental effects are sufficient to alter noticeably, but not to destabilize, important attributes of the resource.

LARGE: Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

In this EIS, the NRC staff evaluates environmental issues applicable to Oconee Station SLR. Table B–1 in Appendix B to Subpart A of 10 CFR Part 51 (TN250) and the LR GEIS disposition these issues as "generic" or "Category 1" issues. However, as explained under "Background," the Commission determined that the staff may not rely on the LR GEIS for SLR reviews. Therefore, in this site-specific EIS, the NRC addresses each of these 54 environmental issues on a site-specific basis.

In this site-specific EIS, additional environmental issues were evaluated on a site-specific basis. Table B–1 in Appendix B to Subpart A of 10 CFR Part 51 (TN250) and the LR GEIS disposition these issues as "site-specific" or "Category 2" issues. In this site-specific EIS, the NRC staff performed site-specific analyses and made site-specific findings of SMALL, MODERATE, or LARGE for each of these issues.

Table ES-1 lists the environmental issues applicable to Oconee Station SLR and the findings related to these issues. Footnotes denote those issues that were formerly addressed in the 2013 LR GEIS as Category 1 issues.

Table ES-1 Summary of Site-Specific Conclusions Regarding Oconee Nuclear Station Subsequent License Renewal

Resource Area	Environmental Issue	Impacts
Land Use	Onsite land use[(a)]	SMALL
Land Use	Offsite land use[(a)]	SMALL
Land Use	Offsite land use in transmission line right-of-ways (ROWs)[(a)]	SMALL
Visual Resources	Aesthetic impacts[(a)]	SMALL
Air Quality	Air quality impacts (all plants)[(a)]	SMALL
Air Quality	Air quality effects of transmission lines[(a)]	SMALL
Noise	Noise impacts[(a)]	SMALL
Geologic Environment	Geology and soils[(a)]	SMALL
Surface Water Resources	Surface water use and quality (non-cooling system impacts) [(a)]	SMALL
Surface Water Resources	Altered current patterns at intake and discharge structures[(a)]	SMALL
Surface Water Resources	Altered thermal stratification of lakes[(a)]	SMALL
Surface Water Resources	Scouring caused by discharged cooling water[(a)]	SMALL

Table ES-1 Summary of Site-Specific Conclusions Regarding Oconee Nuclear Station Subsequent License Renewal (Continued)

Resource Area	Environmental Issue	Impacts
Surface Water Resources	Discharge of metals in cooling system effluent[(a)]	SMALL
Surface Water Resources	Discharge of biocides, sanitary wastes, and minor chemical spills[(a)]	SMALL
Surface Water Resources	Surface water use conflicts (plants with once-through cooling systems)[(a)]	SMALL
Surface Water Resources	Effects of dredging on surface water quality[(a)]	SMALL
Surface Water Resources	Temperature effects on sediment transport capacity[(a)]	SMALL
Groundwater Resources	Groundwater contamination and use (non-cooling system impacts)[(a)]	SMALL
Groundwater Resources	Groundwater use conflicts (plants that withdraw less than 100 gallons per minute [gpm])[(a)]	SMALL
Groundwater Resources	Radionuclides released to groundwater	SMALL
Terrestrial Resources	Effects on terrestrial resources (non-cooling system impacts)	SMALL
Terrestrial Resources	Exposure of terrestrial organisms to radionuclides[(a)]	SMALL
Terrestrial Resources	Cooling system impacts on terrestrial resources (plants with once-through cooling systems or cooling ponds)[(a)]	SMALL
Terrestrial Resources	Bird collisions with plant structures and transmission lines[(a)]	SMALL
Terrestrial Resources	Transmission line right-of-way (ROW) management impacts on terrestrial resources[(a)]	SMALL
Terrestrial Resources	Electromagnetic fields on flora and fauna (plants, agricultural crops, honeybees, wildlife, livestock)[(a)]	SMALL
Aquatic Resources	Impingement and entrainment of aquatic organisms (plants with once-through cooling systems or cooling ponds)	SMALL
Aquatic Resources	Entrainment of phytoplankton and zooplankton (all plants)[(a)]	SMALL
Aquatic Resources	Thermal impacts on aquatic organisms (plants with once-through cooling systems or cooling ponds)	SMALL
Aquatic Resources	Infrequently reported thermal impacts (all plants)[(a)]	SMALL
Aquatic Resources	Effects of cooling water discharge on dissolved oxygen, gas supersaturation, and eutrophication[(a)]	SMALL
Aquatic Resources	Effects of non-radiological contaminants on aquatic organisms[(a)]	SMALL

Table ES-1 Summary of Site-Specific Conclusions Regarding Oconee Nuclear Station Subsequent License Renewal (Continued)

Resource Area	Environmental Issue	Impacts
Aquatic Resources	Exposure of aquatic organisms to radionuclides[(a)]	SMALL
Aquatic Resources	Effects of dredging on aquatic organisms[(a)]	SMALL
Aquatic Resources	Effects on aquatic resources (non-cooling system impacts)[(a)]	SMALL
Aquatic Resources	Impacts of transmission line right-of-way (ROW) management on aquatic resources[(a)]	SMALL
Aquatic Resources	Losses from predation, parasitism, and disease among organisms exposed to sublethal stresses[(a)]	SMALL
Special Status Species and Habitats	Threatened, endangered, and protected species and essential fish habitat	May affect but is not likely to adversely affect the tricolored bat or monarch butterfly; no effect on essential fish habitat
Historic and Cultural Resources	Historic and cultural resources	Would not adversely affect known historic properties
Socioeconomics	Employment and income, recreation, and tourism[(a)]	SMALL
Socioeconomics	Tax revenues[(a)]	SMALL
Socioeconomics	Community services and education[(a)]	SMALL
Socioeconomics	Population and housing[(a)]	SMALL
Socioeconomics	Transportation[(a)]	SMALL
Human Health	Radiation exposures to the public[(a)]	SMALL
Human Health	Radiation exposures to plant workers[(a)]	SMALL
Human Health	Human health impact from chemicals[(a)]	SMALL
Human Health	Microbiological hazards to the public (plants with cooling ponds or canals or cooling towers that discharge to a river)	SMALL
Human Health	Microbiological hazards to plant workers[(a)]	SMALL
Human Health	Chronic effects of electromagnetic fields (EMFs)[(b)]	Uncertain impact
Human Health	Physical occupational hazards[(a)]	SMALL
Human Health	Electric shock hazards	SMALL
Postulated Accidents	Design-basis accidents[(a)]	SMALL
Postulated Accidents	Severe accidents	See EIS Appendix F
Environmental Justice	Minority and low-income populations	No disproportionately high and adverse human health and environmental effects on minority and low-income populations
Waste Management	Low-level waste storage and disposal[(a)]	SMALL
Waste Management	Onsite storage of spent nuclear fuel[(a)]	SMALL
Waste Management	Offsite radiological impacts of spent nuclear fuel and high-level waste disposal[(a)]	[(c)]

Table ES-1 Summary of Site-Specific Conclusions Regarding Oconee Nuclear Station Subsequent License Renewal (Continued)

Resource Area	Environmental Issue	Impacts
Waste Management	Mixed-waste storage and disposal[(a)]	SMALL
Waste Management	Nonradioactive waste storage and disposal[(a)]	SMALL
Cumulative Impacts	Cumulative impacts	See EIS Section 3.15
Uranium Fuel Cycle	Offsite radiological impacts—individual impacts from other than the disposal of spent fuel and high-level waste[(a)]	SMALL
Uranium Fuel Cycle	Offsite radiological impacts—collective impacts from other than the disposal of spent fuel and high-level waste[(a)]	[(d)]
Uranium Fuel Cycle	Nonradiological impacts of the uranium fuel cycle[(a)]	SMALL
Uranium Fuel Cycle	Transportation[(a)]	SMALL
Termination of Nuclear Power Plant Operations and Decommissioning	Termination of plant operations and decommissioning[(a)]	SMALL

EIS = environmental impact statement; EMF = electromagnetic fields; gps = gallons per minute; ROW = right-of-way.

(a) Dispositioned as generic (Category 1) for initial license renewal of nuclear power plants in Table B–1 in Appendix B to Subpart A of Title 10 CFR Part 51 (TN250).

(b) This issue was not designated as Category 1 or 2 and is discussed in Section 3.11.6.6

(c) The ultimate disposal of spent fuel in a potential future geologic repository is a separate and independent licensing action that is outside the regulatory scope of this site-specific review. Per 10 CFR Part 51 (TN250) Subpart A the Commission concludes that the impacts presented in NUREG-2157 (NRC 2014-TN4117) would not be sufficiently large to require the NEPA conclusion, for any plant, that the option of extended operation under 10 CFR Part 54 (TN4878) should be eliminated. Accordingly, while the Commission has not assigned a single level of significance for the impacts of spent nuclear fuel and high-level waste disposal, this issue is considered generic to all nuclear power plants and does not warrant a site-specific analysis.

(d) There are no regulatory limits applicable to collective doses to the general public from fuel-cycle facilities. The practice of estimating health effects on the basis of collective doses may not be meaningful. All fuel-cycle facilities are designed and operated to meet the applicable regulatory limits and standards. As stated in the 2013 LR GEIS, “The Commission concludes that these impacts are acceptable in that these impacts would not be sufficiently large to require the NEPA conclusion, for any plant, that the option of extended operation under 10 CFR Part 54 (TN4878) should be eliminated.” (10 CFR Part 54; TN4878) (Section 3.13.3.3 of this EIS)

<u>Alternatives</u>

As part of its environmental review, the NRC is required to consider alternatives to SLR and evaluate the environmental impacts associated with each alternative. These alternatives can include other methods of power generation (replacement energy alternatives), as well as not renewing the Oconee Station operating licenses (no-action alternative).

The NRC considered 16 alternatives to the proposed action and eliminated 13 from detailed study due to technical viability, resource availability, or commercial limitations that are likely to exist when the Oconee Station operating licenses expire. Three replacement energy alternatives were determined to be commercially viable, and include:

- new nuclear (advanced light-water reactor facility located at Duke Energy’s W.S. Lee Nuclear Station site combined with a small modular reactor located at the Oconee Station site)

- new natural gas-fired power plant (natural gas-fired combined-cycle facility located at the Oconee Station site)
- a combination of solar photovoltaic, offshore wind, small modular reactor, and demand-side management.

These alternatives, along with the no-action alternative, were evaluated in detail in this EIS. In addition, NRC staff also evaluated new and significant information that could alter the conclusions of the severe accident mitigation alternatives analysis previously performed for the Oconee Station initial license renewal in 2000, which authorized continued reactor operation for an additional 20 years beyond the original 40-year operating license term.

Preliminary Recommendation

The NRC staff's preliminary recommendation is that the adverse environmental impacts of Oconee Station SLR are not so great that preserving the option of SLR for energy-planning decisionmakers would be unreasonable. The NRC staff based its preliminary recommendation on the following:

- Duke Energy's environmental report, as supplemented
- consultation with Federal, State, Tribal, and local governmental agencies
- the NRC staff's independent environmental review
- the consideration of public comments received during the scoping processes

ABBREVIATIONS AND ACRONYMS

$	$ dollar(s) (U.S.)
§	Section
°C	degree(s) Celsius
°F	degree(s) Fahrenheit
AADT	average annual daily traffic
ac	acre(s)
AD	Anno Domini
ADAMS	Agencywide Documents Access and Management System
AEA	Atomic Energy Act of 1954 (as amended)
ALARA	as low as reasonably achievable
ALWR	advanced light-water reactor
AOI	area of influence
ASA	ASA Analysis & Communication Inc.
BC	Before Christ
BEIR	Biologic Effects of Ionizing Radiation
BMP	best management practice(s)
BOEM	Bureau of Ocean Energy Management
BTA	best technology available
CAA	Clean Air Act, as amended through 1990
CDF	core damage frequency
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
CLB	current licensing basis/bases
cm	centimeter(s)
CO	carbon monoxide
CO_2	carbon dioxide
CO_2eq	carbon dioxide equivalent
CTP	chemical treatment pond
CWA	Clean Water Act (Federal Water Pollution Control Act)
CZMA	Coastal Zone Management Act

dB	decibel(s)
DBA	Design-basis accidents
dBA	A-weighted decibels
DMR	discharge monitoring reports
DOE	U.S. Department of Energy
DSM	demand-side management
Duke Energy	Duke Energy Carolinas, LLC
EAB	Exclusion area boundary
EFH	essential fish habitat
EI	exposure index
EIA	Energy Information Administration
EIS	environmental impact statement
ELF	extremely low frequency
EMF	electromagnetic field
EO	Executive Order
EPA	U.S. Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
EPRI	Electric Power Research Institute
ER	environmental report
ESA	Endangered Species Act
FCDF	Fire core damage frequency
FERC	Federal Energy Regulatory Commission
fps	feet per second
FR	*Federal Register*
ft	feet
ft/min	feet per minute
ft^2	feet squared
ft^3	cubic feet
FWS	U.S. Fish and Wildlife Service
g	gram(s)
g Ceq/kWh	grams carbon equivalent per kilowatt-hour
gal	gallons
GEIS	Generic Environmental Impact Statement
GHG	greenhouse gas

GI	Generic Issue
gpd	gallons per day
gpm	gallons per minute
gpy	gallons per year
GT	gigatons
GWd/MTU	gigawatt days per metric ton
GWP	global warming potential
GWPI	Groundwater Protection Initiative
ha	hectare(s)
HCP	Habitat Conservation Plan
HDR	HDR Engineering, Inc.
IM	impingement mortality
in.	inch(es)
in. of Hg	inch(es) of mercury
IPCC	Intergovernmental Panel on Climate Change
IPE	individual plant examination
IPEEE	individual plant examination of external events
ISFSI	Independent spent fuel storage installation
km	kilometer(s)
kV	kilovolt
kW	kilowatt(s)
$kWh/m^2/day$	kilowatt-hour per square meter per day
L	liter(s)
lb	pound(s)
LERF	large early release frequency
LLRW	low-level radioactive waste
LR GEIS	NUREG-1437, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*
LR	license renewal
m	meters
m/s	meter(s) per second

m^3	cubic meter(s)
m^3/min	cubic meters per minute
MACCS	MELCOR Accident Consequence Code System
MBTA	Migratory Bird Treaty Act
mgd	million gallons per day
mgy	million gallons of water per year
mi	mile(s)
mL	milliliter(s)
mLd	million liters per day
mm	millimeter(s)
mm of Hg	millimeter(s) of mercury
mph	miles per hour
mrad	milliradiation absorbed dose
mrem	millirem
MSL	mean sea level
mSv	millisievert
MT	metric ton
MW	megawatt(s)
Mw	moment magnitude
MWd/MTU	megawatt days per metric ton uranium
MWe	megawatts electric
MWt	megawatts thermal
NAAQS	National Ambient Air Quality Standards
NEI	Nuclear Energy Institute
NEPA	National Environmental Policy Act
NGCC	Natural gas combined cycle
NHPA	National Historic Preservation Act
NIEHS	National Institute of Environmental Health Sciences
NLAA	may affect but is not likely to adversely affect
NMFS	National Marine Fisheries Service
NMSA	National Marine Sanctuaries Act
NOAA	National Oceanic and Atmospheric Administration
NOV	notices of violation
NOx	nitrogen oxide
NPDES	National Pollutant Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission

NRHP	National Register of Historic Places
NTTF	Near-Term Task Force
NUREG	U.S. Nuclear Regulatory Commission technical report designation
NW	northwest
O_3	ozone
Oconee Station	Oconee Nuclear Station
ODCM	Offsite Dose Calculation Manual
OSHA	Occupational Safety and Health Administration
oz	ounce(s)
PAM	primary amebic meningoencephalitis
Pb	lead
pCi/L	picoCuries per liter
PDR	population dose risk
PM	particulate matter
PNNL	Pacific Northwest National Laboratory
PRA	probabilistic risk assessment
PV	photovoltaic
PWR	pressurized-water reactor
RCI	Request for Confirmation of Information
RCP	representative concentration pathway
RCRA	Resource Conservation and Recovery Act of 1976, as amended
rem	roentgen equivalent(s) man
REMP	radiological environmental monitoring program
RG	Regulatory Guide
ROI	region(s) of influence
ROW	right-of-way
RW	recovery well
SAMA	severe accident mitigation alternatives
SAR	safety analysis report
SC	South Carolina
SCDF	Seismic core damage frequency
SCDHEC	South Carolina Department of Health and Environmental Control
SCDNR	South Carolina Department of Natural Resources

SCDoT	South Carolina Department of Transportation
SCR	South Carolina Regulation
SDWA	Safe Drinking Water Act of 1974
sec	second
SEIS	supplemental environmental impact statement
SHPO	State Historic Preservation Office
SLRA	subsequent license renewal application
SLR	subsequent license renewal
SMR	small modular reactor
SNM	square nautical mile
SO_2	sulfur dioxide
SOARCA	State-of-the-Art Reactor Consequence Analysis
SPCC	spill prevention, control and countermeasure
SPEO	Subsequent Period of Extended Operation
SPID	Screening, Prioritization and Implementation Details
SPRA	Seismic Probabilistic Risk Assessment
SQG	small-quantity hazardous waste generator
SSC	structures, systems, and components
SSF	Safe Shutdown Facility
Sv	sievert(s)
SWPPP	Stormwater Pollution Prevention Plan
TSCA	Toxic Substances Control Act
U.S.	United States
U.S.C.	*United States Code*
UCB	Upper-Confidence Bound
USACE	United States Army Corps of Engineers
USCB	U.S. Census Bureau
USGCRP	U.S. Global Change Research Program
WTG	wind turbine generator
yr	year
μm	micrometer

1 INTRODUCTION AND GENERAL DISCUSSION

The U.S. Nuclear Regulatory Commission's (NRC's) environmental protection regulations in Title 10 of the *Code of Federal Regulations* (10 CFR) Part 51 (TN250), "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions," implement the National Environmental Policy Act of 1969 (NEPA), as amended (42 U.S.C. 4321 et seq.; TN661). In part, the regulations at 10 CFR Part 51 require the NRC to prepare an environmental impact statement (EIS) before the issuance or renewal of a license to operate a nuclear power plant.

The Atomic Energy Act (AEA) of 1954, as amended (42 U.S.C. 2011 et seq.; TN663), specifies that licenses for commercial power reactors can be granted for up to 40 years. The initial 40-year licensing period was based on economic and antitrust considerations rather than on technical limitations of the nuclear facility. NRC regulations permit these licenses to be renewed beyond the initial 40-year term for additional time, limited to 20-year increments per renewal. Renewal is based on the results of (1) the environmental review and (2) the NRC staff's safety review (10 CFR 54.29, "Standards for Issuance of a Renewed License"; TN4878). Neither the AEA nor NRC regulations restrict the number of times a license may be renewed. The decision to seek a renewed license rests entirely with nuclear power plant owners and typically is based on the power plant's economic viability and the investment necessary to continue to meet all safety and environmental requirements. The NRC makes the decision to grant or deny license renewal based on whether the applicant has demonstrated reasonable assurance that it can meet the environmental and safety requirements in the agency's regulations during the period of extended operation.

Pursuant to 10 CFR Part 51 (TN250), the NRC conducted an environmental review of Duke Energy Carolinas, LLC's (Duke Energy's), June 7, 2021, request for subsequent license renewal (SLR) (Duke Energy 2021-TN8897), as supplemented on November 11, 2021, (Duke Energy 2021-TN8898), and November 7, 2022 (Duke Energy 2022-TN8899). Duke Energy requested renewed facility operating licenses for Oconee Nuclear Station, Units 1, 2, and 3 (Oconee Station) for a period of 20 years beyond the dates when the initial renewed facility operating licenses would expire.

On February 24, 2022, the NRC Commission issued three memoranda and orders that addressed SLR proceedings for five operating nuclear power plants. Two of these orders, Commission Legal Issuance (CLI)-22-03 (NRC 2022-TN8272), which references CLI-22-02 (NRC 2022-TN8182), are relevant to the Oconee Station SLR environmental review. In the orders, the Commission concluded that the License Renewal Generic Environmental Impact Statement (LR GEIS), which the NRC staff relies on in part to meet its obligations under 10 CFR Part 51 (TN250) and NEPA, did not consider the impacts from operations during the SLR period.

In CLI-22-03, the Commission directed the NRC staff to review and update the LR GEIS so that it covers nuclear power plant operation during the SLR period (NRC 2022-TN8272). The Commission stated that it believed the most efficient way to proceed would be for the NRC staff to review and update the LR GEIS and then take appropriate action with respect to pending SLR applications to ensure that the environmental impacts for the period of SLR are considered. However, the Commission allowed that SLR applicants may submit a revised environmental report (ER) providing information on environmental impacts during the SLR period. In such a submittal, SLR applicants must evaluate the impacts of those environmental issues dispositioned in Table B-1 in Appendix B to Subpart A of 10 CFR Part 51 (TN250) and the LR GEIS as generic (Category 1) issues. The NRC staff would then address the impacts of these issues during the SLR period in site-specific EISs.

On November 7, 2022, Duke Energy submitted a site-specific environmental review of the impacts of continued operations of Oconee Station during the SLR period (Duke Energy 2022-TN8899). That review, which supplemented the ER included in Duke Energy's SLR application, addressed, on a site-specific basis, each environmental issue previously dispositioned as a Category 1 issue in the environmental report. Duke Energy also performed a review to identify any new, materially significant information relevant to the applicable Category 2 issues addressed in its June 7, 2021, application, and determined that there was no new and significant information identified since the SLR application was submitted.

The NRC staff prepared this site-specific EIS in accordance with CLI-22-03 (NRC 2022-TN8272), that references CLI-22-02 (NRC 2022-TN8182), and requirements in 10 CFR 51.70 (TN250), "Draft Environmental Impact Statements—General Requirements." This EIS considers the impacts of all license renewal issues applicable to Oconee Station SLR on a site-specific basis. This EIS considers information in Duke Energy's SLR application, as supplemented; Duke Energy's November 7, 2022, submittal; the staff's consultation with Federal, State, Tribal, and local government agencies; and other new information, as appropriate.

In this site-specific EIS, the NRC evaluates environmental issues applicable to Oconee Station SLR. Table B–1 in Appendix B to Subpart A of 10 CFR Part 51 (TN250) and the LR GEIS disposition of these issues as generic (Category 1) issues. However, as explained under "Background," the Commission determined that the staff may not rely on the LR GEIS for SLR reviews pending updates to the LR GEIS and 10 CFR Part 51. Therefore, in this EIS, each of these environmental issues are addressed on a site-specific basis.

In this site-specific draft EIS, additional environmental issues were evaluated on a site-specific basis. Table B-1 in Appendix B to Subpart A of 10 CFR Part 51 (TN250) and the LR GEIS disposition these issues as site-specific (Category 2) issues. The NRC staff performed site-specific analyses and made site-specific findings of SMALL, MODERATE, or LARGE for each of these issues.

1.1 Proposed Action

Duke Energy initiated the proposed Federal action (whether to renew the Oconee Station operating licenses) by requesting the SLR of Oconee Station's operating licenses to the NRC. The initial renewed facility operating licenses are set to expire at midnight on February 6, 2033, for Unit 1 (DPR-38); October 6, 2033, for Unit 2 (DPR-47); and July 19, 2034, for Unit 3 (DPR-55). The NRC's Federal action is to decide whether to renew the Oconee Station operating licenses for an additional 20 years of operation. If the NRC issues subsequent renewed licenses, Oconee Station would be authorized to operate until February 6, 2053 (Unit 1), October 6, 2053 (Unit 2), and July 19, 2054 (Unit 3).

1.2 Purpose and Need for the Proposed Federal Action

The purpose and need for the proposed Federal action (renewal of the Oconee Station operating licenses) is to provide an option that allows for power generation capability beyond the term of the current nuclear power plant operating licenses to meet future system generating needs, as such needs may be determined by energy-planning decisionmakers, such as State regulators, utility owners, and, where authorized, Federal agencies other than the NRC. This definition of purpose and need reflects the Commission's recognition that, unless there are findings in the safety review required by the AEA, as amended, or in the NEPA environmental analysis that would lead the NRC to reject the SLR application, the NRC does not have a role in energy-planning decisions as to whether a particular nuclear power plant should continue to operate.

1.3 Major Environmental Review Milestones

Duke Energy submitted an ER as an appendix to its SLR application on June 7, 2021 (Duke Energy 2021-TN8897). The NRC published a notice of the receipt of the application in the *Federal Register* (FR) on June 25, 2021 (Volume 86 of the FR, p. 33784 [86 FR 33784-TN8900]). After reviewing the SLR application and ER, as supplemented, the NRC staff accepted the application for a detailed technical review on July 22, 2021. The staff published a *Federal Register* notice of acceptability for docketing and opportunity for hearing on July 28, 2021 (86 FR 40662-TN8901). On August 10, 2021, the NRC published a notice in the *Federal Register* (86 FR 43684-TN8902) informing the public of the staff's intent to conduct an environmental scoping process, which began a 30-day scoping comment period. The NRC staff held a virtual public scoping meeting on August 25, 2021. In January 2022, the NRC issued a scoping summary report for Oconee Station SLR (NRC 2022-TN8905), which included the comments received during the 2021 scoping process (Appendix A.1 of this EIS).

The NRC staff conducted a virtual environmental and severe accident mitigation alternatives (SAMAs) audit of Oconee Station during the week of October 11, 2021, to independently verify information in Duke Energy's ER. During the audit, the NRC staff held meetings with nuclear power plant personnel and reviewed site-specific documentation and photos. The staff summarized the audit in a letter dated November 23, 2021 (NRC 2021-TN8910).

As explained previously, in February of 2022, the Commission issued memoranda and orders that, among other things, determined that the NEPA review for Oconee Station SLR may not rely upon the LR GEIS. Accordingly, the NRC staff performed a site-specific review of the Oconee Station SLR application for those environmental issues dispositioned in the LR GEIS and Table B–1 in Appendix B to Subpart A of 10 CFR Part 51 (TN250) as generic (Category 1) issues. As part of this review, the NRC staff issued a notice of intent to prepare an EIS and to conduct a limited second period of EIS scoping in the *Federal Register* (87 FR 77643-TN8903) on December 19, 2022. An additional *Federal Register* notice extending the limited scoping period to February 2, 2023 (88 FR 2645-TN9125), was published on January 17, 2023. In February 2024, the NRC issued a scoping summary report (NRC 2024-TN9478), which included comments received during the 2022–2023 limited second scoping period. The NRC staff conducted a supplemental virtual environmental audit of Oconee Station the week of April 24, 2023, to independently verify information in Duke Energy's ER Supplement 2 (NRC 2023-TN8911, NRC 2023-TN8934).

Figure 1-1 shows the major milestones of the environmental review portion of the NRC's SLR application review process for the Oconee Station SLR application. The EIS public comment process provides an opportunity for the incorporation of public comments and updating.

The NRC has established a process that NRC staff and license renewal applicants can complete in a reasonable period of time and that includes clear requirements to assure safe nuclear power plant operation for up to an additional 20 years of nuclear power plant life, pursuant to 10 CFR Part 54 (TN4878), "Requirements for Renewal of Operating Licenses for

Nuclear Power Plants." This process consists of separate safety and environmental reviews, which the NRC staff conducts simultaneously and documents in two reports: (1) the safety evaluation report documents the safety review and (2) the EIS documents the environmental review. Both reports factor into the NRC's decision to issue or deny a renewed license.

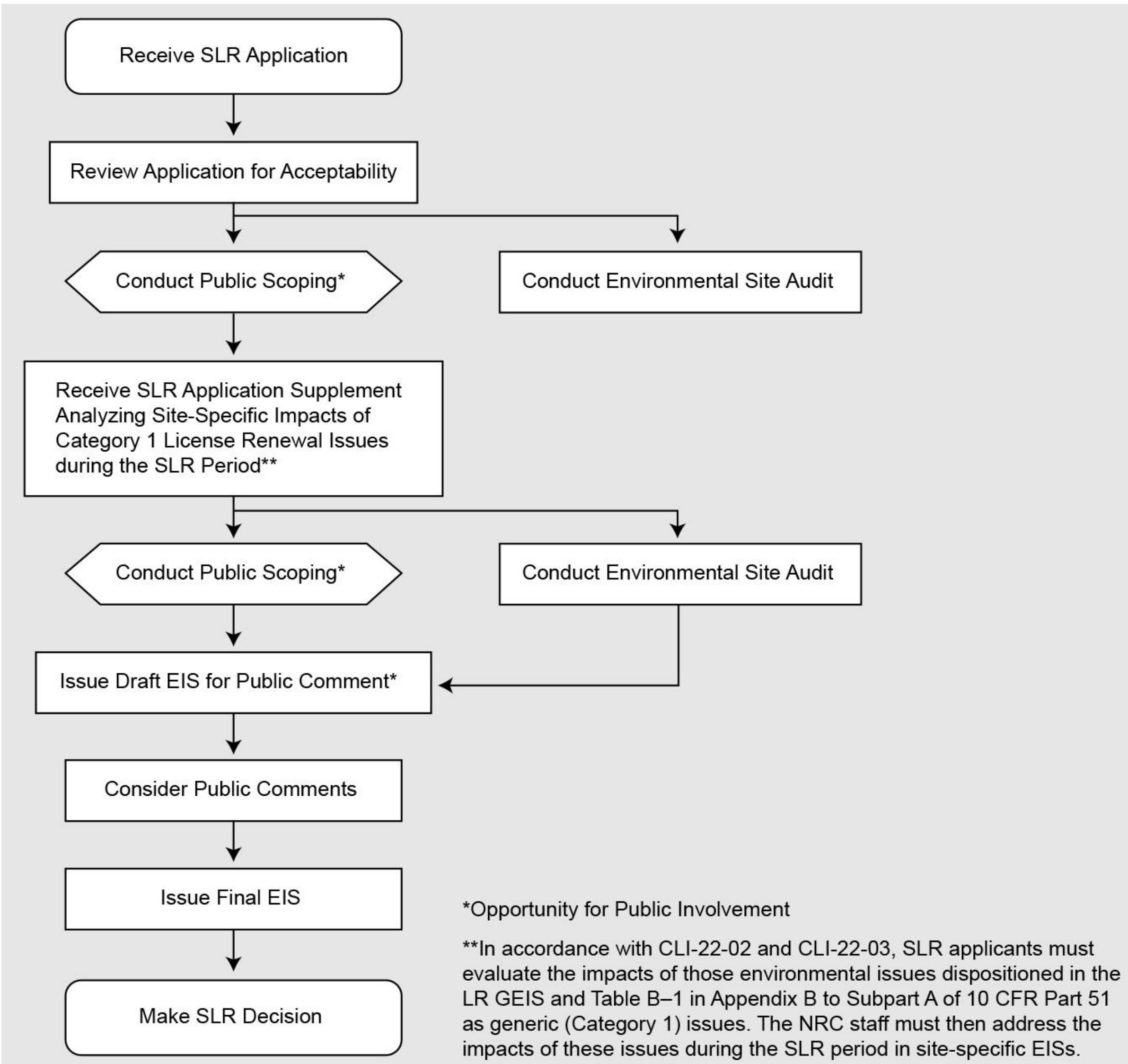

Figure 1-1 Environmental Review Process

1.4 Environmental Issues Evaluated in This EIS

In 1996, as supplemented in 1999 and revised in 2013, the NRC generically assessed the environmental impacts of license renewal of nuclear power plants in U.S. Nuclear Regulatory Commission (NUREG)-1437, *Generic Environmental Impact Statement for License Renewal of Nuclear Power Plants* (NRC 1996-TN288, NRC 1999-TN289, NRC 2013-TN2654). The NRC undertook this generic review to establish a systematic approach to evaluating environmental consequences of renewing individual nuclear power plant operating licenses for up to a 20-year period.

The 2013 revision of the LR GEIS (NRC 2013-TN2654) establishes 78 environmental impact issues for license renewal. For each of these issues, the NRC determines whether the analysis of the environmental issue in the LR GEIS could be applied to all nuclear power plants seeking license renewal and whether additional mitigation measures would be warranted. Based on this determination, the NRC designates each environmental issue as Category 1 (generic to all or a distinct subset of nuclear power plants) or Category 2 (site-specific to certain nuclear power plants only). For license renewal applications, a site-specific supplement to the LR GEIS is developed that considers the applicable Category 1 and Category 2 issues for the site under review. For generic issues (Category 1), the staff can adopt the LR GEIS's analysis and conclusions unless new and significant information that invalidates the conclusion summary in the LR GEIS is identified during a site-specific review. For Category 2 issues, the staff must perform a site-specific environmental review for each license renewal application. The NRC codified the conclusions in the LR GEIS in Appendix B to Subpart A of 10 CFR Part 51 (TN250), "Environmental Effect of Renewing the Operating License of a Nuclear Power Plant."

The NRC staff prepared this site-specific EIS in accordance with CLI-22-03 (NRC 2022-TN8272), that references CLI-22-02 (NRC 2022-TN8182), and requirements in 10 CFR Part 51.70 (TN250), "Draft Environmental Impact Statements—General Requirements." The impacts of all license renewal issues applicable to Oconee Station SLR were considered on a site-specific basis. This EIS considers information in Duke Energy's SLR application, as supplemented, including Duke Energy's November 7, 2022 (Duke Energy 2022-TN8899), supplement; the staff's consultation with Federal, State, Tribal, and local government agencies; and other new information, as appropriate.

In this EIS, the NRC evaluates the environmental issues applicable to Oconee Station SLR and considered whether any additional environmental issues exist beyond the issues that would apply to the SLR period. The NRC staff identified no such issues during its review of Duke Energy's ER or as a result of the environmental scoping process, the environmental site audit, or consultations with Federal agencies, State, and local agencies and American Indian Tribes. Generally, Oconee Station would continue current operating conditions rather than introduce new environmental impacts that did not exist during the original license or the initial license renewal period. Therefore, in this EIS, the NRC structures its analysis using the environmental issues established in the LR GEIS.

The NRC's standard of significance for impacts uses the Council on Environmental Quality (CEQ) terminology for "Determine the appropriate level of NEPA review" (40 CFR 1501.3(b)-TN4876). In considering whether the effects of the proposed action are significant, the NRC analyzes the potentially affected environment and degree of the effects of the proposed action (license renewal). The potentially affected environment consists of the affected area and its resources, such as listed species and designated critical habitat under the Endangered Species Act of 1973, as amended (ESA) (16 U.S.C. 1531 et seq.-TN1010). For site-specific issues, significance would depend on the effects in the local area, including (1) both short- and long-term effects; (2) both beneficial and adverse effects; (3) effects on public health and safety; and (4) effects that would violate Federal, State, Tribal, or local law protecting the environment.

The NRC characterizes potential impacts according to three levels of significance for potential impacts—SMALL, MODERATE, and LARGE.

SMALL: Indicates that the environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource.

MODERATE: Indicates that the environmental effects are sufficient to alter noticeably, but not to destabilize, important attributes of the resource.

LARGE: Indicates that the environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

1.5 Structure of This EIS

This site-specific EIS presents the analysis of the environmental effects of the continued operation of Oconee Station through the SLR term, reasonable alternatives to SLR, and mitigation measures for minimizing adverse environmental impacts. Chapter 3, "Affected Environment, Environmental Consequences, and Mitigating Actions," contains an analysis and comparison of the potential environmental impacts from SLR and alternatives to SLR. Chapter 4, "Conclusion," presents the NRC staff's preliminary recommendation on whether the environmental impacts of SLR are so great that preserving the option of SLR would be unreasonable. The NRC will consider public comments that it receives on this draft site-specific EIS and will then issue its final site-specific EIS. The NRC will make its final determination on Oconee Station's SLR in a record of decision to be issued following issuance of the final site-specific EIS.

In preparing this draft site-specific EIS, the NRC staff carried out the following activities:

- reviewed Duke Energy's ER, as supplemented
- consulted with Federal agencies, State and local agencies, and American Indian Tribes
- conducted site-specific analysis of each environmental issue relevant to Oconee Station SLR
- performed environmental and SAMA site audits
- considered public comments received during the scoping comment periods

New information can come from many sources, including the applicant, the NRC, other agencies, and public comments. If new information reveals an issue of which the NRC was unaware, the staff will first analyze the newly identified issue to determine if it is within the scope of the license renewal environmental review. If the NRC determines that the issue is relevant to the proposed action or its impacts, the staff then will determine the significance of the issue for the plant and address the issue in the EIS, as appropriate.

1.6 Decision to Be Supported by the EIS

This site-specific EIS provides information and analyses to support the NRC's decision on whether to renew the Oconee Station operating licenses for an additional 20 years. The regulation at 10 CFR 51.103(a)(5) (TN250) specifies the NRC's decision standard as follows:

> In making a final decision on a license renewal action pursuant to [10 CFR] Part 54 of this chapter, the Commission shall determine whether or not the adverse environmental impacts of license renewal are so great that preserving the option of license renewal for energy planning decisionmakers would be unreasonable.

There are many factors that the NRC considers when deciding whether to renew the operating license of a nuclear power plant. The analysis of environmental impacts in this EIS will provide the NRC's decisionmakers (i.e., the Commission) with important environmental information for consideration in deciding whether to renew the Oconee Station operating licenses.

1.7 Cooperating Agencies

During the scoping process, the NRC staff did not identify any Federal, State, or local agencies as cooperating agencies for this EIS.

1.8 Consultations

The ESA, as amended (16 U.S.C. 1531 et seq.-TN1010); the Magnuson–Stevens Fisheries Conservation and Management Act (MSA) of 1996 (16 U.S.C. § 1801 et seq.-TN4482); and the National Historic Preservation Act (NHPA) of 1966, as amended (54 U.S.C. 300101 et seq.-TN4157), require Federal agencies to consult with applicable State and Federal agencies and organizations before taking an action that may affect endangered species, fisheries, or historic and archaeological resources, respectively. See Appendix C for a list of the agencies and groups with which the NRC staff consulted.

1.9 Correspondence

During the review, the NRC staff contacted the Federal, State, regional, local, and Tribal agencies listed in Appendix C. Appendix C chronologically lists all correspondence the NRC staff sent and received associated with the ESA, the MSA, and the NHPA. Appendix D chronologically lists all other correspondence.

1.10 Status of Compliance

Duke Energy is responsible for complying with all NRC regulations and other applicable Federal, State, and local requirements. Appendix F, "Laws, Regulations, and Other Requirements," of the LR GEIS, Revision 1, describes some of the major applicable Federal statutes. Numerous permits and licenses are issued by Federal, State, and local authorities for activities at Oconee Station. Appendix B of this EIS contains further information from the Oconee Station application about Duke Energy's status of compliance.

1.11 Related State and Federal Activities

The NRC staff reviewed the possibility that activities (projects) of other Federal agencies might impact the renewal of the operating licenses for Oconee Station. Any such activities could result in cumulative environmental impacts and the possible need for the Federal agency to become a cooperating agency for preparing this EIS. The NRC staff has determined that there are no Federal projects that would make it necessary for another Federal agency to become a cooperating agency in the preparation of this EIS (10 CFR 51.10(b)(2); TN250). Table E-1 in Appendix E includes the Federal facilities in the vicinity of Oconee Station. In addition, Table E-1 identifies the activities (projects) including State activities that were considered during the cumulative environmental impacts review.

Section 102(2)(C) of NEPA (42 U.S.C. § 4332-TN4880) requires the NRC to consult with and obtain comments from any Federal agency or designated authority that has jurisdiction by law or special expertise with respect to any environmental impact involved in the subject matter of the EIS. For example, during the preparation of this site-specific EIS, the NRC consulted with the South Carolina State Historic Preservation Officer, among others. Appendix C provides a complete list of consultation correspondence.

The NRC staff reviewed the Oconee Station status of compliance in Chapter 3 and Appendix B and notes that some State or Federal permitting and certification activities could affect NRC license renewal. In appropriate circumstances (not present here), construction of water intake structures, access roads, or rail spurs may be required for the NRC to issue a renewed license. In such instances, some nuclear power plant construction activities may require a license amendment and an environmental review by the NRC. However, no such activities have been identified for Oconee Station SLR.

2 ALTERNATIVES INCLUDING THE PROPOSED ACTION

The NRC's decision-making authority in license renewal is limited to deciding whether to renew a nuclear power plant's operating license; the agency's implementation of NEPA (42 U.S.C. 4321 et seq.; TN661), requires consideration of the environmental impacts of potential alternatives to renewing a nuclear power plant's operating license. Although the ultimate decision on which alternative (or the proposed action) to carry out falls to the nuclear plant owner, State, or other non-NRC Federal officials, comparing the environmental impacts of renewing the operating license to the environmental impacts of alternatives allows the NRC to determine whether the environmental impacts of license renewal are so great that it would be unreasonable for the agency to preserve the option of license renewal for energy planning decisionmakers (10 CFR Part 51.71(d) footnote 3; TN250).

Ultimately, energy planning decisionmakers and utility owners decide whether the nuclear power plant will continue to operate, and economic and environmental considerations play important roles in this decision. In general, the NRC's responsibility is to ensure the safe operation of nuclear power facilities, not to formulate energy policy or promote nuclear power, or encourage or discourage the development of alternative power generation. The NRC does not engage in energy planning decisions, and it makes no judgment as to which replacement energy alternatives would be the most likely alternative selected in any given case.

This chapter describes: (1) the Oconee Station nuclear power plant site and its operation, (2) the proposed action (subsequent renewal of the Oconee Station operating licenses), (3) reasonable alternatives to the proposed action (including the no-action alternative), and (4) alternatives eliminated from detailed study.

2.1 Description of Nuclear Power Plant Facility and Operation

The physical presence of Oconee Station buildings and facilities, as well as the nuclear power plant's operations, are integral to creating the environment that currently exists at and around the site. This section describes certain nuclear power plant operating systems and certain nuclear power plant infrastructure, operations, and maintenance.

2.1.1 External Appearance and Setting

Oconee Station is in Oconee County in northwestern South Carolina, approximately 8 mi (13 km) northeast of Seneca, South Carolina, at latitude 34°-47'-38.2" North and longitude 82°-53'- 55.4" West. As shown in Figure 2-1, Oconee Station is situated on the shore of Lake Keowee. Lake Keowee was formed by impounding the waters of the Little River and the Keowee River. Duke Energy's Lake Keowee occupies the area immediately north and west of the site. The United States Army Corps of Engineer's Hartwell Reservoir is south of the site. Duke Energy's Lake Jocassee lies approximately 11 mi (17.7 km) to the north (Duke Energy 2021-TN8897).

As shown in Figure 2-2, the principal Oconee Station structures are the reactor containment buildings for Units 1, 2, and 3; auxiliary building; turbine building; independent spent fuel storage installation (ISFSI), meteorology towers, and service building, as well as 525-kV and 230-kV switchyards (Duke Energy 2021-TN8897).

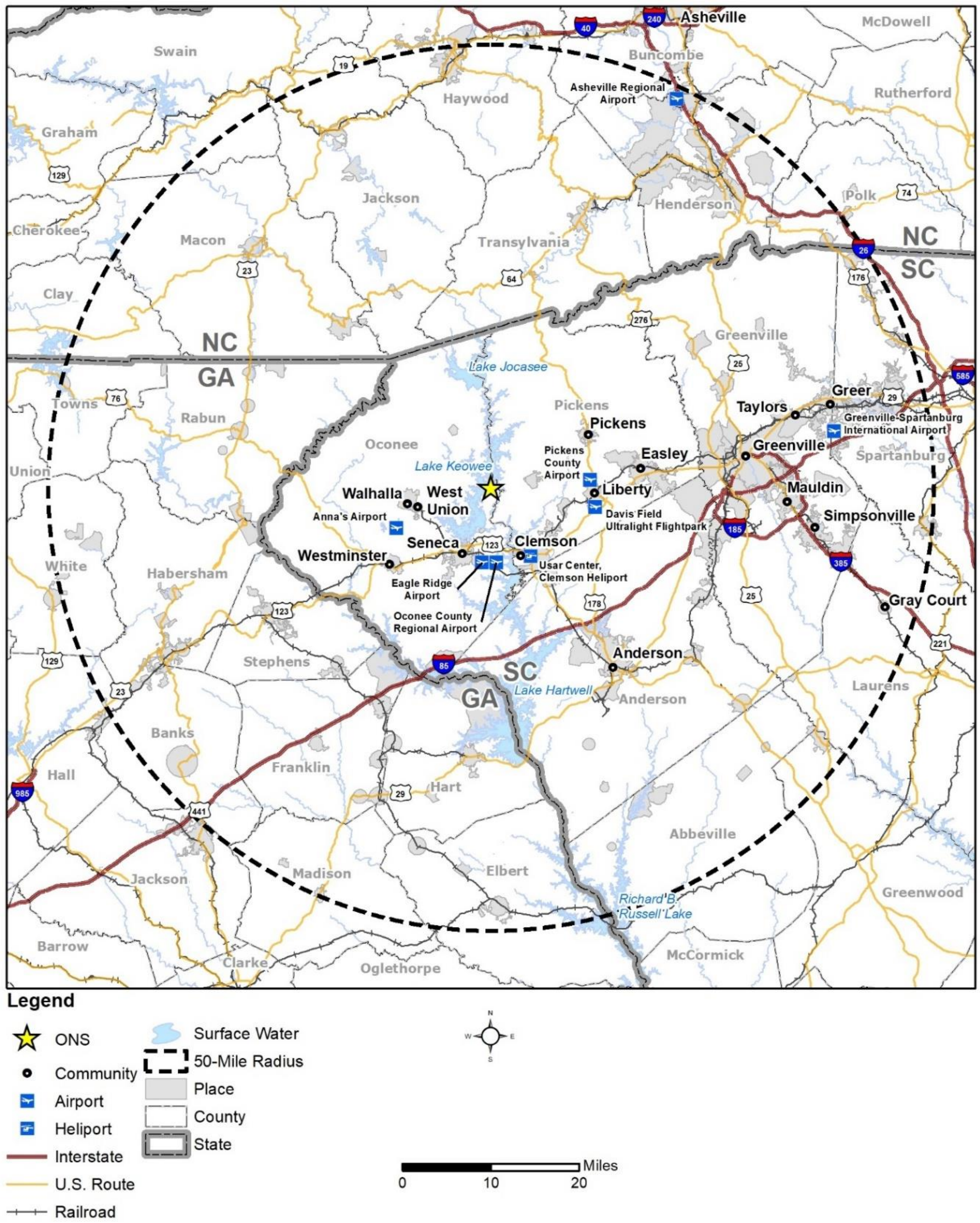

Figure 2-1 Oconee Station 50-mi (80-km) Radius Map. Source: Duke Energy 2021-TN8897.

The land surrounding Oconee Station is mostly forested with some cropland and pasture. The open waters of Lake Keowee are the predominant geographic feature and shoreline is developed with private residences and recreation (Duke Energy 2021-TN8897).

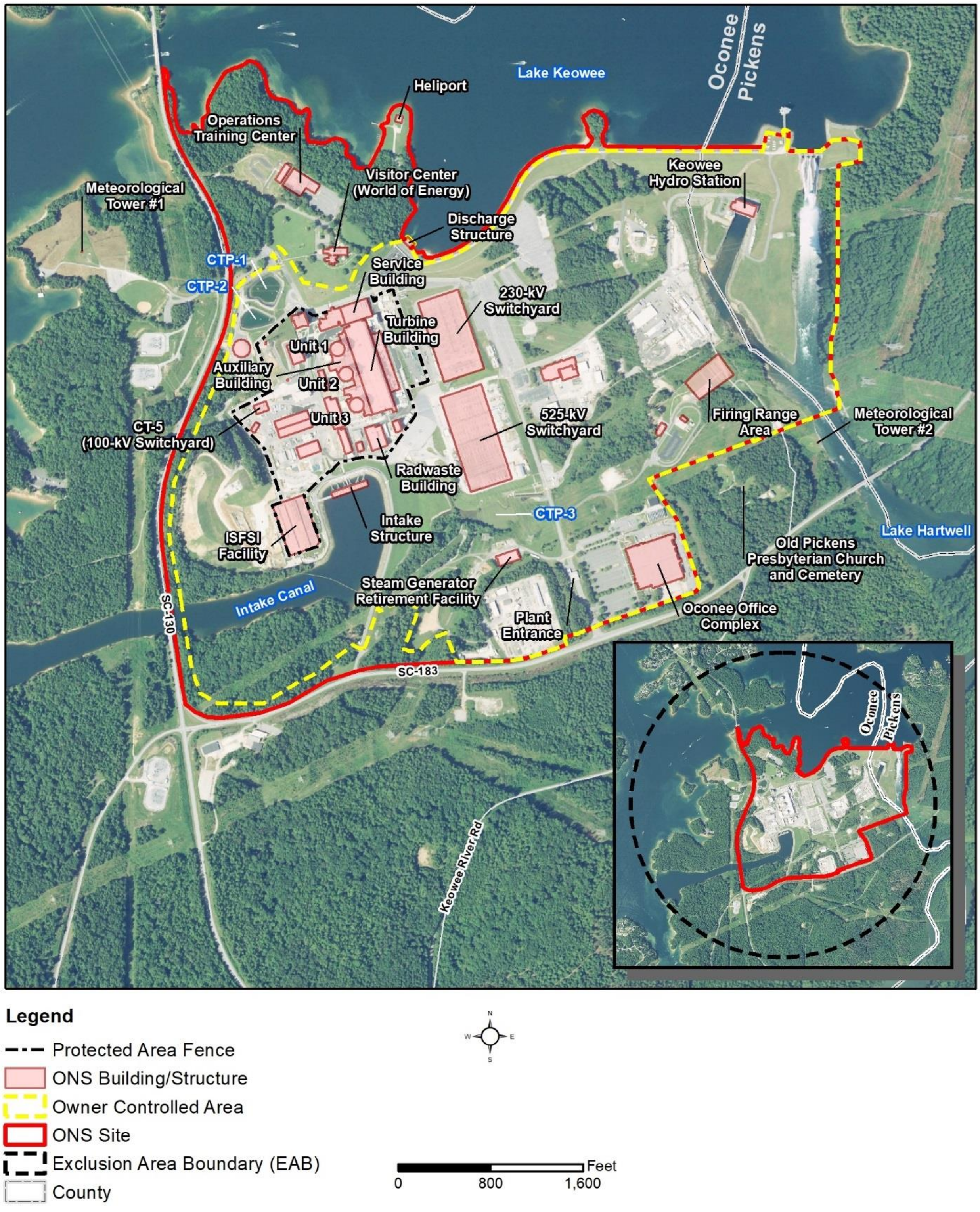

Figure 2-2 Oconee Station Layout and Surrounding Features. Source: Duke Energy 2021-TN8897.

2.1.2 Nuclear Reactor Systems

Oconee Station units are Babcock & Wilcox pressurized water reactors with dry containments (steel lined and reinforced concrete). The NRC issued the original Oconee Station Unit 1 operating license on February 6, 1973, the Unit 2 operating license on October 6, 1973, and the Unit 3 operating license on July 19, 1974. All three units received their first renewed licenses on May 23, 2000. The nuclear reactors produce a nominal core power rating of 2,568 megawatts thermal (MWt) for each unit (Duke Energy 2021-TN8897).

Oconee Station uses low-enriched uranium dioxide (limited to 5 percent by weight uranium-235) fuel sealed in zirconium alloy of M5 clad fuel rods. Refueling occurs about every 24 months (Duke Energy 2021-TN8897).

2.1.3 Cooling and Auxiliary Water Systems

Section 2.2.3 of Duke Energy's ER provides a detailed description of Oconee Station's cooling and auxiliary water systems, including the condenser circulating water system, emergency core cooling system, component cooling system, high- and low-pressure service water systems, recirculated cooling water system, protected service water system, and associated subsystems. Section 2.2.3 also describes the nuclear power plant's thermal effluent discharge to surface waters (Duke Energy 2021-TN8897: Appendix E, Section 2.2.3, pp. 2-5–2-10). The NRC staff incorporates this information here by reference. Except as otherwise cited for clarity, the staff summarizes below the information incorporated here by reference and considers any new and potentially significant information since the NRC staff issued NUREG-1437, Supplement 2 (NRC 1999-TN8942).

Pressurized-water reactors, such as Oconee Station, heat water to a high temperature under pressure inside the reactor. This type of steam and power conversion system uses three heat transfer (exchange) loops. Section 3.1.2 of NUREG–1437, *Generic Environmental Impact Statement for License Renewal of Nuclear Power Plants* (known as the LR GEIS), describes this process (NRC 2013-TN2654). Oconee Station uses a once-through cooling loop (circulating water system) to dissipate heat from the turbine condensers. Figure 2-3 provides a basic schematic diagram of this system.

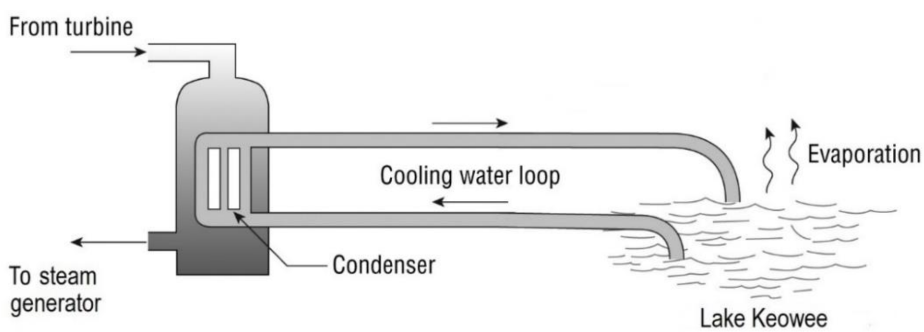

Figure 2-3 Once-through Cooling Water System with Lake Water Source. Adapted from NRC 2013-TN2654, Fig. 3.1-4.

2.1.3.1 Cooling Water Intake and Discharge

The nuclear power plant's condenser circulating water system is the principal, direct interface with the hydrologic environment during normal operating conditions. This system also normally supplies water to various other nuclear power plant cooling systems. The principal components of this water intake system include a skimmer wall, intake canal, submerged dam, and intake structure and associated equipment.

Oconee Station withdraws cooling water from the Little River arm of Lake Keowee from underneath the skimmer wall, which extends across the entrance to Oconee Station's intake canal. This entrance was a natural cove that was deepened and extended during nuclear power plant construction to form the mouth of the intake canal. The intake canal has a total length of approximately 1 mi (1.6 km). The skimmer wall extends from just above the surface of the water (i.e., 800 ft [244 m] mean sea level [MSL]) at the lake's full pond elevation) to a depth of 65 ft (20 m) below the water surface, so that only cooler water from near the bottom of the lake enters the intake canal. In addition, a submerged dam (weir) structure is located approximately 850 ft (259 m) downstream of the skimmer wall to retain water in the intake canal, in the interval between the weir and Oconee Station's intake structure. This emergency pond of water would serve as a source of cooling water if the water supply from Lake Keowee (i.e., the ultimate heat sink) were to be lost. This impounded water can be recirculated through the condensers and back to the intake canal for decay heat removal so long as water remains in the intake canal.

Water flows down the length of the intake canal toward the intake structure. A trash boom extends across the canal at a point 900 ft (270 m) upstream of the intake structure. The boom is angled to direct large floating debris to the shoreline and away from the intake structure and its 24 intake bays.

In the intake structure, water entering the intake bays first passes through trash racks where the bars are spaced 5.5 in. (14 cm) apart. After the trash racks, the intake water passes through a set of two fixed screens. These screens have ⅜ in. (0.95 cm) mesh openings. The screens are equipped with a differential pressure alarm to warn of debris buildup. As necessary, Duke Energy personnel manually lift the screens and clean them with a high-pressure wash.

The 12 condenser circulating water intake pumps (four pumps serving each unit) that are housed in the intake structure supply water through conduits to a common condenser intake header. Each of Oconee Station's 12 circulating water pumps are rated at 177,000 gallons per minute (gpm) (670,000 liters per minute [Lpm]). The number of pumps in operation is seasonally dependent, ranging from four pumps per unit in the summer to two pumps per unit in the winter.

In the event of a power loss and loss of the circulating water pumps, the nuclear power plant's emergency condenser circulating water system is automatically initiated and operates as an unassisted siphon system, supplying sufficient water to the condenser for decay heat removal and emergency cooling requirements. Upon activation, an emergency discharge pipeline is opened that redirects water from each of the three nuclear power plant condensers to the Keowee Hydro Station's tailrace (Duke Energy 2019-TN8943, Duke Energy 2021-TN8897).

In addition to the circulating water pumps housed in the intake structure, Oconee Station also maintains a dedicated emergency pump (i.e., the B5B pump). This pump is used to satisfy the requirements imposed by NRC Order EA-02-026, which was codified in the NRC's regulations at 10 CFR 50.54(hh); 50.155(b) (TN249). The B5B pump's rated capacity is 1,500 gpm (5,700 Lpm).

In total, Oconee Station's peak (design) surface water withdrawal rate is 2,125,500 gpm (8.04 million Lpm). This rate is equivalent to approximately 3,060 million gallons per day (mgd) (11,600 million liters per day [mLd]). Section 3.5.1.2 of this site-specific EIS summarizes Oconee Station's actual (measured) surface water withdrawals over the last 5 years and permit limits.

The heated circulating water from the nuclear power plant's main condensers and other sources of non-contact cooling water are discharged back to Lake Keowee through the nuclear power plant's discharge structure (see Figure 2-2). This discharge point is designated as Outfall 001 under Duke Energy's National Pollutant Discharge Elimination System (NPDES) permit for Oconee Station, as further discussed in Section 3.5.1.3 of this EIS.

2.1.3.2 Well Water Supply System

No onsite groundwater is withdrawn for domestic (potable) or other uses at Oconee Station. Potable water is supplied by the city of Seneca public system. Its source is Lake Keowee. Historically, onsite wells were used to supply various, non-potable needs across the Oconee Station site. Duke Energy reports that these wells have not been used within the last 10 years and all have either been abandoned or are being assessed for abandonment. However, Duke Energy does periodically operate three groundwater drawdown wells and one groundwater recovery well. Section 3.5.2.2 of this site-specific EIS further discusses these wells and associated groundwater withdrawals.

2.1.4 Radioactive Waste Management Systems

Section 2.2.6 of Duke Energy's ER, submitted as part of its SLR application, provides an expanded description of Oconee Station's radioactive waste management systems (Duke Energy 2021-TN8897: Appendix E, Section 2.2.6, pp. 2-13 to 2-30). The NRC staff incorporates this information here by reference. Except as otherwise cited for clarity, the staff summarizes the information incorporated here by reference below.

The NRC licenses nuclear power plants with the expectation that they will release radioactive material to both the air and water during normal operations. However, NRC regulations require that gaseous and liquid radioactive releases from nuclear power plants meet radiation dose-based limits specified in 10 CFR Part 20 (TN283), "Standards for Protection Against Radiation," and the as low as reasonably achievable (ALARA) criteria in 10 CFR Part 50 (TN249), Appendix I, "Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion 'As Low as is Reasonably Achievable' for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents." In other words, the NRC places regulatory limits on the radiation dose that members of the public can receive from radioactive effluents of a nuclear power plant. For this reason, all nuclear power plants use radioactive waste management systems to control and monitor radioactive wastes.

Oconee Station uses the liquid, gaseous, and solid waste management systems to collect and process radioactive materials and waste produced as a byproduct of nuclear power plant operations. Liquid waste disposal systems are used to collect, hold, treat, monitor, dispose, and record the liquid effluent. The gaseous wastes disposal systems are used to collect, hold (if necessary), filter, monitor, and record the gaseous effluent. Duke Energy built an interim radioactive waste facility to accommodate the greater gaseous and liquid waste volume than was originally anticipated. The four holdup tanks are the only equipment being used in the interim radioactive waste facility. The holdup tanks are used for the decay of gaseous waste. Oconee Station built a separate radioactive waste facility to handle the increased liquid wastes. Solid wastes are stored, packaged, and shipped offsite. Solid waste is comprised of reactor components, equipment, and tools that have been removed from service, contaminated protective clothing, paper, rags, and other trash generated from nuclear power plant design, operations modifications, routine maintenance activities, and non-fuel solid waste. Non-fuel solid waste consists of the treatment and separation of radionuclides from gases and liquids, in addition to contaminated materials from various reactor areas (Duke Energy 2021-TN8897: Appendix E, p. 2-15).

The waste disposal system outside containment is common to all three units. The waste disposal systems can process the waste produced by continuous operation of the systems, assuming that the fission products escape to the reactor coolant by diffusion through defects in the cladding of 1 percent of the fuel rods. These radioactive waste management systems assure that the dose to members of the public from radioactive effluents is reduced to ALARA levels in accordance with NRC regulations (Duke Energy 2021-TN8897).

Duke Energy maintains a radiological environmental monitoring program (REMP) to assess the radiological impact, if any, to the public and the environment from radioactive effluents released during operations at Oconee Station (Duke Energy 2021-TN8897). The REMP is discussed in Section 2.1.4.5 of this EIS.

Duke Energy has an Offsite Dose Calculation Manual (ODCM) that contains the methods and parameters for calculating offsite doses resulting from liquid and gaseous radioactive effluents. These methods ensure that radioactive material discharges from Oconee Station meet NRC and U.S. Environmental Protection Agency (EPA) regulatory dose standards. The ODCM also contains the requirements for the REMP (Duke Energy 2023-TN8947).

2.1.4.1 Radioactive Liquid Waste Management

Duke Energy uses waste management systems to collect, analyze, and process radioactive liquids produced at Oconee Station. These systems reduce radioactive liquids before they are released to the environment. The Oconee Station liquid waste disposal system meets the design objectives of 10 CFR Part 50 (TN249), Appendix I, and controls the processing, disposal, and release of radioactive liquid wastes.

Radioactive liquid wastes are collected in storage tanks in the Auxiliary Building according to the liquid waste source and process train. The waste is then transferred to the Radwaste Facility for processing by filtration, demineralization, or both, to separate impurities for final disposal. The redesigned Auxiliary Building coolant treatment header aids the processing of liquid wastes from high-activity waste tanks, low-activity waste tanks, and the miscellaneous waste holdup tanks in the Radwaste Facility. Based on analysis, wastewater is continuously monitored and controlled and is either reprocessed or released (Duke Energy 2021-TN8897: Appendix E, Section 2.2.6.1).

The liquid waste disposal system was designed to receive, process, and discharge potentially radioactive liquid waste. Holdup capacity is provided for retention of liquid effluents, particularly where unfavorable environmental conditions can be expected to require operational limitations upon the release of radioactive effluents to the environment. Radioactive fluids entering the waste disposal system are processed or collected in tanks until a determination of subsequent treatment can be made. The waste is sampled and analyzed to determine the quantity of radioactivity. Liquid wastes are processed as required and then released under controlled conditions. In summary, the liquid waste effluent is diluted as necessary to permissible concentration limits. Waste released from the three units is integrated and controlled by process radiation monitors, interlocks, and by the operator, to ensure that it does not exceed the station release limits.

All liquid wastes are monitored prior to release to ensure that they will not exceed the limits of 10 CFR Part 20 (TN283). The radiation monitoring system monitors the effluent, closing the discharge valve if the amount of radioactive material in the effluent exceeds preset values. Duke Energy performs offsite dose calculations based on effluent samples obtained at this release point to ensure that the limits of 10 CFR Part 50 (TN249), Appendix I are not exceeded. The ODCM prescribes the alarm/trip setpoints for the liquid effluent radiation monitors. Duke Energy's use of these radiological waste systems and the procedural requirements in the ODCM provides assurance that the dose from radiological liquid effluents at Oconee Station complies with NRC and EPA regulatory dose standards. Duke Energy calculates dose estimates for members of the public using radiological liquid effluent release data.

Duke Energy's annual radioactive effluent release reports contain a detailed presentation of liquid effluents released from Oconee Station and the resultant calculated doses (Duke Energy 2021-TN8897). These reports are publicly available on the NRC's website (https://www.nrc.gov/).

The NRC staff reviewed 5 years of radioactive effluent release data from 2018 through 2022 (Duke Energy 2019-TN8943, Duke Energy 2020-TN8944, Duke Energy 2021-TN8945, Duke Energy 2022-TN8946, Duke Energy 2023-TN8947). A 5-year period provides a dataset that covers a broad range of activities that occur at a nuclear power plant, such as refueling outages, routine operation, and maintenance, which can affect the generation of radioactive effluents into the environment. The NRC staff compared the data against NRC dose limits and looked for indications of adverse trends (i.e., increasing dose levels or increasing radioactivity levels).

As discussed below, effluent release data for the 5-year period analyzed by the NRC staff were found to be well below regulatory standards. For example, the calculated doses from radioactive liquid effluents released from Oconee Station during 2022 (Duke Energy 2023-TN8947) are summarized below:

<u>Oconee Station Unit 1 in 2022</u>

- The total-body dose to an offsite member of the public from Oconee Station Unit 1 radioactive effluents was 6.93×10^{-2} millirem (mrem) (6.93×10^{-4} millisievert [mSv]), which is well below the 3 mrem (0.03 mSv) dose criterion in Appendix I to 10 CFR Part 50 (TN249).
- The maximum organ dose (gastrointestinal tract) to an offsite member of the public from Oconee Station Unit 1 radioactive effluents was 6.93×10^{-2} mrem (6.93×10^{-4} mSv), which is well below the 10 mrem (0.1 mSv) dose criterion in Appendix I to 10 CFR Part 50.

<u>Oconee Station Unit 2 in 2022</u>

- The total-body dose to an offsite member of the public from Oconee Station Unit 2 radioactive effluents was 6.93×10^{-2} mrem (6.93×10^{-4} mSv), which is well below the 3 mrem (0.03 mSv) dose criterion in Appendix I to 10 CFR Part 50.
- The maximum organ dose (gastrointestinal tract) to an offsite member of the public from Oconee Station Unit 2 radioactive effluents was 6.93×10^{-2} mrem (6.93×10^{-4} mSv), which is well below the 10 mrem (0.1 mSv) dose criterion in Appendix I to 10 CFR Part 50.

<u>Oconee Station Unit 3 in 2022</u>

- The total-body dose to an offsite member of the public from Oconee Station Unit 3 radioactive effluents was 6.93×10^{-2} mrem (6.93×10^{-4} mSv), which is well below the 3 mrem (0.03 mSv) dose criterion in Appendix I to 10 CFR Part 50.

- The maximum organ dose (gastrointestinal tract) to an offsite member of the public from Oconee Station Unit 3 radioactive effluents was 6.93×10^{-2} mrem (6.93×10^{-4} mSv), which is well below the 10 mrem (0.1 mSv) dose criterion in Appendix I to 10 CFR Part 50.

In the values cited above, the NRC staff divided Duke Energy's reported total-body and maximum organ liquid effluent doses for the entire facility evenly among Units 1, 2, and 3. This was done to attribute the approximate dose contribution to each of the licensed nuclear units. The NRC staff's review of Duke Energy's radioactive liquid effluent control program shows that radiation doses to members of the public were maintained within NRC and EPA radiation protection standards, as contained in Appendix I to 10 CFR Part 50 (TN249), 10 CFR Part 20 (TN283), and Title 40, "Protection of Environment," of the 40 CFR Part 190 (TN739), "Environmental Radiation Protection Standards for Nuclear Power Operations." The NRC staff observed no adverse trends in the dose levels.

During the SLR term, Duke Energy will continue to perform routine nuclear power plant refueling and maintenance activities. Based on Duke Energy's past performance in operating a radioactive waste system at Oconee Station that maintains ALARA doses from radioactive liquid effluents, the NRC staff expects that Duke Energy will maintain similar performance during the SLR term.

2.1.4.2 Radioactive Gaseous Waste Management

Radioactive gaseous wastes develop from gases in liquid contained in tanks and piping at Oconee Station. The gaseous wastes are monitored and released at an acceptable rate designated by the ODCM. The ODCM determines the effluent release rate to ensure that releases are within predetermined limits, which ensures compliance with dose limitations of licensee commitments. Oconee Station Units 1 and 2 share a Gaseous Waste Disposal System. Oconee Station Unit 3 has a separate system that can be interconnected with the Unit 1 and Unit 2 systems. The Gaseous Disposal Systems maintain a non-oxidizing cover gas of nitrogen in tanks and equipment that may contain radioactive gas. These systems also provide for holdup gas decay, and they release the gases under controlled conditions.

Duke Energy calculates dose estimates for members of the public based on radioactive gaseous effluent release data and atmospheric transport models. Duke Energy's annual radioactive effluent release reports present in detail the radiological gaseous effluents released from Oconee Station and the resultant calculated doses. As described above in Section 2.1.4.1, the NRC staff reviewed 5 years of radioactive effluent release data from the 2018 through 2022 reports (Duke Energy 2019-TN8943, Duke Energy 2020-TN8944, Duke Energy 2021-TN8945, Duke Energy 2022-TN8946, Duke Energy 2023-TN8947). The NRC staff compared the data against NRC dose limits and looked for indications of adverse trends (i.e., increasing dose levels) over the period.

As discussed below, effluent release data for the 5-year period analyzed by the NRC staff were found to be well below regulatory standards. For example, the calculated doses from radioactive gaseous effluents released from Oconee Station during 2022 (Duke Energy 2023-TN8947) are summarized below:

<u>Oconee Station Unit 1 in 2022</u>

- The air dose due to noble gases with resulting gamma radiation in gaseous effluents was 1.24×10^{-4} millirad (mrad) (1.24×10^{-6} milligray), which is well below the 10 mrad (0.1 milligray) dose criterion in Appendix I to 10 CFR Part 50 (TN249).

- The air dose from beta radiation in gaseous effluents was 1.01 × 10^{-4} mrad (1.01 × 10^{-6} milligray), which is well below the 20 mrad (0.2 milligray) dose criterion in Appendix I to 10 CFR Part 50.
- The critical organ dose to an offsite member of the public from radiation in gaseous effluents as a result of iodine-131, iodine-133, hydrogen-3, and particulates with greater than 8-day half-lives was 1.02 × 10^{-1} mrem (1.02 × 10^{-3} mSv), which is below the 15 mrem (0.15 mSv) dose criterion in Appendix I to 10 CFR Part 50.

Oconee Station Unit 2 in 2022

- The air dose due to noble gases with resulting gamma radiation in gaseous effluents was 1.24 × 10^{-4} mrad (1.24 × 10^{-6} milligray), which is well below the 10 mrad (0.1 milligray) dose criterion in Appendix I to 10 CFR Part 50.
- The air dose from beta radiation in gaseous effluents was 1.01 × 10^{-4} mrad (1.01 × 10^{-6} milligray), which is well below the 20 mrad (0.2 milligray) dose criterion in Appendix I to 10 CFR Part 50.
- The critical organ dose to an offsite member of the public from radiation in gaseous effluents as a result of iodine-131, iodine-133, hydrogen-3, and particulates with greater than 8-day half-lives was 1.02 × 10^{-1} mrem (1.02 × 10^{-3} mSv), which is below the 15 mrem (0.15 mSv) dose criterion in Appendix I to 10 CFR Part 50.

Oconee Station Unit 3 in 2022

- The air dose due to noble gases with resulting gamma radiation in gaseous effluents was 1.24 × 10^{-4} mrad (1.24 × 10^{-6} milligray), which is well below the 10 mrad (0.1 milligray) dose criterion in Appendix I to 10 CFR Part 50.
- The air dose from beta radiation in gaseous effluents was 1.01 × 10^{-4} mrad (1.01 × 10^{-6} milligray), which is well below the 20 mrad (0.2 milligray) dose criterion in Appendix I to 10 CFR Part 50.
- The critical organ dose to an offsite member of the public from radiation in gaseous effluents as a result of iodine-131, iodine-133, hydrogen-3, and particulates with greater than 8-day half-lives was 1.02 × 10^{-1} mrem (1.02 × 10^{-3} mSv), which is below the 15 mrem (0.15 mSv) dose criterion in Appendix I to 10 CFR Part 50.

In the values cited above, Duke Energy’s reported air dose due to noble gases, air dose from beta radiation, and critical organ dose for the entire facility were divided evenly among Units 1, 2, and 3. This was done by the NRC staff to attribute the approximate dose contribution to each of the licensed nuclear units. The NRC staff’s review of Oconee Station’s radioactive gaseous effluent control program showed radiation doses to members of the public that were well below NRC and EPA radiation protection standards contained in Appendix I to 10 CFR Part 50 (TN249), 10 CFR Part 20 (TN283), and 40 CFR Part 190 (TN739). The NRC staff observed no adverse trends in the dose levels over the 5 years reviewed.

During the SLR term, Duke Energy will continue to perform routine nuclear power plant refueling and maintenance activities. Based on Duke Energy’s past performance in operating a radioactive waste system at Oconee Station that maintains ALARA doses from radioactive gaseous effluents, the NRC expects that Oconee Station will maintain similar performance during the SLR term.

2.1.4.3 Radioactive Solid Waste Management

Oconee Station's solid waste disposal system provides for packaging and/or solidification of radioactive waste that will subsequently be shipped offsite to an approved burial facility. These activities reduce the amount of waste shipped for offsite disposal. Solid radioactive wastes are logged, processed, packaged, and stored for subsequent shipment and offsite burial. Solid radioactive wastes and potentially radioactive wastes include reactor components, equipment and tools removed from service, chemical laboratory samples, spent resins, used filter cartridges, and radioactively contaminated hardware, as well as compacted wastes such as contaminated protective clothing, paper, rags, and other trash generated from nuclear power plant design modifications and operations, and routine maintenance activities. In addition, nonfuel solid wastes result from treating and separating radionuclides from gases and liquids, and from removing containment material from various reactor areas.

2.1.4.4 Radioactive Waste Storage

At Oconee Station, low-level radioactive waste (LLRW) is stored temporarily onsite at a low-level waste storage facility before being shipped offsite for processing or disposal at licensed LLRW treatment and disposal facilities. Energy Solutions is the processing and disposal facility Oconee Station uses. The LLRW is classified as Class A, Class B, or Class C (minor volumes are classified as greater than Class C). Class A includes both dry active waste and processed waste (e.g., dewatered resins). Classes B and C normally include a low percentage of the LLRW generated. Radioactive waste that is greater than Class C waste is the responsibility of the Federal Government. Low-level mixed waste is managed and transported to an Energy Solutions licensed vendor under the “green is clean” program. As indicated in Duke Energy's ER and discussed with NRC staff at the virtual audit, Oconee Station has sufficient existing capability to store all generated LLRW onsite. No additional construction of onsite storage facilities is necessary for LLRW storage during the subsequent period of extended operation.

Oconee Station Units 1, 2, and 3 each store spent fuel in a spent fuel pool and in two onsite ISFSIs. The ISFSIs safely store spent fuel onsite in licensed and approved dry cask storage containers. The original ISFSI is operated under a site-specific ISFSI license (No. SNM-2503) per 10 CFR Part 72, Subpart B, and the second ISFSI is operated under the Oconee Station license per 10 CFR Part 72, Subpart K. The possible need to expand the size of the ISFSI would depend on the U.S. Department of Energy's (DOE) future performance of its obligation to accept spent nuclear fuel, or the availability of other interim storage options. Per the Oconee Station ER, the ISFSI may need to be expanded during the SLR period of extended operation. If the ISFSI expansion were needed, Duke Energy expects that there is enough land area available for expansion within the site boundary of the existing facility (Duke Energy 2021-TN8897, Section 3.1.4). During the audit, the licensee stated that expanding the ISFSI would cause no significant environmental impact. Currently, Oconee Station has not proposed the installation of additional spent fuel storage pads to the current ISFSI area to support SLR. If future changed circumstances require the installation of additional spent fuel storage pads, then this would be subject to a separate NEPA review. Therefore, the staff does not consider expansion of the ISFSI in this EIS. The NRC staff notes, however, that the impacts of onsite storage of spent nuclear fuel during the period of extended operation have been determined to be SMALL, as stated in 10 CFR Part 51 (TN250), Appendix B, Table B-1; see also NUREG-2157, *Generic Environmental Impact Statement for Continued Storage of Spent Nuclear Fuel* (NRC 2014-TN4117).

2.1.4.5 Radiological Environmental Monitoring Program

Duke Energy maintains a REMP to assess the radiological impact, if any, to the public and the environment from Oconee Station operations.

The REMP measures the aquatic, terrestrial, and atmospheric environment for ambient radiation and radioactivity. Monitoring is conducted for the following: direct radiation, air, precipitation, well water, river water, surface water, milk, food products and vegetation (such as edible broad leaf vegetation), fish, silt, and shoreline sediment. The REMP also measures background radiation (i.e., cosmic sources, global fallout, and naturally occurring radioactive material, including radon).

In addition to the REMP, Duke Energy established an Oconee Station onsite groundwater protection initiative program in accordance with Nuclear Energy Institute (NEI) 07-07, “Industry Groundwater Protection Initiative” (NEI 2007-TN1913). This program monitors the onsite nuclear power plant environment to detect leaks from nuclear power plant systems and pipes containing radioactive liquid. Section 3.5.2.3, “Groundwater Quality,” of this site-specific EIS contains information on Oconee Station’s groundwater protection initiative program. Since implementing the groundwater protection initiative program, the groundwater monitoring network at Oconee Station has expanded and, at the time of the ER publication, consists of 63 onsite monitoring wells (Duke Energy 2021-TN8897). As part of the REMP program, Duke Energy conducts analyses of selected wells for the presence of gamma emitters, tritium, and difficult-to-detect radionuclides in groundwater on a quarterly, semi-annual, or annual basis.

Section 3.5.2.3 describes the results from groundwater sampling. During the 2020 sampling period, tritium was detected in groundwater at concentrations well below the EPA-established safe drinking water maximum contaminant level of 20,000 picocuries per liter (pCi/L) (Duke Energy 2023-TN8947). In addition, no gamma or difficult-to-detect radionuclides were detected in the groundwater between 2014 and October 2020 (Duke Energy 2021-TN8897).

Section 3.5.2.3 of this site-specific EIS also contains a more complete description of the groundwater protection program and a historical description of tritium and other radionuclides monitoring in groundwater at the site.

Based on its review of the information on groundwater quality presented in Section 3.6.4.2 of the ER (Duke Energy 2021-TN8897: Appendix E), as summarized in Section 3.5 of this EIS, the staff determined that over the period of extended operation, potential groundwater contamination would likely remain onsite and no offsite wells should be affected. Oconee Station has implemented a groundwater protection program to identify and monitor leaks through the installed monitoring well network. With a robust sampling strategy, potential future releases of tritium into the groundwater would be readily detected.

The NRC staff reviewed 5 years of annual radiological environmental monitoring data from 2018 through 2022 (Duke Energy 2019-TN8943, Duke Energy 2020-TN8944, Duke Energy 2021-TN8945, Duke Energy 2022-TN8946, Duke Energy 2023-TN8947). A 5-year period provides a dataset that covers a broad range of activities that occur at a nuclear power plant, such as refueling outages, routine operation, and maintenance that can affect the generation and release of radioactive effluents into the environment. The NRC staff looked for indications of adverse trends (i.e., increasing radioactivity levels) over the period of 2018 through 2022.

Based on its review of the REMP and inadvertent release data, the NRC staff finds no apparent increasing trend in concentration or pattern indicating either a new inadvertent release or persistently high tritium or other radionuclide concentration that might indicate an ongoing inadvertent release from Oconee Station. The groundwater monitoring program data at Oconee Station show that Duke Energy monitors, characterizes, and actively remediates spills, and that there were no significant radiological impacts to the environment from operations at Oconee Station.

2.1.5 Nonradioactive Waste Management Systems

Section 2.2.7 of Duke Energy's ER provides an expanded description of Oconee Station's nonradioactive waste management systems (Duke Energy 2021-TN8897, Section 2.2.7, 2-20 – 2-27). The NRC staff incorporates this information here by reference. Except as otherwise cited for clarity, the staff summarizes below the information incorporated here by reference and considers any new and potentially significant information since the NRC staff issued NUREG-1437, Supplement 2 (NRC 1999-TN8942).

As any other industrial facility, nuclear power plants generate wastes that are not contaminated with either radionuclides or hazardous chemicals. Oconee Station generates nonradioactive waste as a result of nuclear power plant maintenance, cleaning, and operational processes. Oconee Station manages nonradioactive wastes in accordance with applicable Federal and State regulations, as implemented through its corporate procedures. Oconee Station generates and manages the following types of nonradioactive wastes:

Hazardous Wastes: Oconee Station is classified by the EPA and the South Carolina Department of Health and Environmental Control (SCDHEC) as a small-quantity hazardous waste generator. The amounts of hazardous wastes generated are only a small percentage of the total wastes generated. These generally consist of paint wastes, spent and off-specification (e.g., shelf-life expired) chemicals, gun cleaning rags with lead residue, and occasional project-specific wastes. Table 2.2-2 in the ER provides a list of the amounts of hazardous waste (Duke Energy 2021-TN8897: Appendix E).

Nonhazardous Wastes: These generally include asbestos insulation and other asbestos-containing materials, lead material, nonhazardous used paint and solvents, batteries, expired shelf-life chemicals, grout and/or concrete, construction demolition debris, sand blasting and metal blasting materials, lamps, paper and office debris, water treatment room products such as used resin and used carbon, laboratory waste material, used oil and grease, cafeteria waste, antifreeze liquids, used refrigerants, scrap metal, scrap wood, used tires and nonradioactive liquid waste. Nonradioactive liquid waste typically comes from the secondary nuclear power plant systems in the turbine building, the water treatment room backwash, and other miscellaneous liquid waste streams. Municipal waste is disposed of at the local permitted solid waste management facility. Table 2.2-2 in the ER provides a list of the amounts of nonhazardous waste (Duke Energy 2021-TN8897: Appendix E).

Universal Wastes: These typically consist of lamps and batteries (Duke Energy 2021-TN8897).

Duke Energy maintains a list of waste vendors that it has approved for use across the entire company to remove and dispose of the identified wastes offsite (Duke Energy 2021-TN8897).

2.1.6 Utility and Transportation Infrastructure

The utility and transportation infrastructure at nuclear power plants typically interfaces with public infrastructure systems available in the region. Such infrastructure includes utilities, such as suppliers of electricity, fuel, and water, as well as roads and railroads that provide access to the site. The following sections briefly describe the existing utility and transportation infrastructure at Oconee Station. Site-specific information in this section is derived from Duke Energy's ER (Duke Energy 2021-TN8897), unless otherwise cited.

2.1.6.1 Electricity

Nuclear power plants generate electricity for other users; however, they also use electricity to operate. Offsite power sources provide power to engineered safety features and emergency equipment in the event of a malfunction or interruption of power generation at the nuclear power plant. Planned independent backup power sources provide power in the event that power is interrupted from both the nuclear power plant itself and offsite power sources.

2.1.6.2 Fuel

Oconee Station operates with low-enriched uranium dioxide fuel. With the NRC approval of Zircaloy-4 and M5 cladding fuel usage, Duke Energy operates the reactor cores to yield an equilibrium cycle (normal cycle) burnup of approximately 20,854 megawatt-days per metric ton uranium (MWd/MTU) for 24 months and maximum burnup rate of 62,000 MWd/MTU. Refueling outages occur on a 58-month cycle for all three units on a staggered schedule, with one fall outage scheduled during odd-numbered years, and spring and fall outages scheduled for even-numbered years. This equates to an effective 24-month refueling schedule for each unit. Duke Energy stores spent fuel in the spent fuel pool in the auxiliary building next to the containment building or in dry cask storage containers at the onsite ISFSI (Duke Energy 2021-TN8897).

2.1.6.3 Water

In addition to cooling and auxiliary water from Lake Keowee, Oconee Station uses potable water supplied by the city of Seneca public water system and Oconee Joint Regional Sewer Authority for sanitary wastewater. In this EIS, Section 2.1.3, "Cooling and Auxiliary Water Systems," describes the Oconee Station cooling and industrial water systems.

2.1.6.4 Transportation Systems

Nuclear power plants are served by controlled access roads that are connected to U.S. highways and Interstate highways. In addition to roads, many nuclear power plants also have railroad connections for moving heavy equipment and other materials. Nuclear power plants located on navigable waters may have facilities to receive and ship loads on barges. Section 3.10.6, "Local Transportation," describes the Oconee Station transportation systems.

2.1.6.5 Power Transmission Systems

For license renewal and subsequent license renewal, the NRC evaluates, as part of the proposed action, the continued operation of those Oconee Station power transmission lines that connect to the substation where it feeds electricity into the regional power distribution system. The transmission lines that are in scope for the Oconee Station SLR environmental review are onsite and are not accessible to the general public (Duke Energy 2021-TN8897). The NRC also considers the continued operation of the transmission lines that supply outside power to the nuclear plant from the grid. Section 3.11.4, "Electromagnetic Fields," describes these transmission lines.

2.1.7 Nuclear Power Plant Operations and Maintenance

Maintenance activities conducted at Oconee Station include inspection, testing, and surveillance to maintain the current licensing basis of the facility and to ensure compliance with environmental and safety requirements (Duke Energy 2021-TN8897). These activities include in-service inspections of safety-related structures, systems, and components; quality assurance and fire protection programs; and radioactive and nonradioactive water chemistry monitoring.

Additional programs include those implemented to meet technical specification surveillance requirements and those implemented in response to NRC generic communications. Such additional programs include various periodic maintenance, testing, and inspection procedures necessary to manage the effects of aging on structures and components. Certain program activities are performed during the operation of the units, whereas others are performed during scheduled refueling outages (Duke Energy 2021-TN8897).

2.2 Proposed Action

As stated in Section 1.1 of this EIS, the NRC's proposed action is to decide whether to renew Oconee Station operating licenses for an additional 20 years. Section 2.2.1 provides a description of normal nuclear power plant operations during the SLR term.

2.2.1 Nuclear Power Plant Operations during the Subsequent License Renewal Term

Nuclear power plant operation activities during the SLR term would be the same as, or similar to, those occurring during the current license term.

Section 2.1, "Description of Nuclear Power Plant Facility and Operation," describes the following general types of activities carried out during nuclear power plant operations:

- reactor operation
- waste management
- security
- office and clerical work; possible laboratory analysis
- surveillance, monitoring, and maintenance
- refueling and other outages

As part of its SLR application, Duke Energy submitted an environmental report. Duke Energy's ER states that Oconee Station will continue to operate during the license renewal term in the same manner as it would during the current license term except for additional aging management programs, as necessary (Duke Energy 2021-TN8897). Such programs would address structure and component aging in accordance with 10 CFR Part 54 (TN4878), "Requirements for Renewal of Operating Licenses for Nuclear Power Plants."

2.2.2 Refurbishment and Other Activities Associated with License Renewal

Refurbishment activities include replacement and repair of major structures, systems, and components. Most major refurbishment activities are actions that would typically take place only once in the life of a nuclear power plant, if at all. For example, replacement of pressurized water reactor steam generator systems is a refurbishment activity. Refurbishment activities may have an impact on the environment beyond those that occur during normal operations and may require evaluation, depending on the type of action and the nuclear power plant-specific design.

In preparation for its subsequent license renewal application, Duke Energy evaluated major structures, systems, and components in accordance with 10 CFR Part 54.21 (TN4878), "Contents of Application—Technical Information," to identify major refurbishment activities necessary for the continued operation of Oconee Station during the proposed 20-year period of extended operation (Duke Energy 2021-TN8897).

Duke Energy did not identify any major refurbishment activities necessary for the continued operation of Oconee Station beyond the end of the existing renewed operating licenses (Duke Energy 2021-TN8897).

2.2.3 Termination of Nuclear Power Plant Operations and Decommissioning after the License Renewal Term

NUREG-0586, Supplement 1, Volumes 1 and 2, *Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities: Regarding the Decommissioning of Nuclear Power Reactors* (the decommissioning GEIS) (NRC 2002-TN665), describes the environmental impacts of decommissioning. The majority of nuclear power plant operations activities would cease with reactor shutdown. Some activities (e.g., security and oversight of spent nuclear fuel) would remain unchanged, whereas others (e.g., waste management, administrative work, laboratory analysis, surveillance, monitoring, and maintenance) would continue at reduced or altered levels. Systems dedicated to reactor operations would cease. However, if these systems are not removed from the site after reactor shutdown, their physical presence may continue to impact the environment. Impacts associated with dedicated systems that remain in place, or with shared systems that continue to operate at normal capacities, could remain unchanged.

Decommissioning could occur whether Oconee Station is shut down at the end of its current renewed operating license or at the end of subsequent license renewal periods of extended operation, 20 years later. The environmental impacts of decommissioning would be similar in either event.

2.3 Alternatives

As stated above, NEPA requires the NRC to consider reasonable alternatives to the proposed action, renewing Oconee Station Units 1, 2, and 3 operating licenses. For a replacement energy alternative to be reasonable, it must be either (1) commercially viable on a utility scale and operational before the reactor's operating license expires or (2) expected to become commercially viable on a utility scale and operational before the reactor's operating license expires.

The first alternative to the proposed action, renewing the Oconee Station operating licenses, is for the NRC to not renew the licenses. This is called the no-action alternative and is described in Section 2.3.1 of this EIS. In addition to the no-action alternative, this section discusses three reasonable replacement energy alternatives. As described in Section 2.3.2, these alternatives seek to replace Oconee Station's generating capacity by meeting the region's energy needs through other means or sources.

2.3.1 No Action Alternative

At some point, all operating nuclear power plants will permanently cease operations and undergo decommissioning. Under the no-action alternative, the NRC does not renew the Oconee Station operating licenses and the reactor units would shut down at or before the expiration of the current renewed licenses on February 6, 2033 (Unit No. 1), October 6, 2033 (Unit No. 2), and July 19, 2034 (Unit No. 3). The NRC expects the impacts to be relatively similar, whether they occur at the end of the current renewed license term (i.e., after 60 years of operation) or at the end of a subsequent renewed license term (i.e., after 80 or more years of operation).

After permanent reactor shutdown, nuclear power plant operators will initiate decommissioning in accordance with 10 CFR 50.82, "Termination of License" (TN249). The decommissioning GEIS (NUREG-0586) (NRC 2002-TN665) describes the environmental impacts from decommissioning a nuclear power plant and related activities. The analysis in the decommissioning GEIS bounds the environmental impacts of decommissioning when Duke Energy terminates reactor operations at Oconee Station. A licensee in decommissioning must assess in its post-shutdown decommissioning activities report submitted to the NRC, whether there are planned decommissioning activities with reasonably foreseeable environmental impacts that are not bounded in previous EISs. Section 3.14.2, "Termination of Plant Operations and Decommissioning," describes the incremental environmental impacts of SLR on decommissioning activities.

Termination of reactor operations would result in the total cessation of electrical power production by Oconee Station. Unlike the replacement energy alternatives described in Section 2.3.2 of this EIS, the no-action alternative does not expressly meet the purpose and need of the proposed action, as described in Section 1.2, because the no-action alternative does not provide a means of delivering baseload power to meet future electric system needs. Assuming that a need currently exists for the electrical power generated by Oconee Station, the no-action alternative would likely create a need for replacement energy.

2.3.2 Replacement Power Alternatives

The following sections describe replacement energy alternatives. The potential environmental impacts of these alternatives are described in Chapter 3. Although NRC's authority only extends to deciding whether to renew Oconee Station Units 1, 2, and 3 operating licenses, the replacement energy alternatives represent possible options for energy-planning decisionmakers may need to consider if the operating licenses are not renewed.

In evaluating replacement energy alternatives, the NRC considered energy technologies in commercial operation, as well as technologies likely to be commercially available by the time the current renewed operating licenses expire. Because energy technologies continually evolve in capability and cost, and because regulatory structures change to either promote or impede the development of certain technologies, the staff's evaluation determined which replacement energy alternatives would be available and commercially viable when the renewed operating licenses expire. The Duke Energy's ER describes possible replacement energy alternatives. In addition, the alternatives considered information from the following sources:

- DOE, Energy Information Administration (EIA)
- other offices within DOE
- EPA
- industry sources and publications

In total, the NRC staff considered 16 replacement power alternatives to the proposed agency action and eliminated 13 of them from the detailed study, leaving three replacement energy alternatives. The three replacement energy alternatives and 13 eliminated alternatives include the following:

- alternatives to the proposed action:
  - new nuclear (advanced light-water reactor and a small modular reactor)
  - natural gas combined-cycle

- combination (solar photovoltaic, offshore wind, small modular reactor, and demand-side management)

- alternatives eliminated from detailed study:
  - solar power alone
  - wind power alone
  - biomass power
  - demand-side management
  - hydroelectric power
  - geothermal power
  - wave and ocean energy
  - municipal solid waste-fired power
  - petroleum-fired power
  - coal-fired power
  - fuel cells
  - purchased power
  - delayed retirement of other power generating facilities

Sections 2.3.2.1 through 2.3.2.3 describe the three replacement energy alternatives. Alternatives that could not provide the equivalent of Oconee Station's current generating capacity and alternatives whose costs or benefits could not justify inclusion in the range of reasonable alternatives were eliminated from detailed study. Alternatives not likely to be constructed and operational by the time the Oconee Station operating licenses expire in 2033 (Units 1 and 2) and 2034 (Unit 3) were also eliminated from detailed study.

To ensure that the replacement energy alternatives are consistent with State or regional energy policies, the NRC reviewed energy-related statutes, regulations, and policies within the Oconee Station region. Accordingly, alternatives that would conflict with these requirements were eliminated from further consideration. Section 2.4 briefly describes the 13 alternatives eliminated from detailed study and provides the basis for each elimination.

As described in Chapter 1, the NRC assigns a significance level of SMALL, MODERATE, or LARGE for most site-specific issues. For ecological resources subject to the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.-TN1010) (ESA) and the Magnuson–Stevens Fishery Conservation and Management Act of 1996, as amended (16 U.S.C. 1801 et seq.-TN7841); and historic and cultural resources subject to the National Historic Preservation Act (54 U.S.C. 300101 et seq.-TN4157), the impact significance determination language is specific to the authorizing legislation. The order in which this EIS presents the different alternatives does not imply increasing or decreasing level of impact; nor does the order imply that an energy-planning decisionmaker would be more (or less) likely to select any given alternative.

Region of Influence

Oconee Station is located on the shore of Lake Keowee in eastern Oconee County, South Carolina, approximately 8 mi (13 km) northeast of the city of Seneca, South Carolina. A small portion of the site extends into neighboring Pickens County. The power station is owned and operated by Duke Energy. Duke Energy is a regulated public utility whose service area covers approximately 24,000 mi^2 (62,000 km^2) across portions of North Carolina and South Carolina (Duke Energy 2021-TN8897). This area constitutes the region-of-influence (ROI) for the analysis of Oconee Station replacement energy alternatives.

In 2020, electric generators in the ROI had a net summer generating capacity of approximately 59,000 megawatts (MW). This capacity included units fueled by natural gas (31 percent), coal (25 percent), nuclear power (20 percent), hydroelectric power (10 percent), and solar pholtaic power (10 percent). Biomass, petroleum, and wind sources comprised the balance of generating capacity in the ROI (EIA 2021-TN8378).The electric industry in the ROI generated approximately 223,000 gigawatt hours of electricity in 2020. This electrical production was dominated by nuclear (44 percent), natural gas (29 percent), and coal power (15 percent). Hydroelectric, solar pholtaic, biomass, wind, and petroleum energy sources collectively fueled the remaining 12 percent of this electricity (EIA 2021-TN8353). In the United States, natural gas-fired generation rose from 16 percent of the total electricity generated in 2000 to 37 percent in 2019 (DOE/EIA 2020-TN7376).

Given known technological and demographic trends, the EIA of the DOE predicts that natural gas fired generation in the United States will remain relatively constant through 2050, whereas electricity generated from renewable energy is expected to double from 21 percent of total generation to 42 percent over that period (EIA 2021-TN8354). However, fossil fuel and renewable energy levels within the Oconee Station ROI may not follow nationwide forecasts, and uncertainties in U.S. energy policies and the energy market could affect forecasts. In particular, the implementation of policies aimed at reducing greenhouse gas emissions could have a direct effect on fossil fuel-based generation technologies (Patel 2018-TN8416). In 2007, North Carolina became the first state in the Southeast to adopt a renewable portfolio standard, which requires investor-owned electric utilities to derive 12.5 percent of their electricity retail sales from renewable energy sources. In 2021, North Carolina passed additional clean energy legislation that requires the State to reduce electricity-related carbon emissions from electric generating facilities 70 percent by 2030, and to reach carbon neutrality by 2050. Although South Carolina does not have a mandatory renewable energy portfolio standard, in 2019 the State passed the South Carolina Energy Freedom Act, which requires utilities to file voluntary renewable energy programs (EIA 2022-TN8955; SCORS 2023-TN9100).The remainder of this section describes three replacement energy alternatives to the proposed action:

- new nuclear alternative (Section 2.3.2.1)
- natural gas combined-cycle alternative (Section 2.3.2.2)
- combination alternative of new nuclear (small modular reactor (SMR)) power, solar photovoltaic, offshore wind power, and demand-side management (Section 2.3.2.3)

Table 2-1 summarizes key characteristics of the replacement energy alternatives.

Table 2-1 Overview of Replacement Energy Alternatives

Alternative	New Nuclear	Natural Gas Combined-Cycle	Combination (Small Modular Reactor, Solar, Offshore Wind, and Demand-Side Management)
Summary	Two ALWR units and one SMR unit for a total of approximately 2,600 MWe	Six units for a total of approximately 2,600 MWe	1,200 MWe from SMR generation, 600 MWe from solar pholtaic, 600 MWe from offshore wind, and 200 MWe from demand-side management
Location	ALWR: On land associated with Duke Energy's W.S. Lee Nuclear Station in Cherokee County, South Carolina. Would use available existing infrastructure, as appropriate (Duke Energy 2021-TN8897) SMR: On available land within the Oconee Station site. Would use existing transmission lines and infrastructure as appropriate (Duke Energy 2021-TN8897)	On available land within the Oconee Station site. Would use Oconee Station's existing transmission lines and some existing infrastructure (Duke Energy 2021-TN8897)	The SMR component would be located on available land within the Oconee Station site. The solar component would be located at multiple sites distributed across the ROI, offsite of the Oconee Station site. The wind component would be located off the North Carolina/South Carolina coasts in Federal waters designated for offshore wind development. Assumes demand-side management energy savings from within Duke Energy's service territory.
Cooling System	Closed cycle with mechanical draft cooling towers ALWR: Cooling water withdrawal—50 mgd Consumptive water use—35 mgd (NRC 2013-TN6435) SMR: Cooling water withdrawal—13.3 mgd Consumptive water use—9.2 mgd (NRC 2019-TN6136)	Closed cycle with mechanical draft cooling towers. Cooling water withdrawal—18 mgd Consumptive water use—14 mgd (NETL 2019-TN7484)	The SMR units would use closed cycle cooling systems with mechanical draft cooling towers. Cooling water withdrawal—13.3 mgd (per SMR unit) Consumptive water use—9.2 mgd (per SMR unit) (NRC 2019-TN6136) No cooling system would be required for the solar pholtaic and wind facilities, or demand-side management.

Table 2-1 Overview of Replacement Energy Alternatives (Continued)

Alternative	New Nuclear	Natural Gas Combined-Cycle	Combination (Small Modular Reactor, Solar, Offshore Wind, and Demand-Side Management)
Land Required	ALWR: Approximately 3,000 ac (1,200 ha) for nuclear power plant facilities, 1,100 ac (450 ha) for cooling water make-up pond, and 990 ac (400 ha) for transmission corridors (NRC 2013-TN6435, Duke Energy 2021-TN8897). SMR: Approximately 36 ac (14 ha) for nuclear power plant facilities (NuScale 2022-TN7327).	Approximately 130 ac (53 ha) for nuclear power plant facilities, with an additional 191 ac (77 ha) for rights-of-way to access existing gas pipelines. No new gas wells would be needed to support the facility (Duke Energy 2021-TN8897).	SMR facilities would require approximately 110 ac (45 ha) (NuScale 2022-TN7327). Solar photovoltaic facilities would collectively require approximately 9,600 ac (3,900 ha) (a). Offshore wind facilities would be sited within an approximately 66 square-nautical mile (57,000 ac) area (BOEM 2020-TN7494). Demand-side management would require no land.
Workforce	ALWR: Peak construction – 4,600 workers Operations. – 950 workers (Duke Energy 2021-TN8897, NRC 2019-TN6136) SMR: Peak construction– 550 workers Operations – 250 workers (NRC 2019-TN6136)	1,000 workers during peak construction and 190 workers during operations (Duke Energy 2021-TN8897, NRC 2013-TN6435)	The SMR, solar photovoltaic, and offshore wind facilities would collectively require approximately 3,500 workers during peak construction and 950 workers during operations (BLM 2019-TN8386; NRC 2019-TN6136; DOE 2011-TN8387; AWEA 2020-TN8355).

ac = acre(s); ALWR = advanced light-water reactor; ha = hectare(s); SMR = small modular reactor; mgd = million gallons per day; MWe = megawatts electric; ROI = region of influence.

2.3.2.1 New Nuclear (Advanced Light-Water Reactor and a Small Modular Reactor)

The NRC staff considers construction of a new nuclear power plant to be a reasonable replacement energy alternative to Oconee Station's SLR. Nuclear power generation currently accounts for approximately 44 percent of the electricity produced in the ROI (EIA 2021-TN8353). In addition to Oconee Station, six other nuclear power plants operate within the ROI, with the nearest being the Virgil C. Summer Nuclear Station, located approximately 96 mi (155 km) to the southeast of Oconee Station (NRC 2023-TN9126).

In its SLR ER, Duke Energy proposed a new nuclear power plant alternative consisting of an advanced light-water reactor (ALWR) nuclear power plant (constructing and operating the proposed W.S. Lee Nuclear Station, Units 1 and 2, in Cherokee County, South Carolina), combined with installing a SMR plant at the Oconee Station site (Duke Energy 2021-TN8897).

In 2016, as part of a separate licensing action, the NRC issued combined licenses to Duke Energy for the construction and operation of two AP1000 nuclear reactor units (W.S. Lee Nuclear Station). These new units would have a combined net electrical output of approximately 2,234 MWe. For the purpose of analysis, the ALWR portion of the new nuclear replacement power alternative would be based on the design and output of the two-unit Westinghouse AP1000 nuclear power plant previously analyzed in the W.S. Lee Nuclear Station Combined License EIS (NUREG-2111) (NRC 2013-TN6435). Accordingly, the ALWR nuclear power plant would utilize closed cycle cooling with mechanical draft cooling towers and require the construction of new intake and discharge structures. Cooling water withdrawal would be approximately 50 mgd (190,000 m^3/d) and consumptive water use would be approximately 35 mgd (130,000 m^3/d) (NRC 2013-TN6435). The ALWR would also require the construction of a cooling water reservoir and a 31 mi (50 km) transmission line corridor. Total land requirements for the ALWR nuclear power plant would be over 3,000 ac (1,200 ha), including approximately 950 ac (380 ha) for power generation; 1,100 ac (450 ha) for the cooling water make-up pond; and 990 ac (400 ha) for transmission line corridors (NRC 2013-TN6435, Duke Energy 2021-TN8897).

Because the proposed W.S. Lee Nuclear Station ALWR units would not fully replace the electrical power generation of Oconee Station, the new nuclear alternative would include the installation of a single SMR nuclear power plant with a total net generating capacity of approximately 400 MWe at the Oconee Station site. In general, SMRs are light water reactors that use water for cooling and enriched uranium for fuel in a similar manner as conventional, large light water reactors currently operating in the United States. SMR modules typically generate 300 MWe or less, compared to the larger designs and outputs generally associated with ALWRs (typically 1,000 MWe or more per reactor unit) (IAEA 2023-TN8956). However, their smaller size means that several SMRs can be bundled together in a single containment. Their smaller size also means greater siting flexibility, because they can fit in locations not large enough to accommodate a conventional nuclear reactor (DOE 2022-TN7250, NRC 2023-TN9126). The design features of an SMR can include below-grade containment and inherent safe shutdown features, longer station blackout coping time without external intervention, and core and spent fuel pool cooling without the need for active heat removal. SMR power generating facilities can be also designed to be deployed in an incremental fashion to meet the power generation needs of a service area, in which generating capacity can be added in increments to match load growth projections (NRC 2019-TN6136).

As indicated in Duke Energy's ER, the SMR portion of the new nuclear alternative would be located within an approximately 135 ac (54.6 ha) area south and east of the of the Oconee

Station 525-kV switchyard, as well as a parcel of land located to the south across South Carolina Highway 183 (SC-183), adjacent to, but outside of, the current Oconee Station site boundary (Duke Energy 2021-TN8897, Duke Energy 2021-TN8898, Duke Energy 2022-TN8948). The SMR is estimated to require approximately 36 ac (15 ha) of land (NuScale 2022-TN7327) and a closed-cycle cooling system with mechanical draft cooling towers. This cooling system would withdraw approximately 13.3 mgd (50 mL/d) of water and consume approximately 9.2 mgd (35 mL/d) of water. Visible structures would include the cooling towers and power block (NRC 2019-TN6136). Infrastructure upgrades may be required, however, existing transmission lines at Oconee Station would be sufficient to support the SMR.

2.3.2.2 Natural Gas-fired Combined-Cycle

Natural gas represents approximately 31 percent of the installed generating capacity and 29 percent of the electrical power generated in the ROI (EIA 2021-TN8378, EIA 2021-TN8353). The NRC staff considers the construction of a natural gas combined cycle power plant to be a reasonable alternative to Oconee Station's SLR because natural gas is a commercially available option for providing baseload electrical generating capacity beyond the expiration of Oconee Station's renewed licenses.

Baseload natural gas combined cycle power plants have proven their reliability and can have capacity factors as high as 87 percent (DOE/EIA 2015-TN7717). In a natural gas combined cycle system, electricity is generated using a gas turbine that burns natural gas. A steam turbine uses the heat from gas turbine exhaust through a heat recovery steam generator to produce additional electricity. This two-cycle process has a high rate of efficiency because the natural gas combined cycle system captures the exhaust heat that otherwise would be lost and reuses it. Similar to other fossil fuel burning plants, natural gas power plants are a source of greenhouse gases, including carbon dioxide (CO_2) (NRC 2013-TN2654).

For the purposes of analysis, six 500 MWe natural gas units with an 87 percent capacity factor would be used to replace Oconee Station's 2,600 MWe generating capacity. Each unit would consist of two combustion turbine generators, two heat recovery steam generators, and one steam turbine generator with mechanical draft cooling towers for heat rejection. The natural gas-fired power plant would incorporate a catalytic reduction system to minimize nitrogen oxide emissions. Natural gas would be extracted from the ground through wells, treated to remove impurities, and then blended to meet gas pipeline standards before being piped to Oconee Station. The natural gas combined cycle alternative would also generate waste material, primarily in the form of spent catalysts used for control of nitrogen oxide emissions.

Duke Energy indicated that the gas-fired power plant would be located within a 135 ac (54.6 ha) area in the same location as the SMR in the new nuclear alternative south and east of the of the Oconee Station 525-kV switchyard, as well as a third Duke Energy-owned parcel located immediately south across SC-183 (Duke Energy 2021-TN8897; Duke Energy 2021-TN8898, Duke Energy 2022-TN8948). Approximately 130 ac (53 ha) of land would be needed to construct and operate the natural gas-fired power plant and an additional 191 ac (77 ha) of land for a right-of-way to connect to an existing natural gas supply line 21 mi (34 km) southeast in Centerville, South Carolina. No new gas wells would be needed to support the facility. Infrastructure upgrades may be required, however, existing transmission line infrastructure would be adequate to support this alternative (Duke Energy 2021-TN8897).

The natural gas combined cycle power plant would use a closed-cycle cooling system with mechanical draft cooling towers, withdrawing 18 mgd (69,000 m^3/d) of water and consume

14 mgd (53,000 m^3/d) of water (NETL 2019-TN7484). Visible structures would include cooling towers, exhaust stacks, intake and discharge structures, transmission lines, natural gas pipelines, and an electrical switchyard.

2.3.2.3 Combined Small Modular Reactor, Solar Photovoltaic, Offshore Wind, and Demand-Side Management (Combination Alternative)

The NRC staff considers a combination of carbon-free replacement power generation technologies with demand-side management to also be a reasonable alternative to Oconee Station's SLR. The amount of energy derived from each type of power generation in this combination could vary. For the purposes of analysis, SMRs would supply 1,200 MWe, solar photovoltaic power installations would supply 600 MWe, offshore wind facilities would supply 600 MWe, and energy efficiency initiatives (i.e., demand-side management) would provide 200 MWe of energy savings.

<u>Small Modular Reactors</u>

A three unit, 1,200 MWe SMR power plant would be installed at Oconee Station. The nuclear power plant would be similar in function and appearance to the SMR portion of the new nuclear alternative power plant described in Section 2.3.2.1. Infrastructure upgrades may be required; however, existing transmission line infrastructure would be adequate to support the SMRs. The SMRs would be located within a 135 ac (54.6 ha) parcel of land located south and east of the of the Oconee Station 525 kV switchyard, as well as a third Duke Energy-owned parcel located immediately south across SC-183 (Duke Energy 2021-TN8897, Duke Energy 2022-TN8948).

The three-unit SMR nuclear power plant would use a closed-cycle cooling system with mechanical draft cooling towers, withdrawing approximately 40 mgd (150,000 m^3/d) of water and consume 28 mgd (105,000 m^3/d) of that amount. Visible structures would include cooling towers and power block (NRC 2019-TN6136).

<u>Solar Photovoltaic</u>

Solar photovoltaic power generation uses solar panels to convert solar radiation into usable electricity. Solar cells are formed into solar panels that can then be linked into photovoltaic arrays to generate electricity. The electricity generated can be stored, used directly, fed into a large electricity grid, or combined with other electricity generators as a hybrid plant. Solar photovoltaic cells can generate electricity when there is sunlight, regardless of whether the sun is directly or indirectly shining on the solar panels. Therefore, solar photovoltaic technologies do not need to directly face and track the sun. This capability has allowed solar photovoltaic systems to have broader geographical use than concentrating solar power (which relies on direct sun) (Ardani and Margolis 2011-TN2522).

The feasibility of solar energy serving as alternative baseload power depends on the location, value, accessibility, and constancy of solar radiation. Representative solar photovoltaic resources range from 4.5 to 5.0 kilowatt hours per square meter per day (kWh/m^2/day) (NREL 2023-TN8959). Nationwide, growth in utility scale solar photovoltaic facilities (greater than 1 MW) has resulted in an increase from 145 MW in 2009, to over 35,000 MW of installed capacity in 2019 (DOE/EIA 2022-TN8958).

Twelve 125-MWe, utility-scale solar facilities would be used to provide replacement energy. Each of the solar facilities would be paired with a 125-MW/500-MWh battery energy storage system at locations within the ROI. Combining a 25 percent solar photovoltaic capacity factor (DOE/EIA 2023-TN8957) with the energy dispatch capabilities of the associated battery systems, the solar units would collectively have a net generating capacity of approximately 600 MWe.

Solar photovoltaic facilities require land for the solar panels, up to 6.2 ac (2.5 ha) per megawatt (NRC 2013-TN2654). Therefore, based on this estimate, approximately 9,600 ac (3,900 ha) of land would be required to operate the 12 solar power and storage facilities. Solar photovoltaic power and storage systems do not require water for cooling.

In its 2020 Integrated Resource Plan, Duke Energy identified plans to increase solar power capacity and generation over the next 15 years (Duke Energy 2021-TN8962). Because solar photovoltaic technology is commercially available in the region, solar photovoltaic power generation would be reasonable when combined with other sources of power generation.

Offshore Wind

Wind generated replacement power under this combination alternative would come from offshore wind farms located along North and South Carolina's Atlantic coasts. The offshore wind generated power would be paired with three, approximately 300-MW/1,200-MWh battery energy storage systems. Offshore wind power would require an installed capacity of 924 MWe. Combining a 50 percent offshore wind capacity factor (NREL 2020-TN8425) with energy dispatch capabilities of the battery systems, offshore wind farms would have a net generating capacity of approximately 600 MWe.

North Carolina and South Carolina have large areas off their Atlantic coasts with wind energy potential (DOE/EIA 2022-TN8955, DOE/EIA 2021-TN9101). Based on planned expansion of offshore wind capabilities, an additional installed capacity of 924 MWe could be reasonably attained by the time the renewed Oconee Station operating licenses expire in 2033 and 2034.

In 2014, the U.S. Bureau of Ocean Energy Management (BOEM) identified more than 300,000 ac (121,000 ha) in Federal waters 10 to 24 nautical miles off the North Carolina and South Carolina coasts as potentially suitable for wind energy development (BOEM 2015-TN9066; BOEM 2021-TN7704). In 2017, the BOEM auctioned 122,000 ac (49,000 ha) off of Kitty Hawk, North Carolina, and in 2021 a construction and operations plan was submitted for developing approximately 40 percent of this tract (BOEM 2023-TN9102). In August 2021, BOEM announced the proposed lease sale of the Wilmington East wind energy area, consisting of 128,000 ac (51,800 ha) in the Carolina Long Bay Area offshore of North Carolina. The Kitty Hawk and Wilmington East wind energy areas are estimated to have the potential to generate approximately 1,500 MWe of offshore wind energy (BOEM 2020-TN8961).

Offshore wind turbine generators (turbines) are substantially larger than those operated on land. From 2000 to 2020, offshore wind turbine sizes have grown from an installed average of 2 MW per turbine to recent designs capable of generating 14 MW per turbine (BOEM 2020-TN7494). For the purposes of analysis, a 14 MW turbine model with a rotor diameter of 722 feet (222 meters) and height of approximately 800 ft (245 meters) would be used. Similar models have been selected for deployment along the Mid-Atlantic Coast (Virginia Business 2020; Siemens Gamesa Undated). Accordingly, 66 turbines would be used to attain an installed capacity of 924 MWe.

Although offshore wind turbines can either be affixed to the seabed or free-floating, water depths associated with the offshore wind energy areas located along the Carolina coasts are more suitable to fixed models, of which there are various foundation designs. The 66 turbines would be constructed in a grid pattern approximately 1 nautical mile (1.9 km) apart using an affixed monopile design driven into the seafloor to depths of approximately 260 ft (80 m) (BOEM 2020-TN7494), and each turbine would be located in the center of each square nautical mile (SNM) block, to better isolate each turbine from passing vessels. Offshore construction impacts are projected to occur within a 95 ac (38.5 ha) temporary work area proximate to each turbine location (BOEM 2015-TN9066). The seabed surrounding each turbine foundation would be protected from ocean current erosion by placement of a permanent 3–6 ft (1–1.5 m) scour protection rock bed covering approximately 1 ac (0.4 ha) (BOEM 2018-TN8428). Accordingly, the construction of the turbines supporting the offshore wind component would result in approximately 6,300 ac (2,500 ha) of temporary disturbance and 66 ac (26 ha) of permanent disturbance.

Additional disturbance would result from trenching activities associated with interconnecting the wind turbine generators and exporting the power to onshore facilities. Available offshore and onshore infrastructure would be used (e.g., offshore electrical service platforms and cable trenches extending to onshore interfaces) associated with current and planned development along the Carolina coasts. The battery storage systems supporting the offshore wind portion would also result in an additional 60 ac (24 ha) of permanent disturbance.

Because offshore wind turbines require ample spacing between one another to avoid inter-turbine air turbulence and allow for navigation by ocean vessels, the total area requirement of utility-scale wind farms is significantly larger than the amount of marine environment that would be directly disturbed. Under this alternative, approximately 66 square nautical miles would be required for an installed capacity of 924 MWe (BOEM 2020-TN7494).

In its 2020 Integrated Resource Plan, Duke Energy identified future planning scenarios that would add over 2,400 MWe of offshore wind energy over the next 15 years (Duke Energy 2021-TN8962). In its September 2021 update to the Integrated Resource Plan, Duke Energy acknowledged North Carolina’s goal for developing 2,800 MW of offshore wind energy resources by 2030 and 8,000 MW by 2040, but it noted that the extent and timing by which the utility incorporates wind resources will depend on deliverability, policy, and market factors (Duke Energy 2021-TN8962, Duke Energy 2021-TN8962). As discussed in Section 2.4.2, although it is unlikely that offshore wind power could fully replace Oconee Station’s generation capacity, the Carolina offshore environment does offer considerable wind power potential, and offshore wind technologies are poised to become a commercially available option for providing electrical generating capacity in the region of interest by the time the renewed Oconee Station operating licenses expire. Accordingly, the installation of offshore wind turbine generators would be a reasonable alternative to Oconee Station’s SLR when combined with other sources of power generation.

Demand-Side Management

Energy conservation and efficiency programs are more broadly referred to as demand-side management. Demand-side management programs can include reducing energy demand through consumer behavioral changes or through altering the electricity load so as to not require the addition of new generating capacity. These programs can be initiated by utilities, power transmission operators, States, or other load serving entities.

Although North Carolina and South Carolina have differing energy efficiency resource standards, demand-side management programs represent a key focus of Duke Energy's 2020 Integrated Resource Plan (Duke Energy 2021-TN8962). Therefore, for this analysis it is assumed that Duke Energy would implement these programs.

Under the combination alternative, demand-side management would be used to replace approximately 200 MWe of the electrical generation that Oconee Station currently provides. Duke Energy projects that by 2035, its demand-side management programs could potentially reduce electrical demand across its service area (Duke Energy 2020-TN9696). Because estimates of reduced electrical demand involve considerable uncertainty, replacement of 200 MWe through demand-side management programs would be a reasonable assumption for the combination alternative.

2.4 Alternatives Considered but Eliminated

The NRC eliminated 13 alternatives from detailed study due to resource availability and commercial or regulatory limitations. Many of these limitations will likely still exist when the current renewed Oconee Station operating licenses expire in 2033 (Units 1 and 2) and 2034 (Unit 3). This section briefly describes the 13 alternatives as well as the reasons why they were eliminated from detailed study.

2.4.1 Solar Power

Solar power, including photovoltaic and concentrating solar power technologies, generates power from sunlight. Solar photovoltaic components convert sunlight directly into electricity using solar cells made from silicon or cadmium telluride. Concentrating solar power uses heat from the sun to boil water and produce steam. Steam drives a turbine connected to a generator to produce electricity (NREL Undated-TN7710).

Solar generators are considered an intermittent electrical power resource because their availability depends on exposure to the sun, also known as solar insolation. Insolation rates of solar photovoltaic resources range from 4.5 to 5.0 kWh/m^2/day (NREL 2018-TN8350). North Carolina ranks third in the nation in installed solar capacity, and all of South Carolina's new utility-scale generating capacity in 2020 and 2021 was powered by solar energy (EIA 2022-TN8955, DOE/EIA 2022-TN8955). With more than 6,000 MWe of utility-scale capacity installed in 2021, solar photovoltaic power represents a small but increasing contribution to these states' electrical power generation (EIA 2021-TN8378, EIA 2021-TN8353).

To be viable, a utility-scale solar alternative must replace the amount of electrical power that Oconee Station currently provides. Assuming a capacity factor of 25 percent (DOE/EIA 2023-TN8821), approximately 6,500 to 10,400 MWe of additional solar energy capacity would need to be installed to replace the electricity generated by Oconee Station.

Accordingly, key design characteristics associated with the solar portion of the combination alternative presented in Table 2-1 and Section 2.3.2.3 of this EIS could be scaled to suggest the relative impacts of using solar as a stand-alone technology to replace the Oconee Station generating capacity. Utility-scale solar facilities require large areas of land for the solar panels. A utility-scale solar alternative would require approximately 40,000 to 64,000 ac (16,000 to 26,000 ha) of land. Based on this information, a utility-scale solar energy alternative would not be reasonable to Oconee Station's SLR. However, a limited amount of solar power generation, in combination with other energy generating technologies, would be a reasonable alternative to Oconee Station's SLR, as explained in Section 2.3.2.3.

2.4.2 Wind Power

As is the case with other renewable energy sources, the feasibility of wind energy providing baseload power depends on the location (relative to electricity users), value, accessibility, and constancy of the resource. Wind energy must be converted to electricity at or near the point where it is used, and there are limited energy storage opportunities available to overcome the intermittency and variability of wind resources.

The American Clean Power Association reports a total of more than 122,000 MW of installed wind energy capacity nationwide as of December 31, 2020. Approximately 200 MW of this wind energy capacity is installed within the ROI (DOE Undated-TN8431). To be considered a reasonable replacement energy alternative to Oconee Station's SLR, a wind power alternative must replace the amount of electrical power that Oconee Station provides. Assuming a capacity factor of 40 percent (NREL 2020-TN8425), land-based wind energy facilities would need to generate 4,700 to 6,500 MW of electricity to replace Oconee Station's generating capacity. However, North Carolina currently has only one utility-scale wind energy facility, and South Carolina has none, with both states having only limited onshore wind potential (EIA 2022-TN8955, DOE/EIA 2022-TN8955).

Increasing attention has been focused on developing offshore wind resources along the Atlantic coast. In 2016, a 30 MW project off the coast of Rhode Island become the first operating offshore wind farm in the United States (Orsted Undated-TN7705). This was followed in 2020 with the construction and operation of the Mid-Atlantic's first offshore wind demonstration project in Federal waters, a 12 MWe demonstration project supporting the planned operation of a 2,600 MWe utility-scale wind farm off the coast of Virginia (BOEM 2021-TN7704). As discussed in Section 2.3.2.3, Duke Energy has identified offshore wind planning scenarios that could add over 2,400 MWe of offshore wind energy over the next 15 years, subject to deliverability, policy, and market factors (Duke Energy 2020, Duke Energy 2021-TN8962).

Assuming a capacity factor of 50 percent for offshore wind farms (NREL 2020-TN8425), these power generating facilities would need an installed capacity of 4,000 to 5,200 MW of electricity to fully replace Oconee Station's generating capacity of 2,600 MWe. A utility-scale offshore wind alternative of this size would therefore require between 286 and 372 wind turbines, between 286 and 372 square nautical miles (242,000 to 315,000 ac, 98,000 to 127,000 ha) exceeding the area of the Federal waters off the Carolina coasts designated for wind energy leasing. Because Duke Energy is already considering potential offshore wind energy strategies to offset current and forecasted fossil-fueled capacity reductions, the NRC staff expects that acquiring additional leases to support this level of offshore wind development would be difficult.

Given the amount of wind capacity necessary to replace Oconee Station, the intermittency of the resource, the limited amount of offshore Federal waters currently designated for wind energy leasing, and the status of wind development, a wind-only alternative—either land based, offshore, or some combination of the two—would be an unreasonable alternative to Oconee Station's SLR. However, a limited amount of offshore wind power generation, in combination with other power generating technologies, would be a reasonable alternative to Oconee Station's SLR, as explained in Section 2.3.2.3.

2.4.3 Biomass Power

Biomass resources used for biomass fuel-fired power generation include agricultural residues, animal manure, wood wastes from forestry and industry, residues from food and paper industries, municipal green wastes, dedicated energy crop, and methane from landfills (IEA 2007-TN8436). Using biomass fuel-fired generation for baseload power depends on the geographic distribution, available quantities, constancy of supply, and energy content of biomass resources. For this analysis, biomass fuel would be combusted for power generation in the electricity sector.

In 2020, biomass fuel-fired power generation in the region had a total installed capacity of approximately 1,160 MW, and approximately 2 percent of the total power in the ROI (EIA 2021-TN8378, EIA 2021-TN8353).

For utility scale biomass fuel-fired electricity generation, technologies used for biomass energy conversion would be similar to the technology used in other fossil fuel-fired power plants, including the direct combustion of biomass fuel in a boiler to produce steam. Accordingly, biomass generation is generally considered a carbon emitting technology.

One of the largest new biomass fuel-fired power plants in the United States, the 103 MW Gainesville Renewable Energy Center, opened in Florida in 2013 (DOE/EIA 2016-TN8963). Replacing the Oconee Station generating capacity using only biomass fuel would require the construction of more than 25 new power plants of this size. However, most biomass fuel-fired power plants generally only reach capacities of 50 MW, which means replacing Oconee Station's generating capacity, using only biomass fuel, would require twice as many new power plants.

Increasing biomass fuel-fired generation capacity by expanding existing or constructing new units by the time Oconee Station's operating licenses expire in 2033 and 2034, respectively, is unlikely. For these reasons, biomass fuel-fired generation would not be a reasonable alternative to Oconee Station's SLR.

2.4.4 Demand-Side Management

Demand-side management refers to energy conservation and efficiency programs that do not require the addition of new generating capacity. Demand-side management programs can include reducing energy demand through consumer behavioral changes or through altering the characteristics of the electrical load. These programs can be initiated by a utility, transmission operators, the State, or other load serving entities. In general, residential electricity consumers have been responsible for the majority of peak load reductions, and participation in most demand-side management programs is voluntary.

Therefore, the existence of a demand-side management program does not guarantee that reductions in electricity demand will occur. Although the energy conservation or energy efficiency potential in the United States is substantial, there have been no cases in which an energy efficiency or conservation program alone has been implemented expressly to replace or offset a large baseload generation station.

Although Duke Energy has considered demand-side management measures as part of its resource planning efforts, it is unlikely that additional demand-side management measures alone would be sufficient to offset the electrical energy lost by the Oconee Station shutdown (Duke Energy 2021-TN8897). Therefore, demand-side management programs alone would not be a reasonable alternative to Oconee Station's SLR. However, in combination with other power generating technologies, demand side management would be a reasonable alternative to Oconee Station's SLR, as explained in Section 2.3.2.3.

2.4.5 Hydroelectric Power

There are about 2,000 operating hydroelectric power facilities in the United States. Hydropower technologies capture flowing water and directs it to turbines and generators to produce electricity. There are three variants of hydroelectric power generation: (1) run of the river (diversion) facilities that direct the natural flow of a river, stream, or canal through a hydroelectric power facility, (2) store and release facilities that block the flow of the river by using dams that cause water to accumulate in an upstream reservoir, and (3) pumped storage facilities that use electricity from other power sources to pump water to higher elevations during off peak hours to be released during peak load periods to generate electricity (EIA 2020-TN8352, EIA 2021-TN8353).

Duke Energy currently has approximately 2,140 MWe of pumped storage hydropower capacity and 1,080 MWe of conventional hydropower generation capacity in the region (Duke Energy 2021-TN8897). Although the EIA projects that hydropower will remain a leading source of renewable power generation in the United States through 2040, there is little expected growth in large-scale hydropower capacity (DOE/EIA 2013-TN2590). The potential construction of large new hydropower facilities has diminished because of public concern over flooding, habitat alteration and loss, and the impact on natural rivers.

Given the projected lack of growth in hydroelectric power, the competing demands for water resources, and public opposition to the environmental impacts from the construction of large hydroelectric power facilities, the use of hydroelectric power would not be a reasonable alternative to Oconee Station’s SLR.

2.4.6 Geothermal Power

Geothermal technologies extract heat from geologic formations to produce steam to drive steam turbine generators. Electricity production from geothermal energy have demonstrated 95 percent or greater capacity factors, making geothermal energy a potential source of baseload electric power. However, the feasibility of geothermal power generation to provide baseload power depends on the regional quality and accessibility of geothermal resources. Utility-scale power generation requires geothermal reservoirs with a temperature above 200°F (93°C). Utility-scale geothermal resources are concentrated in the western United States, specifically Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming and most assessments of geothermal power generation resources have been conducted in these states (DOE Undated-TN7698; USGS 2008-TN7697). There is currently no utility-scale geothermal power production in the ROI (NREL 2016-TN8469). Given its low potential, geothermal power generation would not be a reasonable alternative to Oconee Station’s SLR.

2.4.7 Wave and Ocean Energy

Ocean waves, currents, and tides are generally predictable and reliable, making them attractive candidates for potential renewable energy generation. Four major technologies can be used to harness wave energy: (1) terminator devices that range from 500 kilowatts to 2 MW, (2) attenuators, (3) point absorbers, and (4) overtopping devices (BOEM Undated-TN7696). Point absorbers and attenuators use floating buoys to convert wave motion into mechanical energy, driving generators to produce electricity. Overtopping devices trap a portion of a wave at a higher elevation than the sea surface; waves enter a tube and compress air that is then used to drive a generator producing electricity. Some of these technologies are undergoing demonstration testing at commercial scales, but none of the technologies are currently used to provide baseload power (BOEM Undated-TN7696). In the United States, there are currently several projects licensed or seeking permits, the largest of which is 20 MW (Duke Energy 2021-TN8897).

The Mid-Atlantic coast is characterized by substantial amounts of ocean wave energy (EPRI 2011-TN8442). However, wave and ocean energy generation technologies are still in their infancy and currently lack commercial application. For these reasons, wave and ocean energy power generation would not be a reasonable alternative to Oconee Station’s SLR.

2.4.8 Municipal Solid Waste-Fired Power

Energy recovery from municipal solid waste converts nonrecyclable waste materials into usable heat, electricity, or fuel through combustion. Three types of municipal solid waste combustion technologies include mass burning, modular systems, and refuse derived fuel systems. Mass burning is the method used most frequently in the United States. The heat released from combustion is used to convert water to steam, which is then used to drive turbine generators to produce electricity. Ash is collected and taken to a landfill, and particulates are captured through a filtering system (EPA 2023-TN8443).

Currently, 75 waste-to-energy power plants are in operation in 21 states, processing approximately 29 million tons of waste per year. These waste-to-energy power plants have an aggregate capacity of 2,725 MWe (Michaels and Krishnan 2019-TN7700). Although some power plants have expanded to handle additional waste and to produce more energy, only one new municipal solid waste combustion power plant has been built in the United States since 1995 (Maize 2019-TN7699). Because the average waste-to-energy power plant produces about 50 MWe, 52 waste-to-energy power plants would be necessary to provide the same level of electrical output as Oconee Station.

The decision to burn municipal solid waste to generate electricity is usually driven by the need for a waste disposal alternative to landfills rather than a need to generate energy. Stable supplies of municipal solid waste would be needed to support 52 new waste-to-energy power plants in the region. Based on this information, municipal solid waste-to-energy power plants would not be a reasonable alternative to Oconee Station’s SLR.

2.4.9 Petroleum-Fired Power

Petroleum-fired electricity generation accounted for less than 1 percent of the ROI’s total electricity generation in 2020 (EIA 2021-TN8353). The variable costs and environmental impacts of petroleum-fired electrical power generation tend to be greater than those of natural gas-fired generation. The historically higher cost of oil has also resulted in a steady decline in its use for electricity generation, and the EIA forecasts no growth in capacity using petroleum-fired power plants through 2040 (DOE/EIA 2013-TN2590, DOE/EIA 2015-TN4585). Therefore, based on this information, petroleum-fired electricity generation would not be a reasonable alternative to Oconee Station’s SLR.

2.4.10 Coal-Fired Power

Although coal has historically been the largest source of electricity in the United States, both natural gas generation and nuclear energy generation surpassed coal generation at the national level in 2020. Coal-fired electricity generation in the United States has continued to decrease as coal-fired units have been retired or converted to use other fuels and as the remaining units have been used less often (DOE/EIA 2021-TN7718). The region mirrors this trend, with coal-fired power plants providing 15 percent of North and South Carolina's electricity generation in 2020, down from 53 percent in 2000 (EIA 2021-TN8353).

Baseload coal-fired power units have proven their reliability and can routinely sustain capacity factors as high as 85 percent. Among the available technologies, pulverized-coal boilers producing supercritical steam (supercritical pulverized-coal boilers) have become increasingly common, given their generally high thermal efficiencies and overall reliability.

Supercritical pulverized-coal facilities are more expensive to build than subcritical coal-fired power plants but consume less fuel per unit output. Integrated gasification combined cycle combines modern coal gasification technology with both gas turbine and steam turbine power generation. The technology is cleaner than conventional pulverized-coal plants because some of the major pollutants are removed before combustion. Although several smaller, integrated gasification combined-cycle power plants have been in operation since the mid-1990s, large-scale projects have experienced setbacks, and public opposition has hindered it from being fully integrated into the energy market.

Since 2010, Duke Energy has retired 56 coal-fired power units, representing a combined capacity of approximately 7,500 MW. In February 2022, the utility announced its plan to fully remove coal-fired power generation from its fleet by 2035 (Duke Energy 2022-TN8951). Based on these considerations, coal-fired power plants would not be a reasonable alternative to Oconee Station's SLR.

2.4.11 Fuel Cells

Fuel cells oxidize fuels without combustion and, therefore, without the environmental side effects of combustion. Fuel cells use a fuel (e.g., hydrogen) and oxygen to create electricity through an electrochemical process. The only byproducts are heat, water, and carbon dioxide (depending on the hydrogen fuel type) (DOE Undated-TN7695). Hydrogen fuel can come from a variety of hydrocarbon resources, including natural gas. As of October 2020, the United States had only 250 MW of fuel cell power generation capacity (EIA 2022-TN8955).

Currently, fuel cells are not economically or technologically competitive with other electricity generating alternatives. The EIA estimates that fuel cells may cost $6,639 per installed kilowatt (total overnight capital costs in 2021 dollars), which is high compared to other replacement energy alternatives (DOE/EIA 2022-TN7694). In June 2021, DOE launched an initiative to reduce the cost of hydrogen production to spur fuel cell and energy storage development over the next decade (DOE 2021-TN7693). However, it is unclear whether, or to what degree, this initiative will lead to increased future development and deployment of fuel cell technologies.

More importantly, fuel cell units used for power production are likely to be small (approximately 10 MW). The world's largest industrial hydrogen fuel cell power plant is a 50 MWe plant in South Korea (Larson 2020-TN8401). Using fuel cells to replace the power that Oconee Station provides would require the construction of approximately 260 units. Given the limited deployment and high cost of fuel cell technology, fuel cells would not be a reasonable alternative to Oconee Station's SLR.

2.4.12 Purchased Power

Power may be purchased and imported from outside the region. Although purchased power would likely have little or no measurable impact, environmental impacts could occur where the power is being generated, depending on the technologies used to generate the power. As discussed in its ER, Duke Energy purchased 2,146 MWe from non-utility generation and wholesale power suppliers in 2018, and this commitment would need to double in order to replace Oconee Station's electrical power generation (Duke Energy 2021-TN8897).

Purchased power is generally economically adverse because, historically, the cost of generating power has been less than the cost of purchasing the same amount of power from a third-party supplier. Purchased power agreements also carry the inherent risk that the supplier may not be able to deliver all of the contracted power. Based on these considerations, purchased power would not provide a reasonable alternative to Oconee Station's SLR.

2.4.13 Delayed Retirement of Other Generating Facilities

Delaying the retirement of a power plant enables it to continue supplying electricity. Because some power generators are required to adhere to regulations requiring significant reductions in power plant emissions, some owners may opt to retire older, less efficient units rather than incur the cost for compliance. Retirements may also be driven by low competing commodity prices (such as low natural gas prices), slow growth in electricity demand, and EPA's Mercury and Air Toxics Standards for fossil-fueled power plants (DOE/EIA 2015-TN4585; EPA 2020-TN8379).

Duke Energy's 2020 Integrated Resource Plan considered retirement of all coal-fired units to meet its carbon dioxide reduction goals and align with state energy policies and legislation. As discussed in Section 2.4.10 of this EIS, Duke Energy has retired 56 coal-fired units since 2010, representing a combined capacity of approximately 7,500 MWe. Delaying the retirement of fossil fueled power generating units would result in higher pollutant air emissions and not meet the goals identified in the 2020 Integrated Resource Plan. Because of these conditions, delayed retirement of older power generating units would not provide a reasonable alternative to Oconee Station's SLR.

2.5 Comparison of Alternatives

This chapter presents the no-action alternative and the following three alternatives to the proposed action (Oconee Station's SLR): (1) new nuclear generation (two-unit advanced light-water reactors with a single-unit small modular reactor), (2) a new natural gas-fired combined-cycle power generating facility, and (3) a combination of a small modular reactor, solar photovoltaic generation with battery storage, offshore wind generation with battery storage, and demand-side management. Chapter 3 describes the environmental impacts of the proposed action and the alternatives. Table 2-2 summarizes the environmental impacts of the proposed action (Oconee Station's SLR) and the alternatives to SLR considered in this EIS.

The environmental impacts of the proposed action (renewing the Oconee Station operating licenses) would be SMALL for all impact categories. In comparison, each of the three replacement power alternatives has environmental impacts in at least five resource areas that are greater than the environmental impacts of the proposed license renewal action. In addition, the replacement energy alternatives also would also result in construction impacts. If the NRC does not renew the Oconee Station operating licenses (no-action alternative), energy-planning decisionmakers would have to choose a replacement power alternative similar to the ones evaluated in this EIS. Based on the review of the replacement energy alternatives, the no-action alternative, and the proposed action, the environmentally preferred alternative is the proposed SLR action. Therefore, the NRC staff's preliminary recommendation is to renew the Oconee Station operating licenses.

Table 2-2 Summary of Environmental Impacts of the Proposed Action and Alternatives

Impact Area (Resource)	Oconee Station License Renewal (Proposed Action)	No-Action Alternative	New Nuclear Alternative (Advanced Light-Water Reactor, Small Modular Reactor)	Natural Gas Combined-Cycle Alternative	Combination Alternative (Small Modular Reactor, Solar, Offshore Wind, Demand-Side Management)
Land Use	SMALL	SMALL	SMALL to MODERATE	SMALL to MODERATE	MODERATE to LARGE
Visual Resources	SMALL	SMALL	SMALL to MODERATE	SMALL to MODERATE	MODERATE to LARGE
Air Quality	SMALL	SMALL	SMALL	MODERATE	SMALL
Noise	SMALL	SMALL	SMALL	SMALL to MODERATE	SMALL to MODERATE
Geologic Environment	SMALL	SMALL	SMALL to MODERATE	SMALL	SMALL to MODERATE
Surface Water Resources	SMALL	SMALL	SMALL	SMALL	SMALL to MODERATE
Groundwater Resources	SMALL	SMALL	SMALL	SMALL	SMALL
Terrestrial Resources	SMALL	SMALL	MODERATE	SMALL to MODERATE	MODERATE to LARGE
Aquatic Resources	SMALL	SMALL	MODERATE	SMALL	MODERATE to LARGE
Special Status Species and Habitats	SEE NOTE[(a)]	SEE NOTE[(b)]	SEE NOTE[(c)]	SEE NOTE[(c)]	SEE NOTE[(c)]
Historic and Cultural Resources	SEE NOTE[(d)]	SEE NOTE[(e)]	SEE NOTE[(f)]	SEE NOTE[(f)]	SEE NOTE[(f)]
Socioeconomics	SMALL	MODERATE to LARGE	LARGE	SMALL to MODERATE	MODERATE
Transportation	SMALL	SMALL	MODERATE	SMALL to MODERATE	MODERATE
Human Health	SMALL[(g)]	SMALL[(g)]	SMALL	SMALL[(g)]	SMALL[(g)]
Environmental Justice	SEE NOTE[(h)]	SEE NOTE[(i)]	SEE NOTE[(j)]	SEE NOTE[(j)]	SEE NOTE[(j)]
Waste Management and Pollution Prevention	SMALL[(k)]	SMALL[(k)]	SMALL	SMALL	SMALL

(a) May affect but is not likely to adversely affect tricolored bat and monarch butterfly. No essential fish habitat (EFH) or National Marine Sanctuaries occur in the affected area.

(b) Overall, the effects on federally listed species and critical habitats and EFH would likely be smaller under the no-action alternative than the effects under continued operation, but would depend on the specific shutdown activities as well as the listed species, critical habitats, and designated EFH present when the no-action alternative is implemented.

Table 2-2 Summary of Environmental Impacts of the Proposed Action and Alternatives (Continued)

Impact Area (Resource)	Oconee Station License Renewal (Proposed Action)	No-Action Alternative	New Nuclear Alternative (Advanced Light-Water Reactor, Small Modular Reactor)	Natural Gas Combined-Cycle Alternative	Combination Alternative (Small Modular Reactor, Solar, Offshore Wind, Demand-Side Management)

(c) The effects on federally listed species and critical habitats and EFH would depend on the proposed alternative site, nuclear power plant design and operation, as well as listed species and habitats present when the alternative is implemented. Therefore, the NRC staff cannot forecast a level of impact for this alternative.

(d) Given (1) the location of known historic properties within and near the area of potential effect, (2) no new ground disturbance or modifications are anticipated during the subsequent license renewal (SLR) period, and (3) Duke Energy has procedures in place to manage and protect cultural resources, the NRC staff concludes that SLR for Oconee Station would not adversely affect any known historic properties or historic and cultural resources.

(e) As a result of facility shutdown, land-disturbing activities or dismantlement are not anticipated as these would be conducted during decommissioning. However, effects on historic properties or historic and cultural resources would depend on the specific shutdown activities when the no-action alternative is implemented.

(f) The impact determination of this alternative would depend on the specific location of the new facility(ies).

(g) The chronic effects of electromagnetic fields on human health associated with operating nuclear power and other electricity generating plants are uncertain.

(h) Disproportionately high and adverse human health and environmental effects to minority and low-income populations are not expected.

(i) Not renewing the operating licenses and terminating reactor operations could have a noticeable impact on socioeconomic conditions in communities near Oconee Station, and a reduction in tax revenue resulting from nuclear power plant shutdown could decrease the availability of public services. Minority and low-income populations dependent on these services could be disproportionately affected.

(j) The NRC staff identified common impacts from the construction and operation of replacement power facilities that could disproportionately affect minority and low-income populations. Construction and operations of replacement power alternatives would not likely have disproportionately high or adverse human health and environmental effects on minority and low-income populations. However, this determination would depend on site location, nuclear power plant design, operational characteristics of the new facility, unique consumption practices and interactions with the environment of nearby populations, and the location of predominantly minority and low-income populations.

(k) NUREG-2157, *Generic Environmental Impact Statement for Continued Storage of Spent Nuclear Fuel*, (NRC 2014-TN4117) discusses the environmental impact of spent fuel storage for the time frame beyond the licensed life for reactor operations.

3 AFFECTED ENVIRONMENT, ENVIRONMENTAL CONSEQUENCES, AND MITIGATING ACTIONS

3.1 Introduction

In conducting its review of the environmental effects of renewing the Oconee Station operating licenses SLR application by Duke Energy, as supplemented, the NRC describes the environment that could be affected by the proposed action (renewal of the operating licenses authorizing an additional 20 years of reactor operation). The NRC also evaluates the environmental consequences of the proposed action as well as reasonable alternatives to the proposed action.

Chapter 2 of this EIS describes the Oconee Station facility and its operation, as well as the scope of the agency's proposed action and the no-action alternative. Chapter 2, Section 2.3, further describes the range of reasonable alternatives to the proposed action, including the replacement power alternatives selected for detailed study and the supporting assumptions and data relied upon. As noted in Chapter 2, Table 2-1, the site location for the replacement power alternatives would be within the Oconee Station site or within Duke Energy's service area. Chapter 2, Table 2-2, compares the environmental impacts of the proposed action and the alternatives to the proposed action.

In this chapter, the affected environment is the environment that currently exists at and around the Oconee Station site. Because existing conditions are at least partially the result of past construction and nuclear power plant operations, this chapter considers the nature and impacts of past and ongoing actions and evaluates how, together, these actions have shaped the current environment. This chapter also describes reasonably foreseeable environmental trends. The effects of ongoing reactor operations at the site have become well established as environmental conditions have adjusted to the presence of the nuclear facility.[1] Sections 3.2 through 3.13 describe the affected environment for each resource area, followed by an evaluation of the environmental consequences of the proposed action and alternatives to the proposed action. The environmental impacts of SLR are compared with those of the no-action alternative and replacement energy alternatives to determine whether the adverse environmental impacts are so great that it would be unreasonable to preserve the option of license renewal for energy-planning decisionmakers.

The evaluation of environmental consequences includes the following:

- impacts associated with the proposed action – continued operations similar to those that have occurred during the current license term
- impacts of various alternatives to the proposed action, including a no-action alternative (not renewing the operating licenses) and replacement energy alternatives (new nuclear, natural gas combined-cycle), and a combination alternative (new nuclear SMR, solar photovoltaic [PV], offshore wind, and demand-side management)
- impacts from the termination of nuclear power plant operations and decommissioning after the license renewal term

[1] Where appropriate, the NRC staff has summarized referenced information or incorporated information by reference into this EIS. This allows the staff to focus on new and potentially significant information identified since initial license renewal of Oconee, Units 1, 2, and 3.

- impacts of the uranium fuel cycle
- impacts of postulated accidents (design-basis accidents and severe accidents)
- cumulative effects of the proposed action
- resource commitments associated with the proposed action, including unavoidable adverse impacts, the relationship between short-term use and long-term productivity, and irreversible and irretrievable commitment of resources
- new and potentially significant information about environmental issues related to the impacts of operation during the renewal term

As stated in Section 1.4 of this EIS, the NRC evaluated environmental issues applicable to Oconee Station's SLR. Table 3-1 lists the Oconee Station SLR environmental issues and the impact findings related to these issues. This EIS considers the environmental impacts of each license renewal issue on a site-specific basis. Section 1.4 provides the definitions of SMALL, MODERATE, and LARGE impact significance.

Table 3-1 Summary of Site-Specific Conclusions Regarding Oconee Station Subsequent License Renewal

Resource Area	Environmental Issue	Impacts
Land Use	Onsite land use[(a)]	SMALL
Land Use	Offsite land use[(a)]	SMALL
Land Use	Offsite land use in transmission line right-of-ways (ROWs)[(a)]	SMALL
Visual Resources	Aesthetic impacts[(a)]	SMALL
Air Quality	Air quality impacts (all plants)[(a)]	SMALL
Air Quality	Air quality effects of transmission lines[(a)]	SMALL
Noise	Noise impacts[(a)]	SMALL
Geologic Environment	Geology and soils[(a)]	SMALL
Surface Water Resources	Surface water use and quality (non-cooling system impacts)[(a)]	SMALL
Surface Water Resources	Altered current patterns at intake and discharge structures[(a)]	SMALL
Surface Water Resources	Altered thermal stratification of lakes[(a)]	SMALL
Surface Water Resources	Scouring caused by discharged cooling water[(a)]	SMALL
Surface Water Resources	Discharge of metals in cooling system effluent[(a)]	SMALL
Surface Water Resources	Discharge of biocides, sanitary wastes, and minor chemical spills[(a)]	SMALL
Surface Water Resources	Surface water use conflicts (plants with once-through cooling systems)[(a)]	SMALL
Surface Water Resources	Effects of dredging on surface water quality[(a)]	SMALL
Surface Water Resources	Temperature effects on sediment transport capacity[(a)]	SMALL

Table 3-1 Summary of Site-Specific Conclusions Regarding Oconee Station Subsequent License Renewal (Continued)

Resource Area	Environmental Issue	Impacts
Groundwater Resources	Groundwater contamination and use (non-cooling system impacts)[(a)]	SMALL
Groundwater Resources	Groundwater use conflicts (plants that withdraw less than 100 gallons per minute [gpm])[(a)]	SMALL
Groundwater Resources	Radionuclides released to groundwater	SMALL
Terrestrial Resources	Effects on terrestrial resources (non-cooling system impacts)	SMALL
Terrestrial Resources	Exposure of terrestrial organisms to radionuclides[(a)]	SMALL
Terrestrial Resources	Cooling system impacts on terrestrial resources (plants with once-through cooling systems or cooling ponds)[(a)]	SMALL
Terrestrial Resources	Bird collisions with plant structures and transmission lines[(a)]	SMALL
Terrestrial Resources	Transmission line right-of-way (ROW) management impacts on terrestrial resources[(a)]	SMALL
Terrestrial Resources	Electromagnetic fields on flora and fauna (plants, agricultural crops, honeybees, wildlife, livestock)[(a)]	SMALL
Aquatic Resources	Impingement and entrainment of aquatic organisms (plants with once-through cooling systems or cooling ponds)	SMALL
Aquatic Resources	Entrainment of phytoplankton and zooplankton (all plants)[(a)]	SMALL
Aquatic Resources	Thermal impacts on aquatic organisms (plants with once-through cooling systems or cooling ponds)	SMALL
Aquatic Resources	Infrequently reported thermal impacts (all plants)[(a)]	SMALL
Aquatic Resources	Effects of cooling water discharge on dissolved oxygen, gas supersaturation, and eutrophication[(a)]	SMALL
Aquatic Resources	Effects of non-radiological contaminants on aquatic organisms[(a)]	SMALL
Aquatic Resources	Exposure of aquatic organisms to radionuclides[(a)]	SMALL
Aquatic Resources	Effects of dredging on aquatic organisms[(a)]	SMALL
Aquatic Resources	Effects on aquatic resources (non-cooling system impacts)[(a)]	SMALL
Aquatic Resources	Impacts of transmission line right-of-way (ROW) management on aquatic resources[(a)]	SMALL
Aquatic Resources	Losses from predation, parasitism, and disease among organisms exposed to sublethal stresses[(a)]	SMALL
Special Status Species and Habitats	Threatened, endangered, and protected species and essential fish habitat	May affect but is not likely to adversely affect the tricolored bat or monarch butterfly; no effect on essential fish habitat
Historic and Cultural Resources	Historic and cultural resources	Would not adversely affect known historic properties

Table 3-1 Summary of Site-Specific Conclusions Regarding Oconee Station Subsequent License Renewal (Continued)

Resource Area	Environmental Issue	Impacts
Socioeconomics	Employment and income, recreation, and tourism[(a)]	SMALL
Socioeconomics	Tax revenues[(a)]	SMALL
Socioeconomics	Community services and education[(a)]	SMALL
Socioeconomics	Population and housing[(a)]	SMALL
Socioeconomics	Transportation[(a)]	SMALL
Human Health	Radiation exposures to the public[(a)]	SMALL
Human Health	Radiation exposures to plant workers[(a)]	SMALL
Human Health	Human health impact from chemicals[(a)]	SMALL
Human Health	Microbiological hazards to the public (plants with cooling ponds or canals or cooling towers that discharge to a river)	SMALL
Human Health	Microbiological hazards to plant workers[(a)]	SMALL
Human Health	Chronic effects of electromagnetic fields (EMFs)[(b)]	Uncertain impact
Human Health	Physical occupational hazards[(a)]	SMALL
Human Health	Electric shock hazards	SMALL
Postulated Accidents	Design-basis accidents[(a)]	SMALL
Postulated Accidents	Severe accidents	See EIS Appendix F
Environmental Justice	Minority and low-income populations	No disproportionately high and adverse human health and environmental effects on minority and low-income populations
Waste Management	Low-level waste storage and disposal[(a)]	SMALL
Waste Management	Onsite storage of spent nuclear fuel[(a)]	SMALL
Waste Management	Offsite radiological impacts of spent nuclear fuel and high-level waste disposal[(a)]	[(c)]
Waste Management	Mixed-waste storage and disposal[(a)]	SMALL
Waste Management	Nonradioactive waste storage and disposal[(a)]	SMALL
Cumulative Impacts	Cumulative impacts	See EIS Section 3.15
Uranium Fuel Cycle	Offsite radiological impacts—individual impacts from other than the disposal of spent fuel and high-level waste[(a)]	SMALL
Uranium Fuel Cycle	Offsite radiological impacts—collective impacts from other than the disposal of spent fuel and high-level waste[(a)]	[(d)]
Uranium Fuel Cycle	Nonradiological impacts of the uranium fuel cycle[(a)]	SMALL
Uranium Fuel Cycle	Transportation[(a)]	SMALL
Termination of Nuclear Power Plant Operations and Decommissioning	Termination of plant operations and decommissioning[(a)]	SMALL

EIS = environmental impact statement; EMF = electromagnetic fields; gpm = gallons per minute; gps = gallons per minute.

(a) Dispositioned as generic (Category 1) for initial license renewal of nuclear power plants in Table B–1 in Appendix B to Subpart A of Title 10 CFR Part 51 (TN250).

Table 3-1 Summary of Site-Specific Conclusions Regarding Oconee Station Subsequent License Renewal (Continued)

Resource Area	Environmental Issue	Impacts

(b) This issue was not designated as Category 1 or 2 and is discussed in Section 3.11.6.6.
(c) The ultimate disposal of spent fuel in a potential future geologic repository is a separate and independent licensing action that is outside the regulatory scope of this site-specific review. Per 10 CFR Part 51 (TN250) Subpart A the Commission concludes that the impacts presented in NUREG-2157 (NRC 2014-TN4117) would not be sufficiently large to require the NEPA conclusion, for any plant, that the option of extended operation under 10 CFR Part 54 (TN4878) should be eliminated. Accordingly, while the Commission has not assigned a single level of significance for the impacts of spent nuclear fuel and high-level waste disposal, this issue is considered generic to all nuclear power plants and does not warrant a site-specific analysis.
(d) There are no regulatory limits applicable to collective doses to the general public from fuel-cycle facilities. The practice of estimating health effects on the basis of collective doses may not be meaningful. All fuel-cycle facilities are designed and operated to meet the applicable regulatory limits and standards. As stated in the 2013 GEIS, "The Commission concludes that these impacts are acceptable in that these impacts would not be sufficiently large to require the NEPA conclusion, for any plant, that the option of extended operation under 10 CFR Part 54 (TN4878) should be eliminated." (10 CFR Part 54; TN4878) (Section 3.13.3.3 of this EIS)

3.2 Land Use and Visual Resources

This section describes land use and visual resources in the vicinity of the Oconee Station site and the potential impacts from the proposed action SLR and replacement energy alternatives. Section 3.2 of Duke Energy's ER (Duke Energy 2021-TN8897: Appendix E) describes current onsite and offsite land use conditions as well as visual resources.

3.2.1 Land Use

The Oconee Station site lies on the shores of Lake Keowee in a rural area of northwestern South Carolina within 25 miles (mi) (40 kilometers [km]) of the North Carolina and Georgia state lines. The nuclear power plant also lies 25 mi (40 km) northwest of Anderson, South Carolina, which is the closest population center in the region (Duke Energy 2021-TN8897, Appendix E, Section 3.1). The nearest towns are Newry, South Carolina, approximately 5 mi (8 km) south and Six Mile, South Carolina, approximately 5 mi (8 km) east (Duke Energy 2021-TN8897). See Figure 3.1 3 in Duke Energy's ER (TN8897: Appendix E, pp. 3-8), which is incorporated here by reference. The sections below describe onsite and offsite land use within a 6 mi (10 km) radius and also describes the South Carolina coastal zone, with an emphasis on the statutory and regulatory provisions that govern its use.

3.2.1.1 Onsite Land Use

According to Duke Energy (TN8897), Oconee Station is located predominantly in eastern Oconee County, South Carolina, with a small portion of the site falling in Pickens County, South Carolina. Lake Keowee, which was built to provide cooling water for the nuclear power plant and generate hydroelectric power, occupies the area to the north and west of the site.

The Oconee Station site consists of 510 ac (210 hectares [ha]) of rolling hills with surface elevations of 700–900 ft (210–270 m). The Oconee Station site is further surrounded by an exclusion area boundary (EAB) formed by a 1 mi (1.6 km) radius as measured from the Oconee Nuclear Station center. All property within this 1 mi (1.6 km) radius EAB is owned in fee, including mineral rights, by Duke Energy with the exception of the Old Pickens Presbyterian Church and cemetery plot, right-of-ways (ROWs) for existing highways, and a 9.8 ac (4 ha) U.S. Government property associated with Lake Hartwell (Duke Energy 2021-TN8897). The

Old Pickens Presbyterian Church is the last remaining building from the Pickens town site (NRC 1999-TN8942), and though it is open to the public on certain days, no regular religious services occur there (Duke Energy 2021-TN8897). Through agreements with the Old Pickens Presbyterian Church property owners and the U.S. Government, Duke Energy has the authority to control activities within the EAB. Commercial enterprises within the EAB include Keowee Hydro Station, Oconee Station, and individual properties managed in partnership by Duke Energy's real estate and water strategy organization (Duke Energy 2021-TN8897). Also within the EAB is Duke Energy's World of Energy visitor center that features a public picnic area and shoreline access, and had more than 22,0000 visitors in 2018 (Duke Energy 2021-TN8897).

Although the Oconee Station site lies in an unincorporated portion of Oconee County with no zoning or land use restrictions (NRC 1999-TN8942), it is located within the Keowee/Jocassee Overlay District, which Duke Energy manages with special density, land use restrictions, and buffer requirements (Oconee County-TN9127). Overlay districts are special areas that have additional standards that overlay existing zoning districts without being separate zoning districts. The Lake Keowee/Jocassee Overlay District is measured as 750 ft (230 m) from the full pond contours of Lake Keowee and Lake Jocassee and is intended to protect water quality, maintain natural beauty, and limit the negative impacts of development around the lakes (Oconee County-TN9127). Duke Energy controls development around Lake Keowee through a property use permit process required for residential docks, private facility construction, modification and maintenance of existing structures, and modification or maintenance of existing shoreline stabilization (Duke Energy 2021-TN8897).

Oconee Station was constructed as part of Duke Energy's integrated energy-producing area, the Keowee-Toxaway Project (Federal Energy Regulatory Commission [FERC] Project 2503). Constructed from 1968–1974, the project included the construction of Lake Keowee, Lake Jocassee, the Keowee Hydroelectric Station, and the Jocassee Hydroelectric Station. The FERC issued a 50-year license for the Keowee-Toxaway Project in 1966 that expired in 2016. In 2014, Duke Energy applied for a new license. FERC issued a new 30-year operating license for the Keowee-Toxaway Hydroelectric Project in 2016 (FERC 2016-TN8967).

A number of recent projects have resulted in onsite land use changes at Oconee Station. From 2016 to 2019, Duke Energy expanded one of Oconee's onsite ISFSI configurations to host additional storage units. Oconee maintains two ISFSIs—the original installation under a site-specific license SNM-2503 and the second under the general license authorized under 10 CFR Part 72, Subpart K, "General License for Storage of Spent Fuel at Power Reactor Sites" (TN4884) The ISFSI expansion took place at the general license ISFSI. Duke Energy cleared a total of 6.6 ac (2.7 ha) for construction and operation of the 4.2 ac (1.7 ha) ISFSI expansion (Duke Energy 2022-TN8948). No wetlands were affected by the construction or operation of the ISFSI expansion. Before it was cleared, the area was forested, and the land use is now developed.

Duke Energy also cleared forested land as part of an expansion of the Operations Training Center. The planned 5 ac (2 ha) expansion required clearing of pine and mixed hardwood forest in the northwest corner of the site (Duke Energy 2018-TN8965).

From June 2020 to December 2020, Duke Energy completed a security tower project that consisted of two main parts: (1) construction of five, new onsite security observation towers ranging from 30–50 ft (9–15 m) in height and (2) vegetation clearance to provide line-of-sight for the towers. The construction of each tower required a 25 by 25 ft (7.6 by 7.6 m) base on previously developed land that was either paved or covered in gravel. In total, 3,125 ft^2 (290 m^2), or 0.07 ac (0.028 ha) of already developed (paved or gravel-covered) land was required for the five towers. Because the land was already cleared and developed, the tower bases did not change onsite land use. For the second part of the project, Duke Energy cleared a total of 5.95 ac (2.4 ha) of trees and vegetation to create lines-of-sight for the towers. The land use in the cleared areas previously consisted of a mix of forested areas and is now classified as open space. The trees were chipped into mulch that was spread as ground cover. Rip rap and sediment blankets also were used to control erosion.

Also in 2020, Duke Energy installed a new watercraft barrier below the Keowee Hydro Dam. Construction of the watercraft barrier required land on which to install two concrete anchor blocks—a west anchor block and an east anchor block. The west anchor block appears to lie in developed land while the east anchor block lies in what was formerly pasture/hay. For the construction of the barrier, two 30 by 30 ft (9 by 9 m) squares of land were disturbed or a total of 1,800 ft^2 (81 m^2). Operation of the dam required the installation of two 20 by 20 ft (6 by 6 m) aggregate bases, each of which supports a concrete anchor block. A total of 800 ft^2 (74 m^2) of land, half of which was already developed, was permanently converted to a developed impervious area.

3.2.1.2 Coastal Zone

Section 307(c)(3)(A) of the Coastal Zone Management Act of 1972, as amended (16 U.S.C. 1456(c)(3)(A)) (TN1243) requires that applicants for Federal licenses who conduct activities in a coastal zone provide a certification to the licensing agency (in this case the NRC) that the proposed activity complies with the enforceable policies of the State’s coastal zone program. The Federal regulations that implement the Coastal Zone Management Act indicate that this requirement is applicable to renewal of Federal licenses for actions not previously reviewed by the State (15 CFR 930.51(b)(1)) (TN4475).

South Carolina Code of Laws Title 48, “Environmental Protection and Conservation,” Chapter 39, Section 10, “Definitions” (SC Code 48-39-TN8966) states that, ‘Coastal zone’ means all coastal waters and submerged lands seaward to the state’s jurisdictional limits and all lands and waters in the counties of the State which contain any one or more of the critical areas. These counties are Beaufort, Berkeley, Charleston, Colleton, Dorchester, Horry, Jasper, and Georgetown.” South Carolina’s Office of Ocean and Coastal Resource Management implements the State’s Coastal Management Program, which includes indirect certification authority of Federal actions within the eight coastal counties listed above. Neither Oconee County nor Pickens County is among the eight coastal counties. As stated in Duke Energy’s ER Section 9.5.10, “ONS [Oconee Nuclear Station], located in Oconee County, is not within the South Carolina coastal zone.” Therefore, the Coastal Zone Management Act does not apply to this SLR application.

3.2.1.3 Offsite Land Use

The 6 mi (10 km) radius of the Oconee Station site boundary includes portions of Oconee County and Pickens County. Lake Keowee is the predominant natural feature. As stated in Section 3.2.2 of Duke Energy’s environmental report (TN8897), the largest land cover categories within the 6 mi (10 km) radius are forest (52.7 percent), open water (18.3 percent), developed land (14.3 percent), and pasture/hay (9.9 percent). The remaining 4.8 percent of land cover categories are grassland/herbaceous, shrub/scrub, barren land, and woody wetlands.

Oconee County traditionally relied on agriculture and textiles but has increased in industrialization and commercialization, especially with the introduction of the Keowee-Toxaway Major Lake and Energy Project in the 1960s. The county occupies 400,850 ac (162,220 ha) with the largest land use being private forest land (approximately 29 percent) followed by a nearly even split between State and Federal forest lands (23.72 percent) and agriculture (23.71 percent). The primary crops in Oconee County are corn, wheat, soybeans, and forage. Livestock is also an important agricultural product. Like Oconee County, Pickens County was also agricultural and rural, but by the end of World War II it had transitioned into manufacturing. The largest land use in Pickens County is residential, followed by agricultural. Its primary crops are corn, soybeans, and forage. Falling in both Oconee and Pickens Counties, Lake Keowee, which was created to provide cooling water to Oconee Station and to generate hydroelectric power, has become a popular residential and recreation destination, thereby greatly influencing offsite land use in the vicinity of the nuclear power plant. There are 4,500 permanent and vacation shoreline residences around Lake Keowee, as well as campgrounds, residential boat slips, commercial marinas, and retail establishments; and the area continues to experience a high volume of growth (FERC 2016-TN8967).

The South Carolina Local Government Comprehensive Planning Enabling Act (SC Code 6-29-TN9129) requires local planning commissions to, in part, review comprehensive plans not less than every 5 years and fully update comprehensive plans not less than once every 10 years. In 2020, Oconee County adopted its Oconee County, South Carolina Comprehensive Plan 2020 (Oconee County 2023-TN9130). In 2022, Pickens County adopted an updated comprehensive plan (Pickens County 2022-TN9041). In addition, in 2014, Duke Energy created a consolidated Keowee-Toxaway Project Shoreline Management Plan as part of its FERC relicensing application (Duke Energy 2014-TN9131). The plan is a comprehensive tool for managing requests for shoreline activities and considers public recreation, public access, protection of environmental resources, shoreline control, and commercial development among other resources.

There are nine public use lands within 6 mi (10 km) of Oconee Station including the Old Pickens Presbyterian Church and the Clemson University Forest, both approximately 1 mi (1.6 km) away (Duke Energy 2021-TN8897).

3.2.2 Visual Resources

The Oconee Station site lies in a forested valley in eastern Oconee County, South Carolina, on the shores of Lake Keowee. The tallest structures are the three reactor containment buildings, at approximately 191 ft (58 m). Other prominent structures include the water tower, turbine building, and the transmission lines (NRC 1999-TN8964, Duke Energy 2021-TN8897). Nuclear power plant structures are visible from adjacent highways in only a few locations (NRC 1999-TN8942). Lake Keowee is a popular recreation destination with boating, fishing, swimming, and sunbathing FERC 2016-TN8967). Recreational boaters on Lake Keowee have a partial view of the nuclear power plant, which is set back from the lake.

In 2020, Duke Energy (TN8897) installed five new security towers at Oconee Station—two 30 ft (9 m) towers, one 40 ft (12 m) tower, and two 50 ft (15 m) towers (Duke Energy 2022-TN8948). Although these towers are visible from publicly accessible areas, they are not predominant features and are part of the Oconee Station industrial setting. A new watercraft barrier completed in 2020 is visible from the Keowee River, though it is also not a predominant visual feature and is in character with the industrial appearance.

3.2.3 Proposed Action

The following sections address the site-specific environmental impacts of the Oconee Station SLR on the environmental issues related to land use and visual resources in accordance with Commission direction in CLI-22-02 and CLI-22-03.

3.2.3.1 Onsite Land Use

Operational activities during the SLR term would be similar to those already occurring at Oconee Station. The industrial nature of onsite land use would continue unchanged. Duke Energy states that it may need to expand the current ISFSI during the SLR term, and that there is sufficient onsite land for the expansion (Duke Energy 2021-TN8897). Based on this information, the NRC staff concludes that the impact of continued nuclear power plant operations on onsite land use during the Oconee Station SLR term would be SMALL. In addition, the NRC staff did not identify any new onsite land use information that would alter this conclusion.

3.2.3.2 Offsite Land Use

License renewal activities have had little to no effect on population or tax revenue in communities near nuclear power plants. Employment levels at Oconee Station have remained the same or have slightly decreased with no increased demand for housing, infrastructure improvements, or services. Operational activities during the SLR term would be similar to those already occurring at Oconee Station and would not affect offsite land use beyond what has already been affected.

Based on this information, the NRC staff concludes that the impact of continued nuclear power plant operations on offsite land use during the Oconee Station SLR term would be SMALL. In addition, the NRC staff did not identify any new offsite land use information that would alter this conclusion.

3.2.3.3 Offsite Land Use in Transmission Line Right-of-Ways

Maintenance activities in transmission line ROWs during the license renewal term would be the same as or similar to those already occurring and would not affect offsite land use beyond what has already been affected. Transmission line ROWs do not preclude the use of the land for other purposes, such as agriculture and recreation. However, land use is limited to activities that do not endanger power line operation.

Based on this information, the NRC staff concludes that the impact of continued nuclear power plant operations during the Oconee Station SLR term on offsite land use in transmission line ROWs would be SMALL. In addition, the NRC staff did not identify any new land use information that would alter this conclusion.

3.2.3.4 Aesthetic Impacts

The visual appearance of Oconee Station and associated transmission lines has become well established during the current licensing term and is not likely to change appreciably over time. The NRC staff concludes that the visual impact of continued nuclear power plant operations at Oconee Station during the SLR term would be SMALL, because the visual appearance of the nuclear power plant and transmission lines would not change. In addition, the NRC staff did not identify any new information that would alter this conclusion.

3.2.4 No-Action Alternative

3.2.4.1 Land Use

Under the no-action alternative, the NRC would not renew the Oconee Station operating licenses, and reactor operations would cease on or before the expiration of the current renewed licenses in 2033 (Units 1 and 2) and 2034 (Unit 3). Under this alternative, land uses would remain similar to those that would occur under the proposed SLR. Shutdown of Oconee Station would not affect onsite land use. Plant structures and other facilities would remain in place until decommissioning. Most transmission lines would remain in service after the cessation of reactor operations.

Maintenance of most existing infrastructure would continue. Based on this information, the NRC staff concludes that land use impacts under the no-action alternative would be SMALL.

3.2.4.2 Visual Resources

Termination of reactor operations because of not renewing the operating licenses under the no-action alternative would not change the visual appearance of the Oconee Station site. The most visible structures are the reactor containment buildings, and they would likely remain in place for some time during decommissioning until they are eventually dismantled. Overall, the NRC staff concludes that visual impacts from the no-action alternative would be SMALL.

3.2.5 Replacement Power Alternatives: Common Impacts

3.2.5.1 Land Use

Land use impacts are determined by the change in use and the amount of land affected by the construction and operation of a replacement power generating facility, infrastructure, and other installations.

<u>Construction</u>

Construction of a replacement power facility would require the permanent commitment of land designated for industrial use. Existing transmission lines and infrastructure would adequately support each of the replacement energy alternatives, thereby reducing the need for additional land commitments.

<u>Operations</u>

Operation of new power generating facilities would have no land use impacts beyond land committed for the permanent use of the replacement power plant. Additional land may be required to support power plant operations, including land for the mining, extraction, and waste disposal activities associated with each alternative.

3.2.5.2 Visual Resources

Visual impacts are determined by the degree of contrast between the replacement power generating facility and the surrounding landscape and the visibility of the new power plant.

Construction

Land for any replacement power generating facility would require clearing, excavation, and the use of construction equipment. Temporary visual impacts may occur during construction because of the use of cranes and other construction equipment.

Operations

Visual impacts during power plant operations of any of the replacement energy alternatives would be similar in type and magnitude. New cooling towers (if built) and their associated vapor plumes would be the most obvious visual impact and would likely be visible farther from the site than other buildings and infrastructure. New power plant stacks or towers may require aircraft warning lights, which would be visible at night.

3.2.6 New Nuclear (Advanced Light-Water Reactor and Small Modular Reactor) Alternative

3.2.6.1 Land Use

Construction

Approximately 3,000 ac (1,200 ha) of land would be temporarily and permanently affected by the construction and operation of the two-unit ALWRs at the W.S. Lee Nuclear Station. This would include 950 ac (650 ac permanently) for power generation, 1,100 ac (1,047 ac permanently) for a cooling water make-up pond, and 990 ac (400 ha) permanently for transmission line corridors (NRC 2013-TN6435; Duke Energy 2021-TN8897). Additional land may also be needed temporarily for construction laydown areas. The 1,928 ac (780 ha) W.S. Lee Nuclear Station industrial site is located at the abandoned Cherokee Nuclear Station site on land already zoned for industrial use. The two-unit ALWR nuclear power plant would require less than half the site acreage for construction. Constructing the make-up pond would inundate 1,050 ac (425 ha) of land. The NRC concluded in the W.S. Lee Nuclear Station Combined License final EIS that land use impacts from the construction of the two-unit ALWR nuclear power plant would be MODERATE (NRC 2013-TN6435).

Approximately 36 ac (15 ha) of land on the Oconee Station site would be required to construct the SMR on land already zoned for industrial use. Additional land would also be required for construction laydown areas. In Table 8.0-2 of its environmental report, Duke Energy (TN8897) identified an area slightly less than 110 ac (44.5 ha) on the Oconee Station site for siting the SMR. Two parcels of land include 72 ac (29 ha) south of the 525 kilovolt (kV) switchyard and 35 ac (14 ha) east of the switchyard. The SMR would use existing Oconee Station infrastructure and transmission lines. Based on this information, land use impacts from the construction of an SMR on the Oconee Station site would be SMALL because the land is already used for energy generation.

Overall, the NRC staff concludes that land use impacts during construction of the replacement power plants under the new nuclear alternative would range from SMALL to MODERATE primarily because of the land use impacts at the proposed W.S. Lee Nuclear Station site.

Operations

Land would be needed for uranium mining and fuel fabrication to support up to 40 years of nuclear power plant operations. Land use impacts would be similar to those experienced during Oconee Station operations. Based on this information, the NRC staff concludes that land use impacts from operating a new two-unit ALWR nuclear power plant and a single SMR nuclear power plant could range from SMALL to MODERATE, depending on how much additional land may be needed for uranium mining and fuel fabrication.

3.2.6.2 Visual Resources

<u>Construction and Operations</u>

Visual impacts from a new nuclear alternative would be similar to the common impacts of all replacement power alternatives described in Section 3.2.5.2, "Visual Resources." The tallest structures during construction of the two-unit ALWR nuclear power plant at the W.S. Lee Nuclear Station site would be the meteorology tower and cranes. The most visible structures would be the shield buildings—229.4 ft (69.9 m) in height. The short and compact mechanical draft cooling towers would have minimal effect on local viewsheds. However, the new reactor containment domes would be visible from local State parks. Nuclear power plant activities would also be visible from the Broad River and Ninety-Nine Islands Reservoir. Clearing forested land near SC 329 for the cooling water make-up pond would also have a noticeable visual impact. The NRC concluded in the W.S. Lee Nuclear Station Combined License final EIS that visual impacts during construction and operation would be MODERATE (NRC 2013-TN6435).

Visual impacts from the construction and operation of a single SMR would also be similar to the common impacts of all replacement power alternatives described in Section 3.2.5.2, "Visual Resources." During operations, the visual appearance of the SMR power block (i.e., reactor containments, auxiliary building, fuel building, and turbine building, which includes the main control room) would be similar to the industrial appearance of the Oconee Station power blocks. The tallest structure would be approximately 160 ft (50 m) in height, which is 31 ft (9.4 m) shorter than the tallest structures at Oconee Station (Duke Energy 2021-TN8897). Mechanical draft cooling towers (approximately 65 ft [20 m] in height) could increase the visual impact by producing water vapor plumes that could be visible from great distances. Based on this information, the NRC staff concludes that visual impacts from the construction and operation of the SMR at the Oconee Station site would be SMALL.

Based on this information, the NRC staff concludes that visual impacts during the construction and operation of the two-unit ALWR nuclear power plant at the W.S. Lee Nuclear Station site and the SMR power plant at the Oconee Station site, including cooling tower plumes that could be visible from great distances, could range from SMALL to MODERATE, depending on seasonal weather conditions.

3.2.7 Natural Gas Combined-Cycle Alternative

3.2.7.1 Land Use

<u>Construction</u>

The natural gas combined-cycle (NGCC or natural gas) replacement power alternative would be constructed on approximately 130 ac (53 ha) of land at the Oconee Station site on land already zoned for industrial use. In addition, the natural gas plant would require 191 ac (77 ha) of land offsite for a new natural gas pipeline ROW. The pipeline would connect with an existing natural gas supply line approximately 21 mi (34 km) southeast in Centerville, South Carolina (Duke Energy 2021-TN8897).

Acquisition of land to establish a new natural gas pipeline ROW to Centerville, South Carolina, would require permanently clearing a corridor of land and converting it to industrial use.

Depending on the route chosen, land use in the ROW corridor may change from agricultural, forest, wetland, or grassland to industrial use.

Given the current industrial nature of the Oconee Station site, land use impacts during construction would be SMALL to MODERATE largely because of the amount of land needed to be cleared and converted to industrial use for a new natural gas pipeline ROW.

Operations

Operation of a natural gas facility would be consistent with the existing industrial land use on the Oconee Station site. No new gas wells would be needed to support the natural gas power plant because of the current abundant supply of natural gas in the United States (Duke Energy 2021-TN8897). Elimination of land used for uranium mining to supply fuel to Oconee Station would partially offset any land use impacts of the natural gas alternative (see Section 3.14.1, "Fuel Cycle," for a description of land use impacts caused by uranium mining and natural gas extraction and collection). Operations would require management of the new natural gas pipeline ROW to keep the area free of woody vegetation (Duke Energy 2021-TN8897). Based on this information, the NRC staff concludes that land use impacts from operating a new natural gas combined-cycle power plant would be SMALL.

3.2.7.2 Visual Resources

Construction and Operations

Visual impacts would be similar to the common impacts described in Section 3.2.5.2, "Visual Resources." However, construction and operation of the natural gas power plant would have little to no additional visual impact and would be consistent with the industrial nature of the developed portions of the Oconee Station site. The tallest structures would be plant exhaust stacks that are approximately 150 ft (46 m) tall, which is 41 ft (12.5 m) shorter than the tallest structures currently at Oconee Station. This lower height profile would result in a lesser visual impact.

New mechanical draft cooling towers (approximately 70 ft [21 m] in height) would increase the visual impact by producing water vapor plumes that could be visible from great distances. Constructing a new natural gas pipeline corridor would result in temporary visual impacts. The gas pipeline corridor ROW would require regular clearing and maintenance. However, Duke Energy indicated they would avoid scenic areas, wildlife habitats, and cultural sites to reduce the visual impact (Duke Energy 2021-TN8897).

Visual impacts during natural gas power plant operations would be similar to those experienced during Oconee Station operation. Therefore, the NRC staff concludes that visual impacts during construction and operation of the natural gas alternative at the Oconee Station site, including steam plumes, could range from SMALL to MODERATE, depending on seasonal weather conditions.

3.2.8 Combination Alternative (Solar Photovoltaic, Offshore Wind, Small Modular Reactor, and Demand-Side Management)

3.2.8.1 Land Use

Construction and Operation

The solar portion of the combination alternative would require 12 utility-scale solar photovoltaic power plants with battery energy storage systems occupying a total area of approximately

9,600 ac (3,900 ha) of land, with additional land required for construction staging and laydown. Each solar photovoltaic power plant would be located within the ROI with access to Duke Energy transmission systems. Land use impacts would depend largely on the nature of the land acquired for the solar PV power plant. For example, installing the solar PV plant on land already designated for industrial use would have less of an impact. If land had to be changed from other uses (e.g., converting residential or prime farmland to industrial use) or if the land was located near residential or recreational land use areas, the impacts would be greater. Adding to the land use impact is the fact that standalone solar PV facilities cannot be co-located with other land uses (e.g., grazing and crop-producing agriculture). Based on this information, the NRC staff concludes that land use impacts during construction and operation of the solar PV plants could range from MODERATE to LARGE, depending on the type and location of land chosen for the 12 installations.

For the offshore wind component, one or more offshore wind energy facilities would be constructed along the North Carolina or South Carolina Atlantic coasts. Although most construction and operation activities for the wind farms would occur offshore, onshore land use would also be affected. Construction of wind facilities requires onshore land for staging and laydown and can disturb beaches, dunes, coastal wetlands, and bays during the installation of onshore components, such as interconnection cables, fiber-optic cables, switch cabinets, and interconnection stations (BOEM 2015-TN8399). During operations, onshore land is required for support facilities as well as a large battery storage system. The NRC staff assumes the offshore wind farm would connect to an onshore battery storage system requiring 60 ac (24 ha) of land. Land use impacts would depend largely on the nature of the land disturbed. If the lands chosen for the battery storage system were previously cleared and used for industrial activity, the impacts would be less significant than if the lands had to be converted from another use. Coastal area economies are also often dependent on tourism and recreation, which could make land use impacts more significant. However, land disturbed during construction and for laying underground cables could be revegetated. In addition, regulations in the Coastal Zone Management programs of South Carolina and North Carolina would mitigate land use impacts by prohibiting locating onshore facilities near sensitive coastal resources. Based on this information, the NRC staff concludes that land use impacts from the construction and operation of an offshore wind facility would be SMALL.

Land use impacts for the SMR portion of the combination alternative would be similar to but greater than the impacts described in Section 3.2.6.1, “Land Use,” for the SMR portion of the new nuclear alternative. Under the combination alternative, three 400 megawatt electrical (MWe) SMR units would be installed, requiring 110 ac (45 ha) of land at Oconee Station, as opposed to 36 ac (15 ha) of land for the single SMR of the new nuclear alternative. Land use impacts associated with uranium mining and fuel fabrication needed to support the three SMRs would be less than the amount of land needed to support Oconee Station operations. Based on this information, the NRC staff concludes that land use impacts from the construction and operation of three SMRs at Oconee Station would be SMALL, because the land is already zoned for industrial use.

Land use impacts associated with demand-side management would be limited to the manufacture of energy-efficient equipment and insulating materials and land used for the disposal of inefficient appliances and material at existing recycling and disposal facilities. The NRC staff concludes that overall land use impacts from the construction and operation of the combination alternative range from SMALL to LARGE, because of the large amount of land and land uses affected by the solar PV installations.

3.2.8.2 Visual Resources

<u>Construction and Operations</u>

Utility-scale solar PV installations require large land areas, and solar PV panels could be visible to the public from offsite locations, depending on the buffer areas or screening. Solar PV installations would be sited to comply with land use zoning and any required buffers or screening. Based on the topography, size, and location of the land chosen, the NRC staff concludes that the construction and operation of 12 solar PV power plants would have a MODERATE to LARGE impact on visual resources.

Offshore wind turbines would be visible from all directions and could have a large impact on the viewshed, depending on the location of the wind farm site. Avoiding impacts on the most scenic viewsheds would reduce the most significant visual impacts, allowing the impact to be noticeable but not destabilizing. Depending on viewing conditions, small to moderately sized turbines placed up to 26 mi (42 km) from the coast can be visible from the shore (Sullivan et al. 2013-TN8444). When visible, offshore wind turbines can have a negative impact on tourism and shoreline property values. For these reasons, wind energy area boundaries were moved farther offshore and away from important recreation and tourism areas, such as the Cape Hatteras National Seashore and the Outer Banks. The wind energy areas were designed to minimize effects on the viewshed of such areas (BOEM 2015-TN9066). Because of larger size utility-scale commercial wind turbines, the number of turbines, the variability of distance from the shore of important coastal areas, and the scenic importance of the coastal areas, the NRC staff concludes that the construction and operation of offshore wind farms could have a MODERATE visual impact.

Visual impacts from constructing and operating three SMRs would be similar and greater than the impacts described in Section 3.2.6.2, “Visual Resources,” for the SMR portion of the new nuclear alternative. The addition of mechanical draft cooling towers (approximately 65 ft [20 m] in height) would increase the visual impact by producing water vapor plumes that could be visible from great distances. Based on this information, the NRC staff concludes that visual impacts during the construction and operation of the three SMRs at Oconee Station, including cooling tower plumes that could be visible from great distances, could range from SMALL to MODERATE, depending on seasonal weather conditions.

Demand-side management is not likely to have any visual impact. Overall, the NRC staff concludes that the visual impacts from the construction and operation of the combination alternative could range from SMALL to LARGE. This range is primarily due to the potential visual impacts from the solar and wind components of this alternative.

3.3 <u>Meteorology, Air Quality, and Noise</u>

This section describes the meteorology, air quality, and noise environment in the vicinity of the Oconee Station site. The description of the resources is followed by the staff’s analysis of the potential air quality and noise impacts from the proposed action (SLR) and alternatives to the proposed action.

3.3.1 Meteorology and Climatology

South Carolina’s climate is humid and subtropical, characterized by hot and humid summers and mild winters. The Appalachian Mountains to the north shield the state from cold air masses and the semi-permanent high-pressure system in the North Atlantic Ocean (Bermuda High) provides a flow of warm, moist air (NOAA 2022-TN9132). The annual average temperature varies across the state from mid-50° F in the mountains to mid-60°F along the coast. Similarly, precipitation varies across the state from 80 in. (203 cm) near the mountains to less than 39 in. (99 cm) in the middle of the state (NOAA 2022-TN9132).

Duke Energy maintains a meteorological monitoring system comprising two meteorological towers. Meteorological Tower Number 1 is located northwest of the units and measures the wind speed and direction, temperature, and vertical temperature gradient. Meteorological Tower Number 2 is located east of the units and measures the wind speed and direction, vertical temperature gradient, and precipitation. In Section 3.3.2 of the ER, Duke Energy provided meteorological observations from Oconee Station's onsite meteorological monitoring system for the 1989–2018 period. The NRC staff obtained climatological data from the Greer, South Carolina, weather station. This station is approximately 48 mi (77 km) northwest of the Oconee Station site and is used to characterize the region's climate because of its location and long period of record. The staff evaluated these data in context with the climatological record from Oconee Station.

The mean annual temperature from Oconee Station's onsite meteorological towers is 61°F (16.1°C) for the 1989–2018 period, with a mean monthly temperature ranging from a low of 43°F (6.1°C) in January to a high of 78°F (25.5°C) in July (Duke Energy 2021-TN8897). The mean annual temperature for the 60-year period of record (1963–2022) at the Greer weather station is 60.7°F (15.9°C), with a mean monthly temperature ranging from a low of 41.4°F (5.2°C) in January to a high of 79.1°F (26.1°C) in July (National Climatic Data Center [NCDC] NOAA 2023-TN9477).

The mean annual total precipitation from Oconee Station's onsite meteorological towers is 53.6 in. (1.35 m) for the 1989–2018 period, with a mean monthly precipitation ranging from a low of 3.8 in. (9.7 cm) in October to a high of 5.1 in. (12.9 cm) in December and March (Duke Energy 2021-TN8897). The mean annual total precipitation for the 60-year period of record (1963–2022) at the Greer weather station is 50.1 in. (1.3 m), with a mean month precipitation ranging from a low of 3.75 in. (9.5 cm) in November to a high of 4.95 in. (12.6 cm) in March (NOAA 2023-TN9477).

The mean annual wind speed from Oconee Station's onsite meteorological towers is 4.5 miles per hour (mph) (7.2 kilometers/hour [km/hr]), with a prevailing wind direction from west-southwest during the months of November through July and from the northeast during the months of August through October (Duke Energy 2021-TN8897). The mean annual wind speed from the Greer weather station for the 39-year period of record (1984–2022) is 6.5 mph (10.5 km/hr), with a prevailing wind direction from the north-northeast (NOAA 2023-TN9477).

South Carolina is subject to occasional extreme weather events, including tornadoes and flooding. The following number of severe weather events have been reported in Oconee County and Pickens County from January 1950 through March 2023 (NOAA NCEI 2023-TN9148):

- flooding: 27 events
- tornadoes: 63 events
- thunderstorms: 602 events
- hail: 352 events

3.3.2 Air Quality

Under the Clean Air Act of 1963, as amended (CAA), 42 U.S.C. 7401, et seq.-TN1141, the EPA has set primary and secondary National Ambient Air Quality Standards (NAAQSs; 40 CFR Part 50, “National Primary and Secondary Ambient Air Quality Standards”) for six common criteria pollutants to protect sensitive populations and the environment (TN1089). The NAAQS criteria pollutants include carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO_2), ozone (O_3), sulfur dioxide (SO_2), and particulate matter (PM). The PM is further categorized by size—PM_{10} (diameter of 10 micrometers or less) and $PM_{2.5}$ (diameter of 2.5 micrometers or less).

The EPA designates areas of attainment and nonattainment with respect to meeting NAAQSs. Areas for which there are insufficient data to determine attainment or nonattainment are designated as unclassifiable. Areas that were once in nonattainment, but are now in attainment, are called maintenance areas; these areas are under a 10-year monitoring plan to maintain the attainment designation status. States have the primary responsibility for ensuring compliance with the NAAQSs. Under CAA Section 110 (42 U.S.C. 7410-TN4851) and related provisions, States are to submit State Implementation Plans that provide for the timely attainment and maintenance of the NAAQSs for EPA approval.

In South Carolina, air quality designations are made at the county level. For the purpose of planning and maintaining ambient air quality with respect to the NAAQSs, the EPA has developed air quality control regions. Air quality control regions are intrastate or interstate areas that share a common airshed. Oconee Station is located primarily in Oconee County, South Carolina, with a portion of the site extending into neighboring Pickens County, South Carolina. Oconee County and Pickens County are within the Greenville-Spartanburg Intrastate Air Quality Control Region (40 CFR 81.106-TN7226). With regard to NAAQSs, the EPA designates Oconee County and Pickens County as being in attainment with respect to all air criteria pollutants (EPA 2023-TN8954).

3.3.3 Noise

Noise is unwanted sound and can be generated by many sources. Sound intensity is measured in logarithmic units called decibels (dB). A dB is the ratio of the measured sound pressure level to a reference level equal to a normal person’s threshold of hearing. Most people barely notice a difference of 3 dB or less. Another characteristic of sound is frequency or pitch. Noise may be composed of many frequencies, but the human ear does not hear very low or very high frequencies. To represent, as closely as possible, the noise levels people experience, sounds are measured using a frequency-weighting scheme known as the A-scale. Sound levels measured on this A-scale are given in units of A-weighted decibels (dBA). Levels can become annoying at 80 dBA and very annoying at 90 dBA. To the human ear, each increase of 10 dBA sounds twice as loud (EPA 1981-TN7412).

Several different terms are commonly used to describe sounds that vary in intensity over time. The equivalent sound intensity level (Leq) represents the average sound intensity level over a specified interval, often 1 hour. The day-night sound intensity level is a single value calculated from hourly Leq during a 24-hour period, with the addition of 10 dBA to sound levels from 10 p.m. to 7 a.m. This addition accounts for the greater sensitivity of most people to nighttime noise. Statistical sound level (Ln) is the sound level that is exceeded n percent of the time during a given period. For example, L90, is the sound level exceeded 90 percent of time and is considered the background level.

Primary offsite noises in the vicinity of the Oconee Station site include vehicular traffic and recreational activities associated with boating and fishing in Lake Keowee (Duke Energy 2021-TN8897). The nearest resident is located approximately 1 mi (1.6 km) from Oconee Station. Primary noise sources at Oconee Station include turbine generators, loudspeakers, firing range, transformers, and main steam safety valves. Between 2014–2022, Duke Energy has not received any noise complaints as a result of operation of Oconee Station (Duke Energy 2021-TN8897, Duke Energy 2021-TN8898, Duke Energy 2022-TN8899).

3.3.4 Proposed Action

The following sections address the site-specific environmental impacts of the Oconee Station SLR on the environmental issues related to meteorology, air quality, and noise in accordance with Commission direction in CLI-22-02 and CLI-22-03.

3.3.4.1 Air Quality Impacts (All Plants)

The ambient air quality in the vicinity of Oconee Station is described in Section 3.3.2 of this EIS. Impacts on air quality during normal plant operations can result from the operation of fossil fuel-fired equipment needed for various plant functions. The SCDHEC regulates air emissions at the Oconee Station site under a conditional major operating permit (Air Permit No. CM-1820-0041). Oconee Station's conditional major operating permit expires on December 31, 2027 (SCDHEC 2023-TN8970). Oconee Station's permitted air emission sources include an auxiliary boiler. In addition to the auxiliary boiler, some air emission sources and activities at Oconee Station are exempt from air quality permitting, including generators and compressors, paint mixing operations, the cement silo, and coating and blasting (SCDHEC 2023-TN8970). These exempt sources, however, must be accounted for in the facility-wide emissions reports submitted to the SCDHEC (SCDHEC 2023-TN8970, SCDHEC 2023-TN8971). Duke Energy submits annual emission reports to the SCDHEC in accordance with Oconee Station's major operating permit. Table 3-2 presents Oconee Station's annual air emissions from 2015–2022. Table 3-3 presents annual air emissions for Oconee and Pickens Counties (EPA 2020-TN8975). The contribution of air emissions from sources at Oconee Station constitutes less than 1 percent of the annual emissions from either Oconee or Pickens County.

Table 3-2 Reported Air Pollutant Emissions from Oconee Station, South Carolina (tons/year[a])

Year	Nitrogen Oxides[b]	Carbon Monoxide	Hazardous Air Pollutants
2015	8.44	1.86	0.27
2016	5.74	1.27	0.25
2017	10.27	2.41	0.21
2018	7.09	N/A[b]	N/A
2019	9.75	N/A	N/A
2020	11.68	N/A	N/A
2021	4.73	N/A	N/A
2022	5.45	N/A	N/A

N/A = not available
(a) To convert tons per year to metric tons per year, multiply by 0.90718.
(b) In accordance with Permit CM-1820-0041, effective 1/1/2018, only nitrogen oxide emissions are quantified and submitted annually (SCDHEC 2023-TN8970; Duke Energy 2021-TN8897).
Sources for Air Emissions: Duke Energy 2021-TN8897, Duke Energy 2022-TN8948.

Duke Energy reports that it has not received any notices of violation or noncompliance associated with Oconee Station's major operating permit between 2014 and 2021 (Duke Energy 2022-TN8948). The NRC staff's review of EPA's Enforcement and Compliance History Online system 3-year compliance history (between April 2019 through March 2023) revealed no notices of violation (EPA 2023-TN8953). However, in 2022, Duke Energy reported two self-identified noncompliance events to SCDHEC (Duke Energy 2022-TN8948). The noncompliance events consisted of preventive maintenance of two generators not being performed within the manufacturer's recommended time frame. The events were entered in Oconee Station's corrective action program to prevent their reoccurrence (Duke Energy 2022-TN8948).

Table 3-3 Annual Air Emissions for Oconee and Pickens Counties in South Carolina (tons/year[a])

County	Nitrogen Oxides	Carbon Monoxide	Sulfur Dioxide	Particulate Matter less than 10 microns
Oconee	1,617	17,876	98	4,825
Pickens	1,659	14,566	45	3,574

(a) To convert tons per year to metric tons per year, multiply by 0.90718.
Source: EPA 2020-TN8975.

The EPA promulgated the Regional Haze Rule to improve and protect visibility in national parks and wilderness areas from haze, which is caused by numerous, diverse air pollutant sources located across a broad region (40 CFR 51.308–309: TN1090). Specifically, 40 CFR 81 Subpart D, "Identification of Mandatory Class I Federal Areas Where Visibility Is an Important Value," lists mandatory Federal areas where visibility is an important value. The Regional Haze Rule requires States to develop State Implementation Plans to reduce visibility impairment at Class I Federal Areas. The nearest Class 1 Federal Area is the Shining Rock Wilderness Area in North Carolina, approximately 48 mi (77 km) from the Oconee Station site.

Federal land management agencies that administer Federal Class I areas consider an air pollutant source that is located more than 31 mi (50 km) from a Class I area to have negligible impacts with respect to Class I areas if the total SO_2, NO_x, PM_{10}, and sulfuric acid annual emissions from the source are less than 500 tons (T) (450 metric tons (MT)) per year (70 FR 39104-TN8374; NPS 2010-TN7925). Given the distance of the Oconee Station site from a Class 1 area and the air emissions presented in Table 3-2, there is little likelihood that ongoing activities at the Oconee Station site adversely affect air quality in the Shining Rock Wilderness Area.

Duke Energy does not anticipate future upgrades or replacement of air emission sources during the SLR term to support plant operations (Duke Energy 2021-TN8897). SLR would continue current operating conditions and, therefore, the impacts of current operations and SLR would be similar. Given Oconee Station's limited air emission as presented in Table 3-2, there is little likelihood that ongoing activities at Oconee Station during the SLR term would adversely affect air quality. Based on these considerations, the NRC staff concludes that the air quality impacts of continued nuclear plant operations at Oconee Station would be SMALL.

3.3.4.2 Air Quality Effects of Transmission Lines

Small amounts of ozone and substantially smaller amounts of oxides of nitrogen are produced during corona, a phenomenon that occurs when air ionizes near isolated irregularities on the conductor surface of transmission lines. Duke Energy has not conducted field tests of ozone and nitrogen oxide emissions generated by Oconee Station’s 230 kV and 525 kV in-scope transmission lines (Duke Energy 2023-TN8952). Several studies have quantified the amount of ozone generated and concluded that the amount produced by even the largest lines in operation (765 kV) is insignificant (SNYPSC 1978-TN7478; Scott-Walton et al. 1979-TN7480; Janes 1978-TN7479; Varfalvy et al. 1985-TN7364). Monitoring by Bonneville Power Administration of ozone levels for 2 years near a 1,200 kV prototype line revealed no increase in ambient ozone levels caused by the line (Lee et al. 1989-TN7481). Similarly, field tests conducted over a 19-month period concerning ozone levels adjacent to Sequoyah Nuclear Plant transmission lines concluded that high-voltage lines up to 765 kV do not generate ozone above ambient measurements made at locations remote from transmission lines (TVA 2013-TN7899; NRC 2015-TN5842). The ozone concentrations generated by transmission lines are therefore too low to cause any significant effects. The minute amounts of oxides of nitrogen produced are similarly insignificant. SLR would continue current operating conditions. On the basis of these considerations, the NRC staff concludes that the air quality impacts of transmission lines during the Oconee Station SLR term would be SMALL.

3.3.4.3 Noise Impacts

The ambient noise conditions in the vicinity of the Oconee Station site are described in Section 3.3.3 of this EIS. Duke Energy does not anticipate refurbishment activities during the proposed SLR term and nuclear power plant operations would not change appreciably with time. Therefore, there would be no noise generated by construction-related activities and equipment typically associated during refurbishment. The primary noise sources and levels currently present at Oconee Station, as discussed in Section 3.3.3, would be the same during the SLR term. Noise from many of the sources at Oconee Station (e.g., loudspeakers, firing range, transformers, and main steam safety valves) are intermittent. Noise from the turbine generator is continuous, but accounting for building walls as a noise barrier and dissipation given the distance to nearby residents (approximately 1 mi [1.6 km]), noise levels are not expected to be distinguishable from other noise in the vicinity of Oconee Station. Duke Energy does not anticipate any subsequent license-related refurbishment; and therefore, noise levels are anticipated to remain the same during the SLR term (Duke Energy 2021-TN8897). Based on these considerations, the NRC staff concludes that noise impacts from continued operation of Oconee Station during the SLR term would be SMALL.

3.3.5 No-Action Alternative

3.3.5.1 Air Quality

Under the no-action alternative, the permanent cessation of Oconee Station operations would reduce overall air emissions (e.g., from boiler and vehicle traffic). Therefore, the NRC staff concludes that if emissions decrease, the impact on air quality from the shutdown of Oconee Station would be SMALL.

3.3.5.2 Noise

The permanent cessation of Oconee Station operations would result in a reduction in noise from the turbine generators, transformers, firing range, main steam safety values, and from vehicle traffic (e.g., workers, deliveries). As site activities are reduced, the NRC staff expects the impact on ambient noise levels to be less than current nuclear power plant operations; therefore, the NRC staff concludes that impacts on noise levels from the no-action alternative would be SMALL.

3.3.6 Replacement Power Alternatives: Common Impacts

3.3.6.1 Air Quality

<u>Construction</u>

Construction of a replacement power alternative would result in temporary impacts on local air quality. Air emissions include criteria air pollutants (PM, nitrogen oxides, CO, and SO_2), volatile organic compounds, hazardous air pollutants, and greenhouse gases (GHGs). Air emissions would be intermittent and would vary based on the level and duration of specific activities throughout the construction phase. During the construction phase, the primary sources of air emissions would consist of engine exhaust and fugitive dust emissions. Engine exhaust emissions would be from heavy construction equipment and commuter, delivery, and support vehicular traffic traveling to and from the facility as well as within the site. Fugitive dust emissions would be from soil disturbances by heavy construction equipment (e.g., earthmoving, excavating, and bulldozing), vehicle traffic on unpaved surfaces, concrete batch plant operations, and wind erosion to a lesser extent.

Various mitigation techniques and best management practices (BMPs) (e.g., watering disturbed areas, reducing equipment idle times, and using ultra-low sulfur diesel fuel) could be used to minimize air emissions and reduce fugitive dust.

<u>Operations</u>

The impacts on air quality as a result of operation of a facility for a replacement power alternative would depend on the energy technology (e.g., nuclear or renewable). Worker vehicles and auxiliary power equipment would result in additional air emissions. Mechanical draft cooling towers would also result in air emissions for the new nuclear, natural gas alternative, and combination alternative.

3.3.6.2 Noise

<u>Construction</u>

Construction of a replacement power facility would be similar to the construction of any industrial facility in that they all involve many noise-generating activities. In general, noise emissions would vary during each phase of construction, depending on the level of activity, types of equipment and machinery used, and site-specific conditions. Typical construction equipment, such as dump trucks, loaders, bulldozers, graders, scrapers, air compressors, generators, and mobile cranes, would be used; and pile-driving and blasting activities could take place. Other noise sources include construction worker vehicle and truck delivery traffic. However, noise from vehicular traffic would be intermittent.

<u>Operations</u>

Noise generated during operations could include noise from transformers, turbines, equipment, and speakers, as well as offsite sources, such as employees and delivery vehicular traffic. Noise from vehicles would be intermittent. Mechanical draft cooling towers also would contribute to noise levels.

3.3.7 New Nuclear (Advanced Light-Water Reactor and Small Modular Reactor) Alternative

3.3.7.1 Air Quality

Construction

Air emissions and sources associated with construction of the new nuclear alternative would include those identified as being common to all replacement power alternatives in Section 3.3.6.1 of this EIS. Air emissions from construction of the SMR portion would be limited, local, and temporary. Additionally, while some infrastructure construction upgrades would be required for the SMR portion at the Oconee Station site, the use of the existing infrastructure (e.g., transmission lines, intake and discharge structures) would be maximized. Furthermore, given the relatively small land requirement, this would result in less fugitive dust emissions. Therefore, the NRC staff concludes that the associated air quality impacts from construction of the SMR portion at the Oconee Station site would be SMALL. The NRC staff evaluated the air quality impacts of constructing two 2,234 MWe ALWRs at the W.S. Lee Nuclear Station site in Section 4.7 of NUREG-2111 (NRC 2013-TN6435, pp. 4-112 through 4-115). In that analysis, the staff considered the impacts on air quality from earthmoving, concrete batch operations, construction equipment emissions, and vehicular emissions. The staff concluded in NUREG-2111 that the impacts from constructing two 2,234 MWe ALWRs on air quality would be SMALL. The NRC staff incorporates the analysis in Section 4.7 of NUREG-2111 (pp. 4-112 through 4-115) here by reference. Therefore, the air quality impacts from construction of the ALWR portion at the W.S. Lee Nuclear Station site would be SMALL. Overall, the NRC staff concludes that the air quality impacts from construction of the new nuclear alternative would be SMALL.

Operations

Air emissions and sources associated with operation of the new nuclear alternative would include those identified as being common to all replacement power alternatives in Section 3.3.6.1 of this EIS. Sources of air emissions from operation of a new nuclear alternative would include stationary combustion sources (e.g., diesel generators, auxiliary boilers, and gas turbines) and mobile sources (e.g., worker vehicles, truck deliveries) (NRC 2019-TN6136). Given the similar air emission sources and uses, operation of an SMR would result in air emissions similar in magnitude to air emissions from operation of Oconee Station. Additional air emissions would result from the use of mechanical draft cooling towers and could contribute to the impacts associated with the formation of visible plumes, fogging, and subsequent icing downwind of the towers. The NRC staff concludes that the impacts of operation of a SMR at the Oconee Station site would be SMALL.

The ALWR portion of this alternative would comprise of two ALWR units providing a net total generation capacity of 2,234 MWe. The NRC staff evaluated the air quality impacts from operation of two ALWR units with a total net electrical output capacity of 2,234 MWe at the W.S. Lee Nuclear Station site in Sections 5.7.2 and 5.7.3 of NUREG-2111 (NRC 2013-TN6435, pp. 5-65 through 5-67). In that analysis, the staff considered the impacts on air quality from the operation of diesel generators and pump emissions, transmission lines, and vehicular emissions. The staff determined in NUREG-2111 that the air quality impacts from operation of two ALWR units on air quality would be minimal. The NRC staff incorporates the analysis in Sections 5.7.2 and 5.7.3 of NUREG-2111 (pp. 5-63 through 5-67) here by reference. Therefore, the air quality impacts from operation of the ALWR portion at the W.S. Lee Nuclear Station site would be SMALL. Overall, the NRC staff concludes that the air quality impacts from operation of the new nuclear alternative would be SMALL.

3.3.7.2 Noise

Construction

Noise sources during construction of a new nuclear alternative would include those discussed for all replacement power alternatives in Section 3.3.6.2 of this EIS. Noise impacts during construction of the SMR portion would be limited to the immediate vicinity of the Oconee Station site. Based on the temporary nature of construction activities, the distance of noise sensitive receptors from the Oconee Station site (approximately 1 mi [1.6 km] away), and consideration of noise attenuation from the construction site, the NRC staff concludes that the potential noise impacts from construction activities from the SMR portion would be SMALL.

The ALWR portion of this alternative would comprise of two ALWR units providing a net total generation capacity of 2,234 MWe. In Section 4.8.2 of NUREG-2111 (pp. 4-117 through 4-118), the NRC staff evaluated the noise impacts from construction of two ALWR units with a total net electrical output capacity of 2,234 MWe at the W.S. Lee Nuclear Station site. The NRC staff concluded in NUREG-2111 (NRC 2013-TN6435) that noise impacts from construction of two ALWR units would be minimal. The staff incorporates the analysis in Section 4.8.2 of NUREG-2111 (pp. 4-117 through 4-118) here by reference. Therefore, the noise impacts from construction of the ALWR portion at the W.S. Lee Nuclear Station site would be SMALL. Overall, the noise impacts associated with construction of the new nuclear alternative would be SMALL.

Operations

Noise sources during operation of the new nuclear alternative would include those discussed for all replacement power alternatives in Section 3.3.6.2. Noise impacts from operation of the SMR portion would be similar to noise levels generated by the operation of Oconee Station. Operation of a mechanical draft cooling tower would result in additional noise. However, given the distance of nearby sensitive receptors (approximately 1 mi [1.6 km] away) from Oconee Station and consideration of noise attenuation, the NRC staff does not expect offsite noise levels from mechanical towers to nearby receptors to be greater than current levels. Therefore, the noise impacts from operation of the of the SMR portion would be SMALL.

The ALWR portion of this alternative would comprise two ALWR units providing 2,234 MWe of generating capacity. The NRC staff evaluated the noise impacts from operations of two ALWR units with a total net electrical output capacity of 2,234 MWe at the W.S. Lee Nuclear Station site in Section 5.8.2 of NUREG-2111 (pp. 5-69 through 5-70). In that analysis, the staff considered noise levels from draft cooling towers, pumps, loudspeakers, and transformers. The staff concluded in NUREG-2111 (NRC 2013-TN6435) that noise impacts from operation of two ALWR units would be minor. The NRC staff incorporates the analysis in Section 5.8.2 of NUREG-2111 (pp. 5-69 through 5-70) here by reference. Therefore, the noise impacts from operation of the ALWR portion at the W.S. Lee Nuclear Station site would be SMALL. Overall, the NRC staff concludes that the noise impacts associated with operations of the new nuclear alternative would be SMALL.

3.3.8 Natural Gas Combined-Cycle Alternative

3.3.8.1 Air Quality

<u>Construction</u>

Air emissions and sources for construction of the natural gas alternative would include those identified as being common to all replacement power alternatives in Section 3.3.6.1 of this EIS. Air emissions would result from some infrastructure construction upgrades at the Oconee Station site and construction of a 21 mi (34 km) natural gas pipeline. However, the use of the existing infrastructure (e.g., transmission lines, intake and discharge structures, roads) would be maximized, thereby minimizing fugitive dust and engine exhaust air emissions. Air emissions would be localized and intermittent and adherence to well-developed and well-understood construction best management practices would mitigate air quality impacts. Therefore, the NRC staff concludes that construction-related impacts on air quality from a natural gas alternative would be SMALL.

<u>Operations</u>

Operation of a natural gas plant would result in emissions of criteria pollutants and GHGs released through the heat-recovery steam generator stacks. The NRC staff estimated air emissions for the natural gas alternative using emission factors developed by the U.S. Department of Energy's National Energy Technology Laboratory (NETL 2019-TN7484). Assuming a total gross capacity of 3,009 MWe and a capacity factor of 0.85, the NRC staff estimates the following air emissions would result from operation of a natural gas alternative:

- carbon monoxide – 160 tons (145 MT) per year
- nitrogen oxides – 260 tons (235 MT) per year
- sulfur dioxide – 80 tons (70 MT) per year
- particulate matter – 160 tons (145 MT) per year
- carbon dioxide – 9.8 million tons (8.9 million MT) per year

Operation of mechanical draft cooling towers and up to 190 worker vehicles would result in additional air emissions. A permit from the SCDHEC for air pollutants associated with the operation of the new natural gas alternative would need to be secured. A new natural gas plant would qualify as a major emitting industrial facility. As such, the new natural gas plant would be subject to Prevention of Significant Deterioration and Title V air-permitting requirement under the CAA (42 U.S.C. 7661 et seq.-TN5268) to ensure that air emissions are minimized and that the local air quality is not degraded substantially.

Based on the NRC staff's air emission estimates, nitrogen oxide and CO_2 emissions from a natural gas plant would be noticeable and significant. The NRC staff concludes that the overall air quality impacts associated with operation of a natural gas alternative would be MODERATE.

3.3.8.2 Noise

<u>Construction</u>

In addition to the onsite and offsite sources of noise discussed in Section 3.3.5.2 of this EIS, construction of a natural gas pipeline to support the operation of a natural gas alternative would result in additional offsite noise. Given the distance to noise-sensitive receptors (approximately

1.0 mi [1.6 km] away), noise generated as a result of the construction of a natural gas alternative at the Oconee Station site would not be noticeable. However, noise generated during construction of a natural gas pipeline may be noticeable, depending on the location of and distance to nearby noise-sensitive receptors relative to the natural gas pipeline corridor. Therefore, the NRC staff concludes that the potential noise impacts of construction activities from a natural gas alternative would be SMALL to MODERATE.

Operations

During operations, sources of noise from a natural gas alternative would include those discussed in Section 3.3.6.2, as well as offsite mechanical noise from compressor stations and pipeline blowdowns. The majority of noise-producing equipment (e.g., turbines, pumps, mechanical draft cooling towers) would be located inside the power block, and the NRC staff does not anticipate noise levels for noise-sensitive receptors to be significantly greater than noise levels from operation of Oconee Station. The FERC requires that any new compressor station or any modification, upgrade, or update of an existing station must not exceed a day-night sound intensity level of 55 dBA at the closest noise sensitive area (18 CFR 157.206-TN7483). A day-night sound intensity level of 55 dBA was designated by the EPA as a noise level that is adequate to protect against outdoor activities (EPA 1974-TN3941). Therefore, the NRC staff concludes that the noise impacts from operation of a natural gas alternative would be SMALL.

3.3.9 Combination Alternative (Solar PV, Offshore Wind, Small Modular Reactor, and Demand-Side Management)

3.3.9.1 Air Quality

Construction

Air emissions associated with the construction of the new nuclear portion of the combination alternative would be similar, but greater than, those associated with the SMR portion discussed in Section 3.3.6.1, because it would consist of three SMRs located at the Oconee Station site. Some infrastructure construction upgrades would be required for the SMR portion at the Oconee Station site, and the use of the existing infrastructure (e.g., transmission lines, intake, and discharge structures) would be maximized. Engine exhaust emissions would be from heavy construction equipment and commuter traffic and would be temporary and intermittent. Therefore, the NRC staff concludes that the air quality impacts associated with construction of the new nuclear portion of the combination alternative would be SMALL. No direct air emissions would result from demand-side management initiatives.

The solar PV portion of the combination alternative would not have a power block. Accordingly, the amount of heavy equipment and size of the workforce, level of activities, and construction duration would be substantially lower than those for other alternatives and consequently would have fewer air emissions. Therefore, the NRC staff concludes that the overall air quality impacts associated with construction of the solar PV portion of the combination alternative would be SMALL.

Air emissions sources related to the construction of the offshore wind portion would include the engine exhaust of heavy equipment and vessel traffic associated with installation of the meteorological data collection facilities (i.e., meteorological towers or meteorological buoys) and wind turbines. However, given the distance to shore (10 to 24 nautical mi, the NRC staff does not anticipate engine exhaust emissions to affect onshore air quality. Because vessel traffic traveling to and from offshore sites would be intermittent, and activity onshore would be of short duration, air emissions would be negligible; and the NRC staff does not anticipate vessel traffic to affect onshore air quality. Therefore, the NRC staff concludes that the air quality impacts associated with construction of the offshore wind portion of the combination alternative would be SMALL.

The NRC staff concludes that the overall air quality impacts associated with construction of the combination alternative would be SMALL.

Operations

No direct air emissions would result from the demand-side management initiatives. Air emissions associated with the operation of the new nuclear portion would be similar to, but slightly greater than, those associated with the SMR portion discussed in Section 3.3.7.1, because this new nuclear portion would consist of three SMRs and a greater number of workers. Operation of onsite combustion sources would be intermittent, and would occur primarily during testing. Worker and delivery emissions would be similarly intermittent. Therefore, the NRC staff concludes that air quality impacts from operations of the new nuclear portion would be SMALL.

Direct air emissions associated with operation of the solar PV portion of the combination alternative would be negligible because no fossil fuels are burned to generate electricity. Emissions from solar fields would include fugitive dust and engine exhaust from worker vehicles and heavy equipment associated with site inspections and maintenance activities, and wind erosion from cleared lands and access roads. Emissions would be localized and intermittent. Therefore, the NRC staff concludes that air quality impacts from operation of the solar PV portion would be SMALL.

Air emissions associated with operation of the offshore wind portion would be derived from the use of diesel generators supporting meteorological data collection facilities (meteorological towers or meteorological buoys) and the engine exhaust of vessel traffic traveling to and from offshore sites for operation and maintenance activities (BOEM 2018-TN8428). However, given the distance to shore (10 to 24 nautical mi [18.5 to 44.4 km]), the use of diesel generators is not anticipated to affect onshore air quality. Vessel traffic traveling to and from offshore sites would be intermittent and activity onshore would be of short duration. Therefore, the NRC staff concludes that the air quality impacts associated with operation of the offshore wind portion of the combination alternative would be SMALL.

The NRC staff concludes that the overall air quality impacts associated with operation of the combination alternative would be SMALL.

3.3.9.2 Noise

Construction

Noise impacts would not result from demand-side management initiatives. Construction-related noise sources for the new nuclear portion of the combination alternative would be similar to those of the SMR portion of the new nuclear alternative discussed in Section 3.3.6.2 of this EIS, because it would consist of three SMRs located at the Oconee Station site. Noise impacts during construction of the new nuclear portion of the combination alternative would be limited to the immediate vicinity of the Oconee Station site. Based on the temporary nature of construction activities, the distance of noise-sensitive receptors from the Oconee Station site (approximately

1 mi [1.6 km] away), and consideration of noise attenuation from the construction site, the NRC staff concludes that the potential noise impacts of construction activities from the new nuclear portion would be SMALL.

No power block buildings would have to be constructed for the solar PV portion of the combination alternative. The amount of heavy equipment and size of the workforce, level of activities, and construction duration would be lower than those for the other alternatives. However, noise levels generated by construction activities associated with a solar PV facility can range from 70 to 80 dBA at 50 ft (15 m) (BLM 2019-TN8386). For the solar PV portion of the combination alternative, noise levels for nearby sensitive receptors would depend on the distance from the sites to the nearby receptors and may be noticeable. Therefore, noise impacts associated with construction of the solar PV portion of the combination alternative would be SMALL to MODERATE.

Construction-related noise sources associated with the offshore wind portion would include boring, drilling, dredging, pile driving, and heavy equipment and vessel traffic. Given the distance from shore (10–24 nautical miles [18.5–44.4 km]) where the construction activities would occur, noise generated during these activities would not be audible onshore. Vessel-traffic-related noise would be intermittent and decrease as the distance from shore increases. Therefore, the NRC staff concludes that noise impacts associated with construction of the offshore wind portion of the combination alternative would be SMALL.

The NRC staff concludes that the overall noise impacts associated with construction of the combination alternative would be SMALL to MODERATE.

<u>Operations</u>

Noise sources associated with the new nuclear portion of the combination alternative would be similar to those described for the SMR portion of new nuclear alternative in Section 3.3.7.2 of this EIS, because it would consist of three SMRs located at the Oconee Station site. Given the distance of nearby sensitive receptors (approximately 1 mi [1.6 km] away) from the Oconee Station site and consideration of noise attenuation, the NRC staff does not expect offsite noise levels from transformers, turbines, cooling towers, or speakers for nearby receptors to be greater than current levels experienced from operation of the Oconee Station site. Therefore, the NRC staff concludes that operation-related noise impacts from the new nuclear portion of the combination alternative would be SMALL.

Because the solar PV portion of the combination alternative would have no power block or cooling towers, a minimal number of noise sources, such as transformers and vehicular traffic, would be associated with maintenance and inspection activities. Therefore, the NRC staff concludes that operations-related noise impacts from the solar PV portion of the combination alternative would be SMALL.

Given the distance from shore (10–24 nautical miles), noise from wind turbines would not be audible onshore. Vessel-traffic-related noise would be intermittent and decrease as the distance from shore increases. Navigation of vessels in the vicinity of the turbines would be short term and intermittent, resulting in minor noise impacts on noise-sensitive receptors. Therefore, the NRC staff concludes that operations-related noise impacts from the offshore wind portion of the combination alternative would be SMALL. Noise impacts would not result from demand-side management initiatives. The NRC staff concludes that the overall noise impacts associated with operation of the combination alternative would be SMALL.

3.4 Geologic Environment

This section describes the geologic environment of the Oconee Station site and vicinity, including landforms, geology, soils, and seismic conditions. The description of the resources is followed by the NRC staff's analysis of the potential impacts on geologic and soil resources from the proposed action (SLR) and alternatives to the proposed action.

3.4.1 Physiography and Geology

Section 3.5 of Duke Energy's ER (Duke Energy 2021-TN8897) describes the physiographic and geologic environment, including the landforms, site geology, soils, and seismicity of the Oconee Station site and vicinity. Except as otherwise cited for clarity, the staff summarizes this information in the following sections. The NRC staff did not identify any new and significant information regarding the geologic environment during the site audit, the scoping process, or as the result of its review of available information as cited in this EIS.

Oconee Station is located within the Piedmont physiographic province and along the Piedmont's northwestern boundary with the Blue Ridge province. The region was subject to extensive uplift, deformation, and compression associated with mountain building. Large-scale deformation across the southeastern United States ended approximately 225 million years ago. Today, the region's topography is characterized by rolling, well-rounded hills, low ridges, and river-cut valleys. The base (grade) elevation of the Oconee Station site, including the power block, lies at 796 ft (243 m) above MSL.

Surficial deposits across the Oconee Station site consist predominantly of saprolite (chemically weathered bedrock) and residual soils, topsoil and engineered fill, and some weathered bedrock. Geologic cross sections show that this sequence of materials ranges from less than 10 ft (3 m) to more than 100 ft (30 m) thick beneath the nuclear power plant. The underlying weathered and competent bedrock is metamorphic in origin and predominantly consists of gneissic rocks (i.e., granite gneiss, hornblende gneiss, and quartz pegmatite intrusions). These fractured, folded, and faulted rocks generally strike in a northeast-southwest direction.

3.4.2 Geologic Resources

Geologic resources, encompassing rock and mineral resources, in the Oconee Station region include crushed stone and industrial mineral deposits. The primary commodity produced in Oconee and Pickens Counties is crushed stone produced from granitic and gneissic rocks (USGS 2019-TN9149). However, there are no mapped mines or quarries (historic or active) within 5 mi (8 km) of the Oconee Station site boundary (USGS 2023-TN8986).

3.4.3 Soils

Natural soils and weathered rock deposits across the Oconee Station site were graded and disturbed during nuclear power plant construction. Soil unit mapping by the Natural Resources Conservation Service (USDA 2023-TN9204) identifies the natural soils, where present and undisturbed, in the central portion of the Oconee Station site, including the power block area, as consisting predominantly of Hayesville and Cecil fine sandy loams and Hayesville and Cecil loams (eroded). These sandy loam, clay loam, and clayey soils extend to the east and north toward the shoreline of Lake Keowee. Before nuclear power plant construction, the soils formed on slopes ranging from 6 to 45 percent from parent material consisting of clayey residuum weathered from granite and gneiss. Aside from areas of severe slopes, the Natural Resources

Conservation Service rates the natural Hayesville and Cecil soils as somewhat limited to very limited for site development involving shallow excavations because of the high clay content and unstable excavation walls. The natural soils generally have a slight to moderate erosion potential. Only a few, relatively small zones of undeveloped areas on the nuclear power plant site are mapped as prime farmland soils or farmland of statewide importance. The largest contiguous area of soils mapped as farmland of statewide importance is now occupied by the power block and 525 kv switchyard. Nevertheless, as reflected in Duke Energy's ER, the main nuclear power plant site was excavated to level grade during facility construction. Backfill was then placed in many locations, including around facility foundations.

Stabilization measures have been in place since Oconee Station became operational to prevent erosion and sedimentation impacts. Additionally, as required by its State-issued NPDES general permit for stormwater discharges associated with industrial activity (No. SCR000074) for Oconee Station, Duke Energy has also developed and implemented a stormwater pollution prevention plan (SWPPP). This plan identifies BMPs, including nonstructural preventive measures and source controls, as well as structural (engineering) controls to prevent erosion, and to prevent or reduce pollutants, including total suspended solids, in stormwater discharges (Duke Energy 2021-TN8897).

3.4.4 Seismic Setting

Northwestern South Carolina has relatively lower seismicity (fewer earthquakes) and fewer seismic hazards than other parts of the state. Hence, seismic activity in the Oconee Station region is more typical of most locations across the Central and Eastern United States where areas can go for years without experiencing an earthquake strong enough for people to feel. Areas to the northwest centered in eastern Tennessee and to the southwest centered in Charleston, South Carolina, are more active and have a relatively higher risk of experiencing damaging earthquakes (Duke Energy 2021-TN8897; Petersen et al. 2020-TN7281). Between 1970 and June 2023, a total of 20 earthquakes with a magnitude equal to, or greater than, 2.5 have been recorded within a 50 mi (80 km) radius of the Oconee Station site (USGS 2023-TN8988). One of the largest and closest to the site earthquakes occurred on July 13, 1971, and was centered approximately 5 mi (9 km) southwest of Oconee Station between the towns of Union and Seneca. This earthquake had a magnitude of 3.7 (USGS 2023-TN8988). It was preceded by a smaller felt earthquake and later by a felt aftershock (Duke Energy 2021-TN8897). While the main earthquake reportedly produced light to moderate shaking, it produced little damage near its epicenter (Duke Energy 2019-TN8943).

The NRC evaluates the potential effects of natural hazards, including seismic events, on nuclear power plants on an ongoing basis that is separate from the license renewal process. All nuclear power plants in the United States are designed and built to withstand strong earthquakes based on their location and nearby earthquake activity. Over time, the NRC's understanding of the seismic hazard for a given nuclear power plant may change as methods of assessing seismic hazards evolve and the scientific understanding of earthquake hazards improves (NRC 2014-TN8997, NRC 2018-TN8998). In 2018, the U.S. Geological Survey published updated seismic hazard maps that included the region encompassing the Oconee Station site (Petersen et al. 2020-TN7281). Based on the 2018 seismic hazard maps, and as measured in terms of predicted earthquake-produced peak horizontal ground accelerations with a 2 percent probability of exceedance in 50 years (i.e., corresponding to a return time of about 2,500 years), the Oconee Station site is in an area with a predicted peak horizontal acceleration between 0.1 and 0.2 g (10 and 20 percent of standard gravity). Previous peak horizontal acceleration estimates for the site were 0.2–0.28 g (USGS 2014-TN6177).

After the accident at the Fukushima Daiichi nuclear power plant resulting from the March 11, 2011, Great Tohoku Earthquake and subsequent tsunami, the NRC established the Near-Term Task Force to review regulatory insights from the Fukushima Daiichi accident as directed by the Commission on March 21, 2011 in COMGBJ-11-0002 (NRC 2011-TN7448). The Near-Term Task Force assessment resulted in the NRC issuing order EA-12-049 (NRC 2012-TN7947) on March 12, 2012 to nuclear power plant licensees requiring them to mitigate beyond-design-basis external events, and issuing 10 CFR 50.54(f) (TN249) letters directing licensees to conduct seismic and flooding reevaluations (NRC 2012-TN2198). In November 2020, the NRC staff issued its determination that Duke Energy had implemented NRC-mandated safety enhancements at Oconee Nuclear Power Station in response to the NRC order and that it had also completed its response to the 10 CFR 50.54(f) letter (NRC 2020-TN8995).

The impacts of natural phenomena, including seismic hazards, on nuclear power plant systems, structures, and components are outside the scope of the NRC's license renewal environmental review. Oconee Station was originally sited, designed, and licensed in consideration of applicable geological and seismic criteria, and seismic issues are assessed as part of the nuclear power plant safety review. Further, the NRC requires all licensees to take seismic activity into account in order to maintain safe operating conditions at all nuclear power plants. When new seismic hazard information becomes available, the NRC evaluates the new information to determine whether any changes are needed at existing nuclear power plants. This reactor oversight process, which considers seismic safety, is separate from the NRC staff's license renewal environmental review.

3.4.5 Proposed Action

The following sections address the site-specific environmental impacts of the Oconee Station SLR on the environmental issues related to the geologic environment in accordance with Commission direction in CLI-22-02 and CLI-22-03.

The impacts on geology and soils were not considered in the 1996 "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (NRC 1996-TN288), and, therefore, were not considered in the 1999 Oconee Station LR Supplemental EIS (SEIS) (NRC 1999-TN8942). In this section, the NRC staff analyzes these impacts at the Oconee Station site for the SLR term.

Although no license renewal-related construction activities are planned (Duke Energy 2021-TN8897), the impact of continued operation and any refurbishment associated with SLR at the Oconee Station site on geologic and soil resources would consist of soil disturbance and excavations for projects, such as replacing or adding buildings, roads, parking lots, and belowground and aboveground utility structures. For such projects, the licensee also may need to obtain geologic resources (e.g., soil or sand borrow or backfill material, aggregate for road building or concrete production) from locations on the nuclear power plant site or from offsite borrow areas or quarries. However, it is more likely that these materials would be obtained from commercial vendors. Regardless, stabilization measures to prevent erosion and sedimentation impacts on the Oconee Station site and surrounding area have been in place since construction began in the early 1970. In addition, the site maintains a SWPPP (Duke Energy 2021-TN8897) that identifies BMPs for preventing or reducing soil erosion and its subsequent impacts on surface water quality. These practices include nonstructural preventive measures and structural controls to prevent erosion or treat stormwater affected by potential pollutants caused by erosion. Any construction activities at the Oconee Station site would be subject to and managed by the current SWPPP and any ground disturbance of one or more acres would require acquisition of a construction stormwater permit from the SCDHEC (Duke Energy 2021-TN8897).

In addition to erosion prevention measures, the Farmland Protection Policy Act of 1981 (7 U.S.C. 4201 et seq.-TN708) requires Federal agencies to take into account agency actions affecting the preservation of farmland, including prime and other important farmland soils, as described in Section 3.4.3. However, the site is not subject to the Farmland Protection Policy Act of 1981 because the Act does not apply to Federal permitting or licensing for activities on private or nonfederal lands.

Based on this nuclear power plant-specific environmental review conducted by the NRC, to date, no significant impact issues related to continued operations and refurbishment activities on geology and soils have been identified.

Geologic and soil conditions at Oconee Station and associated transmission lines have been well established during the current licensing term. These conditions are expected to remain unchanged during the 20-year SLR term. SLR would continue current operating conditions and environmental stressors rather than introduce entirely new impacts. For these reasons, the effects of continued operations on geologic and soil resources would be minor and would neither destabilize nor noticeably alter any important attribute of this resource during the SLR term. The NRC staff concludes that the impacts of SLR on geology and soils during the Oconee Station SLR term would be SMALL. There are no site-specific (Category 2) geologic environment issues, as shown in Table 3-2.

3.4.6 No-Action Alternative

Under the no-action alternative there would be few or no incremental impacts on site geology and soils associated with the shutdown of Oconee Station because, before beginning decommissioning activities, little or no new ground disturbance would occur at the nuclear power plant site while operational activities are reduced and eventually cease. As a result, the NRC staff concludes that the impact of the no-action alternative on geology and soils would be SMALL.

3.4.7 Replacement Power Alternatives: Common Impacts

Construction

During facility construction for the replacement power alternatives and associated components, aggregate material (such as crushed stone, riprap, sand, and gravel) would be required to construct buildings, foundations, roads, parking lots, pad sites, transmission lines, and other supporting infrastructure, as applicable. The NRC staff presumes that these resources would be obtained from commercial suppliers using local or regional sources. Land clearing, grading, and excavation work would expose soils to erosion and alter surface drainage. The NRC staff also presumes that BMPs would be implemented in accordance with applicable State and local permitting requirements to reduce soil erosion and associated offsite impacts. These practices would include measures such as the use of sediment fencing, staked hay bales, check dams, sediment ponds, riprap aprons at construction and laydown yard entrances, mulching and geotextile matting of disturbed areas, and rapid reseeding of temporarily disturbed areas, where applicable. Standard construction practice dictates that topsoil removed during construction and any suitable excavated materials would be stored onsite for redistribution, such as for backfill at the end of construction.

Operations

Replacement power facilities would be built in accordance with applicable State and local building codes and would consider such siting and design factors to mitigate potential impacts from natural phenomena. Once facility construction is completed, areas disturbed during construction, whether on land or offshore, would be within the footprint of the completed facilities, overlain by other impervious surfaces (such as roadways and parking lots), or revegetated or stabilized as appropriate, so there would be no additional land disturbance and no direct operational impacts on geology and soils. Consumption of aggregate materials or topsoil for maintenance purposes during operations would be negligible.

3.4.8 New Nuclear Alternative (ALWR and SMR)

The impacts on geologic and soil resources from construction and operations associated with the new nuclear alternative would likely be similar to, but substantially greater than, those described and assumed to be common to all alternatives in Section 3.4.7 of this EIS. The NRC staff evaluated the impacts of the ALWR portion of this alternative in its 2013 final EIS for the proposed W.S. Lee Nuclear Station, Units 1 and 2 (NUREG–2111) (NRC 2013-TN6435). As described in NUREG–2111, preconstruction and NRC-authorized construction for a new ALWR would disturb more than 2,000 ac (800 ha). Excavation depths for the nuclear island of each unit would extend approximately 40 ft (12 m). In addition, construction of the nuclear units and support facilities would require a substantial volume of geologic material (e.g., aggregate and soil backfill).

Implementation of the SMR component would use existing infrastructure at Oconee Station to the maximum extent possible, which would reduce construction impacts and related impacts on site geology and soils, as well as consumption of geologic resources for new facility construction. Disturbance of geologic strata and soil erosion and loss under this alternative would generally be localized to the construction sites, and offsite soil erosion impacts would be mitigated by using BMPs. However, excavation work for the nuclear power block associated with the SMR modules may extend to a depth of approximately 140 ft (43 m) below grade (NRC 2019-TN6136). This would likely require excavation in weathered and sound rock and the application of methods (e.g., grouting and dewatering) to stabilize the deep excavation during construction. Because this alternative would require multiple excavations, including a deep excavation for the SMR, and substantial soil disturbance, the NRC staff concludes that the overall impacts on geology and soil resources from the new nuclear alternative would be SMALL to MODERATE.

3.4.9 Natural Gas Combined-Cycle Alternative

The impacts on geologic and soil resources from construction and operations associated with the natural gas alternative would likely be similar to, but of lesser intensity, than those described and assumed to be common to all alternatives in Section 3.4.7. Impacts would be less than those associated with the new nuclear alternative. However, the potential construction impacts of this alternative on soil resources at the Oconee Station site could be somewhat greater than those associated with the SMR component of the new nuclear alternative, because a larger area of land would be disturbed and converted to industrial use to extend a natural gas pipeline to the Oconee Station site. However, the intensity of excavation work for the power block would be less under this alternative. In sum, the NRC staff concludes that the impacts on geology and soil resources from the natural gas combined-cycle alternative would be SMALL.

3.4.10 Combination Alternative (Solar PV, Offshore Wind, Small Modular Reactor, and Demand-Side Management)

Under this combination alternative, the impacts on geologic and soil resources would likely be similar to, but greater in overall magnitude, than those described and assumed to be common to all alternatives in Section 3.4.7 of this EIS, and greater than those under either the new nuclear or natural gas alternatives. This greater potential for impacts is primarily driven by the substantial land area that would be disturbed, along with additional seafloor areas, at multiple offsite locations, in addition to impacts on and adjacent to the Oconee Station site associated with the SMR component of this alternative. Overall impacts would be driven by the potential for soil erosion and loss of natural soils and sediments due to the conversion of land to industrial uses for the build-out of the solar PV and wind components of the alternative. Based on these considerations, the NRC staff concludes that the potential impacts on geology and soil resources from the combination alternative could range from SMALL to MODERATE.

3.5 Water Resources

This section describes surface water and groundwater resources at and around the Oconee Station site. The description of the resources is followed by the NRC staff's analysis of the potential impacts on surface water and groundwater resources from the proposed action (SLR) and alternatives to the proposed action.

3.5.1 Surface Water Resources

Surface water encompasses all water bodies that occur above the ground surface, including rivers, streams, lakes, ponds, and manmade reservoirs or impoundments.

3.5.1.1 Surface Water Hydrology

The NRC staff previously considered the interaction of Oconee Station's cooling and auxiliary water systems with the hydrologic environment in Sections 2.1.3, 2.2.2, and 2.2.3 of NUREG-1437, Supplement 2 for initial license renewal of the nuclear power plant (NRC 1999-TN8942) (see also Section 2.1.3 of this EIS). In Section 3.6.1 of its ER (Duke Energy 2021-TN8897), Duke Energy provides a detailed description of the surface water environment of the Oconee Station site, including the Lake Keowee and Lake Jocassee reservoir systems and their watersheds, reservoir hydroelectric station operations, flooding potential, and related operational interactions between Oconee Station and surface water resources. Except as cited for clarity, the staff summarizes this information here and in the following sections. The NRC staff did not identify any new and significant information regarding the surface water affected environment during the site audit, the scoping process, or as the result of its review of available information as cited in this EIS.

Local and Regional Hydrology

The central surface water feature of the Oconee Station site is Lake Keowee. Lake Keowee (reservoir) was formed in 1971 with the construction of the Keowee Dam on the Keowee River and the Little River Dam on the Little River. The Keowee River and Little River watersheds are connected by the human-made canal adjoining the Oconee Station site. Other major surface waters near the Oconee Station site include the portion of Keowee River downstream of the Keowee Dam that runs along the eastern and southern boundary of the nuclear power plant site.

Lake Keowee occupies 18,357 ac (7,430 ha) and includes 388 mi (624 km) of shoreline at full pond elevation (i.e., 800 ft [240 m] above MSL). This impoundment principally exists to provide cooling water for Oconee Station and to operate Keowee Hydro Station.

Lake Jocassee is located upstream of Oconee Station and primarily supports hydroelectric power generation. It also is owned by Duke Energy. At full pond elevation (1,110 ft (338 m) MSL), Lake Jocassee has a surface area of 7,565 ac (3,060 ha), and a shoreline of approximately 75 mi (121 km). The spillway of the lake flows into the Keowee River and Lake Keowee. Lake Hartwell is downstream from Oconee Station. This publicly accessible, multiuse reservoir is maintained by the U.S. Army Corps of Engineers (USACE). Figure 3-1 depicts the surface water features of the region in relationship to the Oconee Station site.

In addition, three small ponds for treating facility wastewater and other flows are located on the Oconee Station site. These ponds are designated chemical treatment ponds (CTP) -1, -2, and -3 (see Figure 2-2 for locations). Section 3.5.1.3 of this EIS provides additional information about these ponds.

Drainage from the plant complex is managed by a system of roof drains, yard drains, and ditches that collect and direct runoff away from Oconee Station plant structures. As a result, surface water generally drains to the south and east across the plant complex as the plant drainage system collects and directs stormwater runoff toward natural drainage channels, principally to the Keowee River. Groundwater collected by the site's groundwater drawdown system is pumped to the yard drainage system. This system discharges to CTP-3.

As previously discussed in Section 2.1.3.1 of this EIS, Oconee Station withdraws water from the lake through an intake structure and associated intake canal located in the southwest portion of the plant complex. Heated cooling water is discharged back to the lake through the discharge structure located on the north side of the plant complex (see Figure 2-2). Cooling water discharges and plant effluents are further discussed in Section 3.5.1.3 of this EIS.

<u>Flooding</u>

The Federal Emergency Management Agency has delineated the flood hazard areas in the vicinity of the Oconee Station site. It has mapped the majority of the nuclear power plant site, including the entire main nuclear power plant complex encompassing the nuclear island as Zone X, representing areas of minimal flood hazard and lying outside the 0.2 percent annual chance flood (500-year flood level). Small strips of land bordering the intake canal, shoreline of Lake Keowee, areas bordering the Keowee Hydro Station tailrace, and the areas along the Lake Keowee spillway and Keowee River to the east of the Oconee Station site are mapped as Zone AE (i.e., within the base floodplain, 1 percent annual chance flood) (Duke Energy 2021-TN8897; FEMA 2017-TN8999).

As further described in the ER and Section 2.4-2 of the Updated Final Safety Analysis Report, Revision 28, the spillways for Lake Keowee and Lake Jocassee are designed to accommodate the design flood with no increase (surcharge) on the full pond elevation of the lakes (Duke Energy 2021-TN8897, Duke Energy 2020-TN9103). Oconee Station's safety-related structures are protected from flooding because the probable maximum flood would be contained within the Keowee Lake reservoir. This protection is because all engineered dikes and dams composing the reservoir, including Oconee Station's intake canal (channel) dike, are constructed to an elevation of 815 ft (248 m) above MSL, higher than the maximum reservoir elevation of 808 ft (246 m) above MSL from the effects of maximum precipitation-induced flooding (Duke Energy 2021-TN8897).

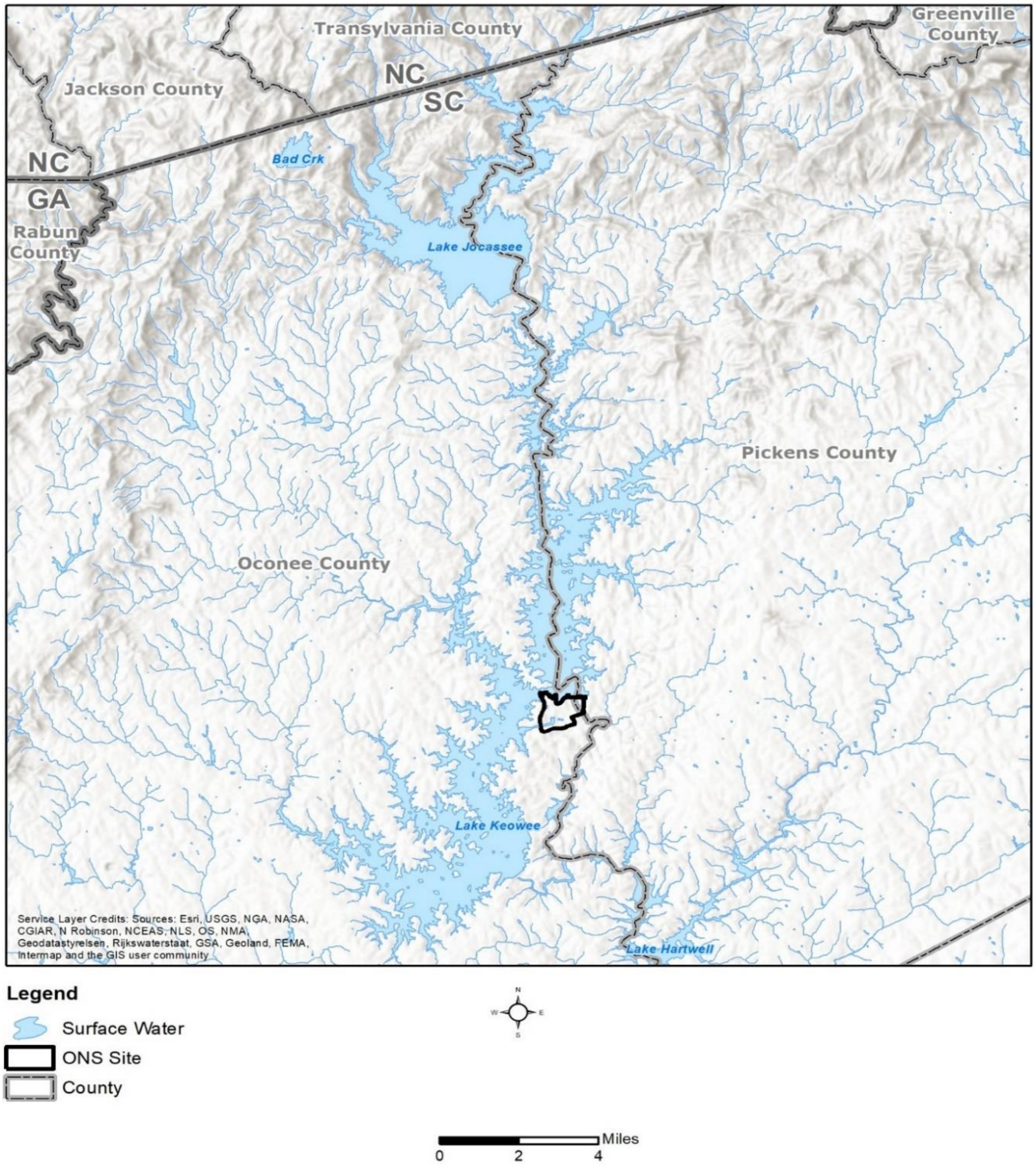

Figure 3-1 Regional Surface Water Features Associated with the Oconee Station Site. Source: Duke Energy 2021-TN8897.

In accordance with the NRC's general design criteria (Appendix A, "General Design Criteria for Nuclear Power Plants," in 10 CFR Part 50 (TN249), "Domestic Licensing of Production and Utilization Facilities"), nuclear power plant structures, systems, and components (SSCs) important to safety are designed to withstand the effects of natural phenomena, such as flooding, without loss of capability to perform safety functions.

Additionally, the NRC staff evaluates nuclear power plant operating conditions and physical infrastructure to ensure ongoing safe operations through its reactor oversight process, which is separate from the NRC's license renewal review process. If new information about changing environmental conditions becomes available, the NRC will evaluate the new information to determine if any safety-related changes are needed. The NRC also evaluates new information important to flood projections and independently confirms that a licensee's actions appropriately consider potential changes in flooding hazards at the site.

3.5.1.2 Surface Water Use

Lake Keowee is a multipurpose impoundment, and its waters support a variety of commercial-industrial, public, and recreational uses. These uses include hydroelectric and thermoelectric power production, pumped-storage operation, water-based recreation, and public water supply.

Oconee Station withdraws water through its intake canal and intake structure on Lake Keowee for use in the circulating water cooling and auxiliary water systems and returns the noncontact cooling water and permitted effluents to the lake through the plant's discharge structure (see Section 2.1.3.1 and Figure 2-3).

Oconee Station's current peak (nominal) surface water withdrawal rate is 2,125,500 gallons per minute (gpm) (8.04 million liters per minute [Lpm]), or approximately 3,060 million gallons per day (mgd) (11,586 million liters per day [mLd]) (see Section 2.1.3.1). The average daily withdrawal rate between 2017–2021 has been 2,648 mgd (10,024 mLd), as reported in Duke Energy's ER (Duke Energy 2021-TN8897). Table 3-4 summarizes Oconee Station's actual surface water withdrawals from 2017 to 2021.

Table 3-4 Surface Water Withdrawals, Oconee Station (2017–2021)

Year	Yearly Withdrawals (mgy) (mLy)	Daily Withdrawals (mgd) (mLd)[(a)]
2017	990,860 (3,750,811)	2,715 (10,277)
2018	944,330 (3,574,676)	2,587 (9,792)
2019	956,314 (3,620,041)	2,620 (9,917)
2020	978,229 (3,702,998)	2,673 (10,118)
2021	956,476 (3,620,654)	2,645 (10,012)
Average	**965,242 (3,653,836)**	**2,648 (10,024)**

mgd = million gallons per day; mgy = million gallons per year; mLy = million liters per year.
(a) All values are rounded. To convert million gallons per year (mgy) to million cubic meters (m^3) divide by 264.2. To convert million gallons per day (mgd), to million liters per day (mLd), multiply by 3.7854.
Source: Duke Energy 2021-TN8897, Duke Energy 2022-TN8948.

Duke Energy monitors Oconee Station's surface water withdrawals from Lake Keowee and submits annual reports (Duke Energy 2021-TN8897) to the SCDHEC in accordance with the terms under the State's surface water withdrawal regulations (SC Code 61-119-TN9007).

Oconee Station's operations also are subject to the terms and conditions of its State-issued Surface Water Withdrawal Permit (Permit No. 37PN001) (Duke Energy 2021-TN8898). The permit was issued to Duke Energy in 2013 and expires in October 2043. Duke Energy's permit limits Oconee Station's surface water withdrawals to a monthly maximum of 94,817 million gallons (mg) (358,920 million liters [ML]) of condenser circulating water at the intake structure and an additional 68 mg (257 ML) through the B5B intake for a combined yearly maximum of 1,138,620 mg (4,309,676 ML). The associated withdrawal volumes are based on the maximum monthly (31-day) production capacity of the pumps assuming continuous operation.

Once-through heat-dissipation systems inherently return all but a very small fraction of the total water withdrawn to the water source, compared to closed-cycle systems. Oconee Station's withdrawal permit includes an assumption that 99 percent of the water withdrawn is returned to the lake (Duke Energy 2021-TN8897).

3.5.1.3 Surface Water Quality and Effluents

<u>Water Quality Assessment and Regulation</u>

In accordance with Section 303(c) of the Federal Water Pollution Control Act (i.e., Clean Water Act of 1972, as amended (CWA) (33 U.S.C. 1251–1387-TN662), States have the primary responsibility for establishing, reviewing, and revising water quality standards for the Nation's navigable waters. Such standards include the designated uses of a water body or water body segment, the water quality criteria necessary to protect those designated uses, and an antidegradation policy with respect to ambient water quality. As established under CWA Section 101(a), water quality standards are intended to restore and maintain the chemical, physical, and biological integrity of the Nation's waters and to attain a level of water quality that provides for designated uses. The EPA reviews each State's water quality standards to ensure they meet the goals of the CWA and Federal regulations that set water quality standards (40 CFR Part 131, "Water Quality Standards" [TN4814]). The SCDHEC promulgates surface water quality standards in the State in accordance with its regulations codified at South Carolina Regulation (SCR) 61-68 and SCR 61-69 (SCDHEC 2014-TN6986, SCDHEC 2012-TN6987).

CWA Section 303(d) requires States to identify all "impaired" waters for which effluent limitations and pollution control activities are not sufficient to attain water quality standards in such waters. Similarly, CWA Section 305(b) requires States to assess and report on the overall quality of waters in their state. States also prepare a CWA Section 303(d) list that identifies the water quality limited water bodies that require the development of total maximum daily loads to assure future compliance with water quality standards. The list also identifies the pollutant or stressor causing the impairment, if known, and establishes a priority for developing a control plan to address the impairment. The total maximum daily loads specify the maximum amount of a pollutant that a water body can receive and still meet water quality standards. Once established, total maximum daily loads are often implemented through watershed-based programs administered by the State, primarily through permits issued under the NPDES permit program, under CWA Section 402, and associated point and nonpoint source water quality improvement plans and associated BMPs. States must update and resubmit their impaired waters list every 2 years, which ensures that impaired waters continue to be monitored and assessed by the State until applicable water quality standards are met.

South Carolina has designated the open waters of Lake Keowee as desirable for the uses of primary and secondary contact recreation, as a source for drinking water supply after conventional treatment, for fishing and the survival and propagation of a balanced indigenous aquatic community of fauna and flora, and for industrial and agricultural uses (SCR 61-68; TN6986, SCR 61-69; TN6987). Overall, the waters of Lake Keowee support their designated uses. However, Lake Keowee, several lake tributaries, and Lake Jocassee are impaired for some designated uses, as listed in South Carolina's 2018 final 303(d) list of impaired waters. The EPA approved the State's list on December 23, 2020 (EPA 2020-TN9008). Specifically, Lake Keowee, including the segment at Oconee Station's dam, is listed as impaired for fish consumption because of mercury in fish tissue (EPA 2020-TN9008, SCDHEC 2022-TN9009).

In addition, the SCDHEC has issued fish consumption advisories for Lake Keowee and Lake Jocassee, which recommend only one meal a week involving consumption of largemouth and spotted bass SCDHEC 2022-TN9009).

National Pollutant Discharge Eliminating System Permitting Status and Nuclear Power Plant Effluents

To operate a nuclear power plant, NRC licensees must comply with the CWA, including associated requirements imposed by EPA or the State, as part of the NPDES permitting system under CWA Section 402. The Federal NPDES permit program addresses water pollution by regulating point sources (e.g., pipes, ditches) that discharge pollutants to waters of the United States. The NRC licensees must also meet State water quality certification requirements under CWA Section 401. The EPA or the States, not the NRC, set the limits for effluents and operational parameters in nuclear power plant-specific NPDES permits. Nuclear power plants require a valid NPDES permit and a current Section 401 Water Quality Certification to operate.

The EPA authorized the State of South Carolina to assume NPDES program responsibility. The State's regulations for administering the NPDES program are contained in the SCRs at SC Code 61-9.122-TN9010. NPDES permits are normally issued on a 5-year cycle.

Oconee Station is authorized to discharge return cooling water and various wastewater effluents under NPDES Permit Number SC0000515. This permit has an effective date of May 1, 2010, and it expired on September 30, 2013 (Duke Energy 2021-TN8897). Duke Energy submitted a timely permit renewal application to the SCDHEC in March 2013 (Duke Energy 2021-TN8898), in accordance with the State's regulations at SCR 61-9.122.21. Therefore, Duke Energy's 2010 permit remains valid and in force. The NRC staff reviewed Duke Energy's NPDES renewal application. Based on its review of the application and current permit, the staff finds that Duke Energy has not proposed any substantial changes in Oconee Station's effluent discharges that would have any consequences for the proposed SLR term. The changes proposed by Duke Energy include desired modifications to monitoring requirements for selected analytical parameters, including removal of requirements deemed obsolete or no longer necessary.

Duke Energy's current NPDES permit for Oconee Station authorizes monitored discharge from six outfalls in total, including four external outfalls (Outfalls 001, 002, 004, and 007) and two internal outfalls (Outfalls 005 and 006). External outfalls discharge directly to a surface water body or to a feature that connects directly to a water body, while internal outfalls contribute flow to other waste stream(s) before collectively discharging into an external outfall.

Duke Energy's NPDES permit (Duke Energy 2021-TN8897) specifies the pollutant-specific discharge limitations and monitoring requirements for effluents discharged through each outfall to ensure that Oconee Station's discharges comply with applicable water quality standards. Depending on the outfall, Duke Energy is required to monitor flow rate, pH, total suspended solids, oil and grease, total residual chlorine, heat rejection, average and maximum discharge temperature, intake temperature, effluent toxicity, and other specified parameters. In addition, under its NPDES permit, Duke Energy must notify and seek approval from the SCDHEC before using any new water maintenance chemicals (e.g., biocides or chemical additives) or to increase quantities used, because such changes could alter Oconee Station's permitted effluent quality. Duke Energy does not use biocides or other chemicals in Oconee Station's condenser circulating water system. Instead, Duke Energy uses a mechanical cleaning system (Duke Energy 2021-TN8898, Duke Energy 2021-TN8897).

Table 3.6-2 in Duke Energy's ER summarizes applicable effluent (water quality) monitoring requirements under Oconee Station's NPDES permit, including a description of the main processes that contribute flow to each outfall. The NRC staff incorporates the information in ER Table 3.6-2 (Duke Energy 2021-TN8897), here by reference. Oconee Station's significant outfalls are further discussed below.

Discharges from Outfall 001 consist of heated condenser cooling water and miscellaneous service water return flows from Oconee Station nuclear units through the nuclear power plant's discharge structure to Lake Keowee (Duke Energy 2021-TN8898; Duke Energy 2021-TN8897) (see Figure 2-2 and Figure 3-2).

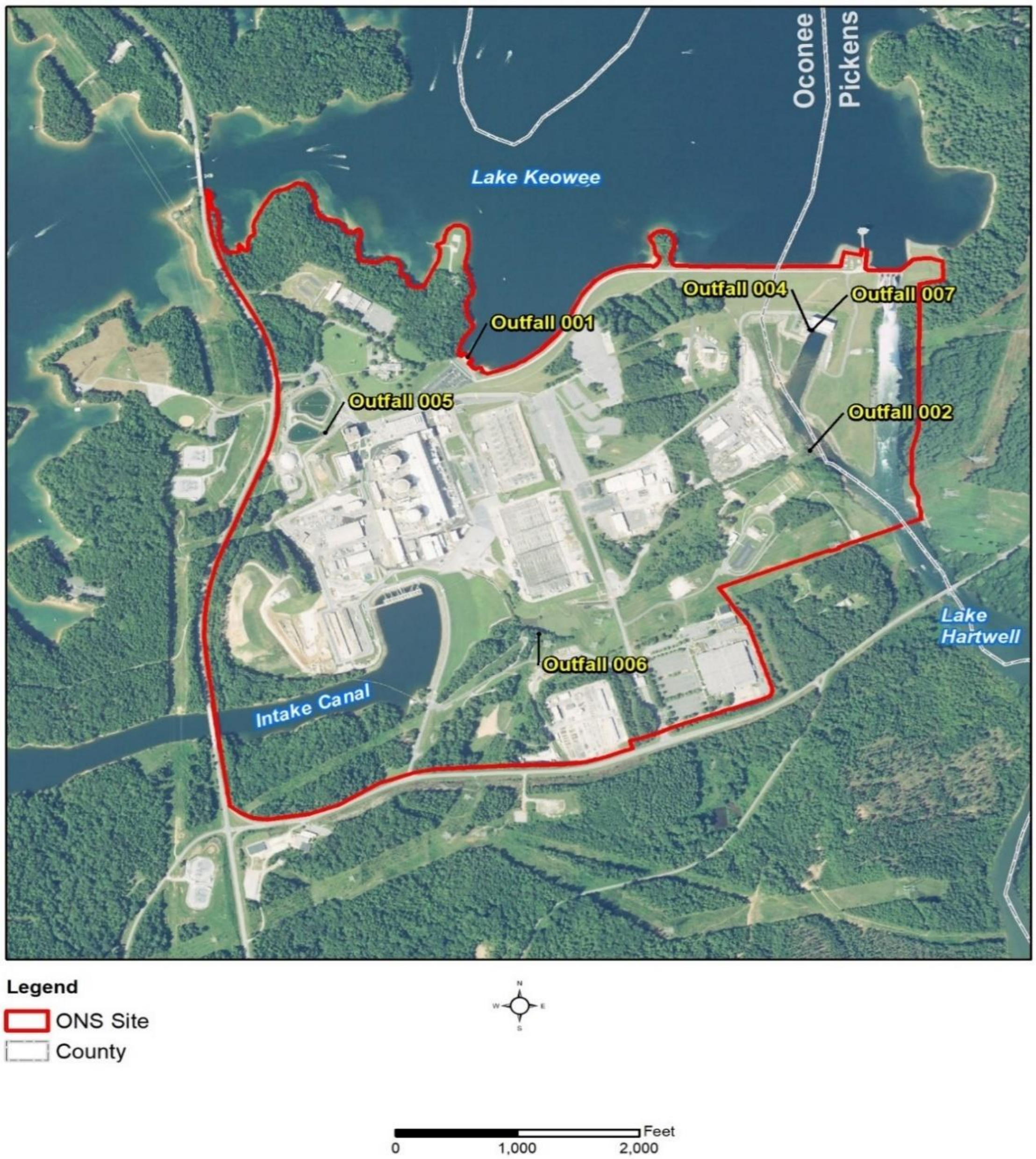

Figure 3-2 Oconee Station NPDES Permitted Outfalls. Source: Duke Energy 2021-TN8897.

The current NPDES permit sets limits on both a daily maximum[2] discharge temperature of 100°F (37.8°C) and on the allowable daily maximum temperature difference between the intake and discharge of 22°F (12.2°C), when the intake temperature is greater than 68°F (20°C). However, if critical hydrological, meteorological, and electric customer demand conditions apply, then the nuclear power plant's discharge temperature cannot exceed a daily maximum of 103°F (39.4°C) (Duke Energy 2021-TN8897).

In its NPDES permit renewal application, Duke Energy has requested that Oconee Station's daily maximum discharge temperature be changed to a 7-day average not to exceed 100°F (37.8°C). Duke Energy states that this change would align with the State water quality standard and would not result in any adverse operational impact on the lake's biological community (Duke Energy 2021-TN8898). Duke Energy's NPDES permit renewal application is not yet approved by SCDHEC; therefore, Duke Energy's proposed discharge temperature limits are not currently followed. The conditions listed in the current NPDES permit remain in effect (Duke Energy 2021-TN8897).

Outfall 002 receives process wastewater and other flows either processed through or entering Oconee Station's conventional wastewater treatment system. This system consists of CTP-1, CTP-2, and CTP-3, as discussed in Section 3.5.1.1 of this EIS. CTP-1 and CTP-2 are parallel ponds with one pond receiving wastewater and the other pond providing treatment or discharging. Pumps are provided for recirculation or controlled discharge by way of the west yard drain system to CTP-3. CTP-3 is equipped with a boom and skimmer wall to contain oil spills. The system receives nuclear power plant wastewater from sumps and air-handling units, treated chemical metal cleaning wastes, water treatment system wastewater, landfill leachate (by way of internal Outfall 006), intake dam underdrain water, yard drainage, and groundwater inflow (Duke Energy 2021-TN8898, Duke Energy 2021-TN8897). The outfall ultimately discharges to the Keowee River and the headwaters of Lake Hartwell (see Figure 3-2).

Outfall 004 is an external outfall that receives low-level radiological wastewater from Oconee Station's liquid radioactive waste treatment system (see Section 2.1.4.1 of this EIS). Wastewater sources include equipment drainage, equipment cooling water, leaks, floor wash, laboratory drains, and metal cleaning wastes, as well as other sources from throughout the nuclear power plant (Duke Energy 2021-TN8898, Duke Energy 2021-TN8897). As described in Section 2.1.4.1 of this EIS, the liquids are handled and treated to meet the NRC release limits before being discharged to the Keowee Hydro Station tailrace and ultimately to the Keowee River.

Outfall 007 primarily receives non-contact cooling water and dewatering and sump water from the Keowee Hydro Station. The outfall discharges to the station's tailrace that flows to the Keowee River.

For all monitored effluent parameters, Duke Energy submits discharge monitoring reports (DMRs) to the SCDHEC in accordance with the reporting schedule specified in the Oconee Station NPDES permit. Duke Energy reports that it has not received any notices of violation (NOVs) from regulatory agencies related to wastewater discharges during the last 5 years (2017–2021), with two exceptions, one in 2017 and another in 2020. SCDHEC later rescinded the 2017 violation, finding that the exceedance event did not result from a release by NPDES Outfall 007. Duke Energy reported an oil and grease exceedance on December 31, 2020, at

[2] The current NPDES Permit (Duke Energy 2021-TN8897) defines the "daily maximum" as the highest average value recorded of samples collected on any single day during the calendar month.

Outfall 002 where the concentration, 10.9 mg/L, exceeded the daily maximum limit of 4.09 mg/L. This exceedance was reported in Oconee Station's December 2020 DMR. In a letter dated February 23, 2021, Duke Energy received an NOV for this exceedance from the SCDHEC. Four additional follow-up samples in December 2020 were all below detectable limits. The SCDHEC stated in the letter that no further response was required by Duke Energy (Duke Energy 2021-TN8897, Duke Energy 2022-TN8899). The December 2020 exceedance, Duke Energy's report to the SCDHEC, and the subsequent SCDHEC actions were confirmed by Duke Energy in its letter to the NRC (Duke Energy 2022-TN8948).

More recently, Duke Energy self-reported two wastewater-related events to the SCDHEC. In its October 2021 DMR, it reported an exceedance of the daily maximum limit for total suspended solids at Outfall 002, which Duke Energy attributed to heavy rainfall. On November 3, 2021, Duke Energy notified the SCDHEC of a wastewater spill that occurred on November 1, 2021. The spill consisted of 3–5 gal (11–19 L) of untreated clear water from a sewage air ejector cracked polyvinyl chloride pipe into the Units 1 and 2 turbine building sump. The spill was diluted and was pumped to CTP-3 and Outfall 002. Neither of these events has resulted in issuance of an NOV to Duke Energy (Duke Energy 2022-TN8948).

Other Surface Water Resources Permits and Approvals

An applicant (in this case, Duke Energy) for a Federal license to conduct activities that may cause a discharge of regulated pollutants into navigable waters of the United States is required by CWA Section 401 to provide the Federal licensing agency (in this case, the NRC) with water quality certification from the certifying authority (in this case, the State of South Carolina). This certification denotes that discharges from the project or facility to be licensed will comply with CWA requirements and will not cause or contribute to a violation of State water quality standards. If the applicant has not received Section 401 certification, the NRC cannot issue a renewed license, unless the State has otherwise waived the requirement.

In July 2020, the EPA published a final rule revising the procedural requirements for CWA Section 401 certifications at 40 CFR Part 121-TN6718 (85 FR 42210-TN6394). The final rule became effective on September 11, 2020. In September 2023, 40 CFR Part 121 was revised again (88 FR 66558-TN9620).[3] The revised regulations at 40 CFR 121.6(b) state that the Federal licensing agency and the certifying authority may jointly establish a "reasonable period of time" not exceeding 1 year from the date of receipt of the certification request, for the certifying authority to act on the request. Under the revised regulations, under no circumstances can the certifying authority take more than 1 year to issue the requested certification, deny certification, or waive its right to certify. The certifying authority's failure or refusal to act on a certification request within the reasonable period of time is considered a waiver.

The NRC recognizes that some NPDES-delegated states explicitly integrate their CWA Section 401 certification process with NPDES permit issuance. South Carolina's CWA Section 401 certification regulations are codified at SC Code 61-101-TN9011.

In its ER, Duke Energy provided copies of both the August 19, 2020, letter it sent requesting confirmation that Oconee Station's existing CWA Section 401 certification (dated

[3] In 2021, the EPA initiated a process to reconsider and revise the 2020 CWA Section 401 Certification Rule (86 FR 29541-TN7623). The proposed rule was issued on June 9, 2022 (87 FR 35318-TN8543). The public comment period for the proposed rule ended August 8, 2022. In September 2023, 40 CFR Part 121 was revised with the publication of the final rule (88 FR 66558-TN9620).

August 2,1976) remains valid for a second (subsequent) license renewal and the letter (dated September 29, 2020) that it received from the SCDHEC in reply. In its reply, the SCDHEC states in part that:

> …unless there is a new federal permit or license associated with the ONS [Oconee] second renewal that may result in a discharge to navigable waters, our position is that the most recent certification remains valid and no additional 401 Water Quality Certification will be required. (Duke Energy 2021-TN8897)

Based on its review of the information referenced above, the NRC staff concludes that the SCDHEC's September 29, 2020, reply to Duke Energy provides the necessary documentation that Oconee Station's CWA Section 401 certification remains valid for continued operations during the proposed SLR term, in satisfaction of Section 401(a)(1) of the CWA. CWA Section 404 governs the discharge of dredge and fill materials to navigable waters, including wetlands, primarily through permits issued by the USACE and applicable State-level permitting programs. Duke Energy states in its ER that no dredging has occurred at Oconee Station since 1998, and no dredging activity is planned during the proposed SLR term (Duke Energy 2021-TN8897).

3.5.2 Groundwater Resources

This section describes the groundwater flow systems (aquifers) and water quality in and around the Oconee Station site. Aquifers are a geologic formation, group of formations, or part of a formation that contain sufficient saturated, permeable material to yield significant quantities of water to wells and springs.

3.5.2.1 Local and Regional Groundwater Resources

Sections 3.5.2 and 3.6.2 of Duke Energy's ER (Duke Energy 2021-TN8897) describe the geology and groundwater resources, respectively, in the Oconee Station site vicinity. A summary of this information is provided in the following sections. The staff also evaluated information related to the groundwater resources during the site audit, the scoping process, and during its review of other available information as cited in this EIS.

In the Piedmont physiographic province of South Carolina where the Oconee Station site is located, groundwater occurs within the fractured bedrock and in the overlying regolith, which generally consists of surface soils; earthy, well-weathered rock referred to as saprolite; and stream deposits (alluvium) found mainly in the valleys (USGS 1990-TN6648). The saprolite develops by the in-place weathering of the underlying bedrock and composes the majority of the regolith. A transition zone of partially weathered bedrock is often present near the top of the bedrock, as shown in Figure 3-3 (LeGrand 2004-TN9017; Harned and Daniel 1992-TN9019). The regolith and fractured bedrock together form the aquifer, with the higher porosity regolith providing most of the water storage and also serving to transmit water to the underlying fractures in the low-porosity bedrock.

The principal source of groundwater recharge to the aquifer is precipitation. Groundwater flow in the Piedmont region occurs as small catchments, generally from topographically high areas to the valleys, where groundwater is discharged to streams, lakes, and springs. Groundwater is generally unconfined, and the water table (the upper surface of saturation) is typically a subdued representation of the ground surface topography.

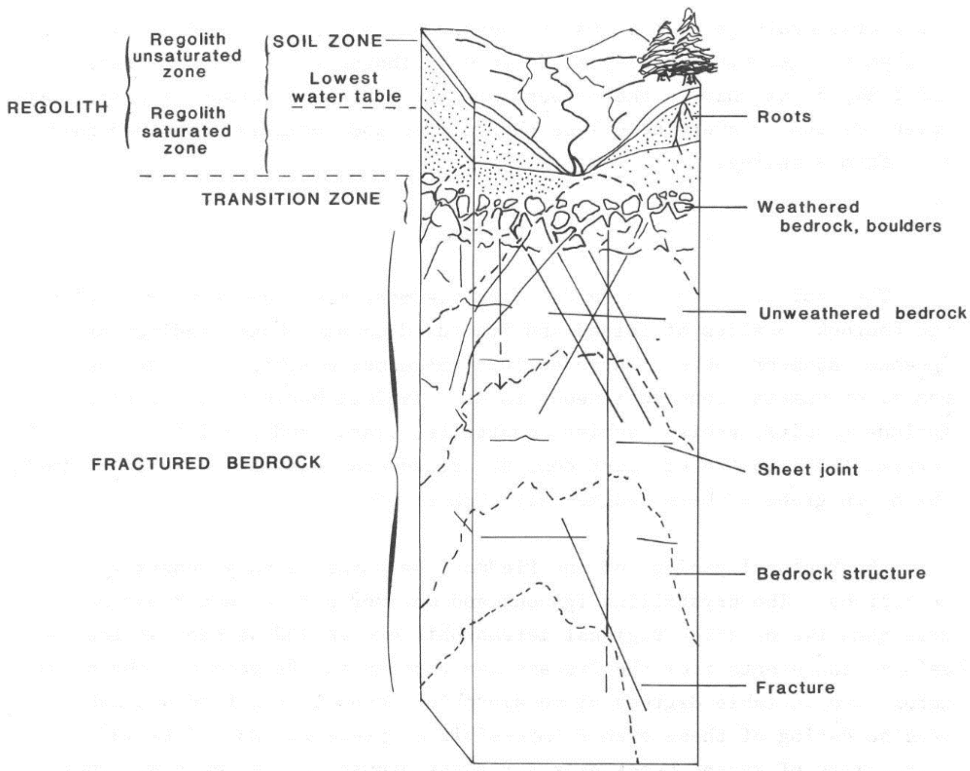

Figure 3-3 Conceptual Components of the Piedmont and Mountains Groundwater System. Source: Harned and Daniel 1992-TN9019.

The EPA has not designated any sole source aquifers in the State of South Carolina or adjoining the Oconee Station site (EPA 2019-TN9022).

In the vicinity of the Oconee Station site, the regolith is observed to exhibit significant spatial variation, ranging from about 10–100 ft (3–30 m) thick (see Section 3.4.1). Depth to the water table varies from approximately 5–40 ft (1.5–12 m) below the land surface, with an average seasonal fluctuation of approximately 3–5 ft (0.9–1.5 m) (Duke Energy 2021-TN8897). Based on maps of groundwater elevations measured in wells (Duke Energy 2021-TN8897), the NRC staff estimates that the horizontal hydraulic gradient at the site is about 0.035. Groundwater flow velocity at the site is estimated to be 150–250 ft/yr (46–76 m/yr) (Duke Energy 2021-TN8897).

At the Oconee Station site, groundwater generally flows from northwest toward the southeast with several localized deviations from this general groundwater flow, as shown in the potentiometric surface maps in Figure 3-4. Groundwater flows from the Lake Keowee intake canal toward CPT-3 and the wastewater conveyance. In addition, groundwater flow is influenced by the dewatering and groundwater contaminant plume control withdrawals. Field hydraulic tests conducted at the site indicate that the permeability of the shallow saprolite is lower than the permeability of deeper soil layers, potentially reducing vertical infiltration of water (Duke Energy 2021-TN8897).

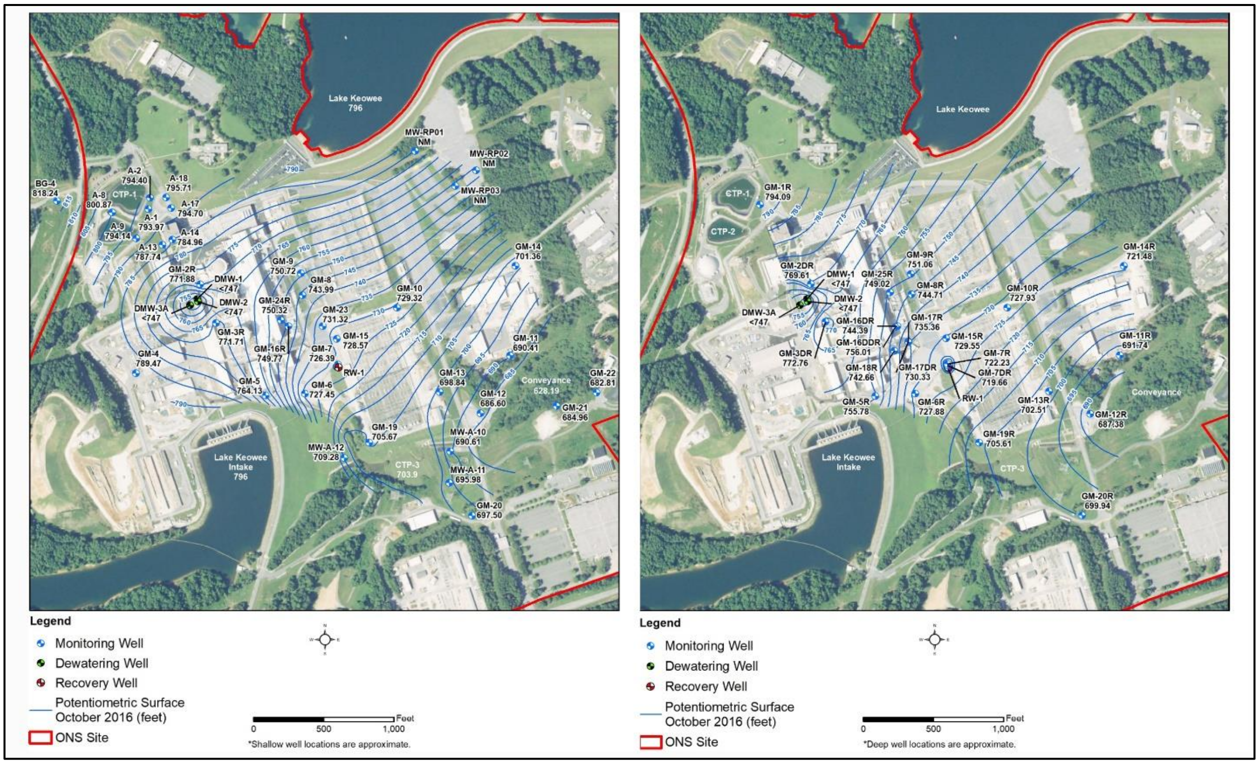

Figure 3-4 Oconee Station Groundwater Potentiometric Surface of Shallow (Left) and Deep Zone (Right). Source: Duke Energy (TN8897).

3.5.2.2 Local and Regional Water Consumption

Compared to the coastal plain aquifers of South Carolina, limited quantities of groundwater can be obtained in the Piedmont region. Well yield is dependent upon the type of rock in which the well is completed (USGS 1990-TN6648). Water yields generally vary between 5 gpm to 20 gpm, but can reach up to 600 gpm locally (Wachob et al. 2009-TN9029). Higher yielding wells are typically completed in fractured zones of the bedrock (USGS 1990-TN6648). In Pickens and Oconee Counties, groundwater is predominantly withdawn for domestic use, followed by public water supply (Dieter et al. 2018-TN6681). No groundwater use for power generation was recorded in either county according to the most recent national water use report (Dieter et al. 2018-TN6681).

Two domestic water supply wells were identified in 2021 within a 2 mi (3.2 km) radius of the Oconee Station plant (Duke Energy 2021-TN8897). The water wells were described as being associated with a recreational vehicle park across Lake Keowee from Oconee Station, approximately 1.3 mi (2.1 km) west of the site. In 2021, no detailed information was reported in the SCDHEC Public Water Supply Wells database, including water use and well construction data (Duke Energy 2021-TN8897). As of June 2023, the two wells are no longer listed in the database (SCDHEC 2021-TN9030), and no further public information is available (SCDHEC 2021-TN9030; USGS 2023-TN9032). The nearest publicly listed water supply well is approximately 4.1 mi (6.7 km) northwest of the site and is associated with Keowee Camp (SCDHEC 2023-TN8970).

Onsite, the Oconee Station plant operates a groundwater drawdown system around the standby shutdown facility. Three wells (DMW-1, DMW-2, and DMW-3A) equipped with automatic pumps withdraw an average of approximately 20 gpm (0.11 mLd) (Duke Energy 2021-TN8897). The wells discharge into CTP-3 via the yard drainage system. Historically, potable groundwater supply wells were installed at the site for irrigation use, but the wells have not been used within the last 10 years and all have been abandoned or are being evaluated for abandonment (Duke Energy 2021-TN8897).

3.5.2.3 Groundwater Quality

Groundwater quality in the Piedmont region is generally good and within drinking water standards for most constituents (USGS 1990-TN6648). In the upper Piedmont region, some radionuclides are detectable in groundwater wells but at concentrations below drinking-water standards (USGS 1990-TN6648, Wachob et al. 2009-TN9029).

3.5.2.3.1 Groundwater Protection Program

Based on the Groundwater Protection Initiative (GWPI) (NRC 2007-TN9033), Duke Energy implemented a groundwater protection program in 2007 at Oconee Station to provide early detection and effective management of any inadvertent releases of licensed radioactive material to groundwater (Duke Energy 2021-TN8897). The program implemented at Oconee Station is based on the results of a risk assessment that investigated information related to (1) nuclear power plant SSCs considered to be potential sources of tritium (Duke Energy 2022-TN8948), (2) the regional conceptual model of geology and hydrogeology for the Piedmont Province of North Carolina (LeGrand 2004-TN9017), and (3) site-specific information about geology and hydrogeology from the Updated Final Safety Analysis Report (Duke Energy 2022-TN9000).

The following nuclear power plant SSCs emerged as potential sources of past or future releases of tritium to the environment (Duke Energy 2022-TN8948):

- CTP-1, -2, and -3
- radioactive waste discharge line
- reactor building sump lines to radioactive waste facility
- turbine building sumps discharge lines
- spent fuel pools, Units 1, 2, and 3
- borated water storage tanks, Units 1, 2, and 3

The monitoring well system implemented as part of the GWPI aims to provide early detection of tritium releases and to verify no offsite migration (Duke Energy 2022-TN8948). Monitoring wells were first selected based on their proximity to nuclear power plant SSC sources, followed by the projected downgradient groundwater flow direction from potential sources (Duke Energy 2022-TN8948). Both shallow and deep wells were selected to account for the SSC locations in relationship to the geologic stratum (i.e., installed in shallow surface soils vs. deep bedrock). Additionally, the historical occurrences of inadvertent releases of radioactive liquids with potential to affect groundwater were reviewed and considered by Duke Energy in the selection of monitoring well locations.

Since the implementation of the GWPI at Oconee Station in 2007, the groundwater monitoring network has expanded and now consists of 63 onsite monitoring wells (Figure 3-5) (Duke Energy 2021-TN8897). Other monitoring programs fulfill requirements for Duke Energy’s NPDES permit (No. SC0000515) and Class 2 Landfill Closure permit (No. 373303-1601). Results are reported to SCDHEC semiannually and annually, respectively.

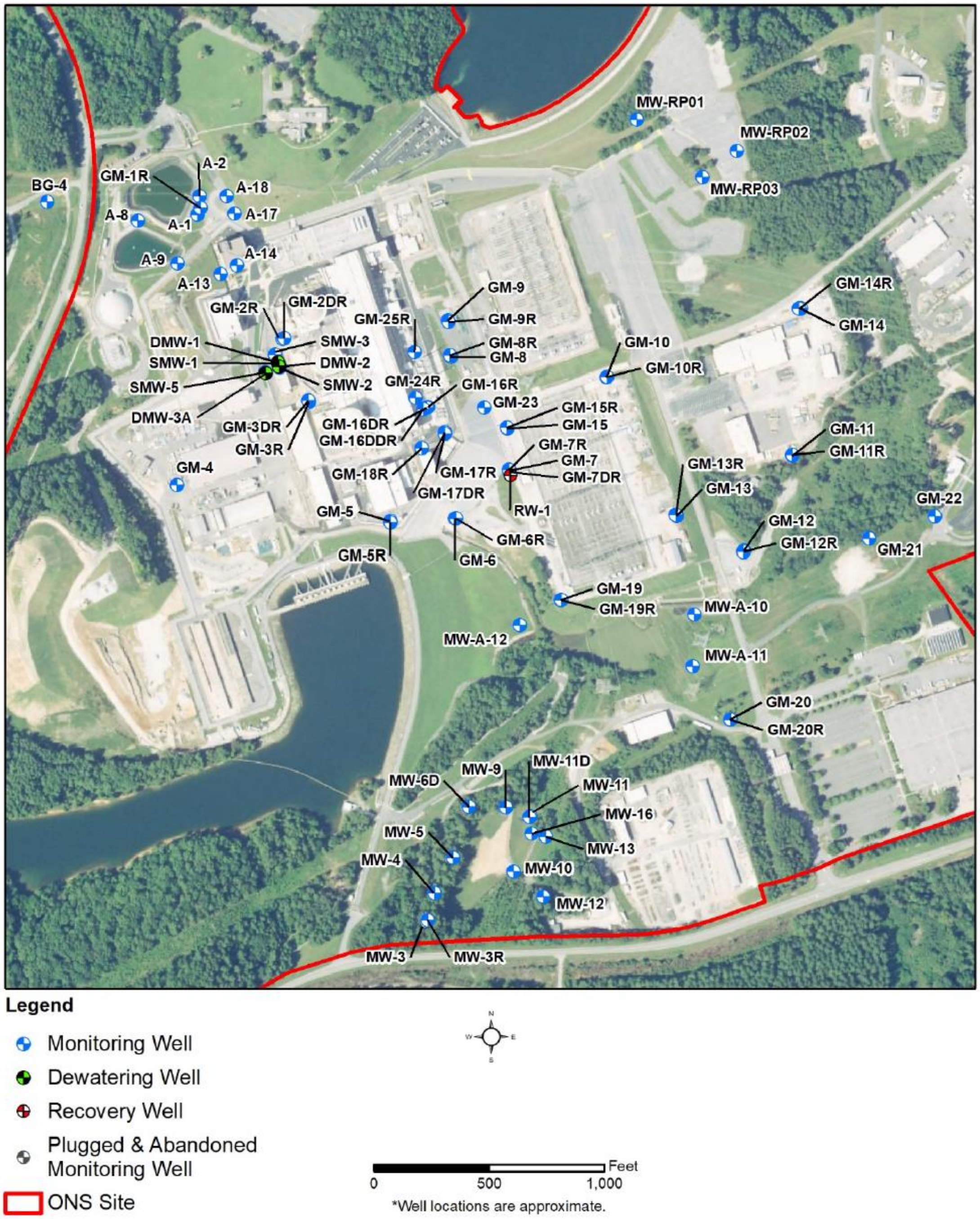

Figure 3-5 Oconee Station Onsite Groundwater Monitoring Wells. Source: Duke Energy 2021-TN8897.

As part of the Oconee Station radiological monitoring program, groundwater samples are normally collected either quarterly, semiannually, or annually for analysis of tritium and gamma emitters, and selected wells are analyzed for difficult-to-detect radionuclides (Duke Energy 2021-TN8897). Results of these samplings and other nonradiologically targeted samples have been submitted to the NRC in annual monitoring reports and are discussed in the section below.

3.5.2.3.2 Radiological and Nonradiological Spills

No inadvertent releases of radioactive or nonradioactive contaminants have been reported to have occurred at the Oconee Station site in the last 5 years, from January 2018 to January 2022 (Duke Energy 2022-TN8948, Duke Energy 2023-TN8952). The most recent liquid release event was reported to have occurred in May 2014. Oconee Station personnel reported observing water seeping from the ground at a location near the transfer piping between CTP-1 and CTP-3 while transferring water from CTP-1 to CTP-3 on May 6, 2014 (Duke Energy 2021-TN8897). A 3 in. hole drilled in the side of the yard drain catch basin was identified as the cause of the release and was repaired. Tritium concentrations in CTP-1 at the time were approximately 4,000 picocuries per liter (pCi/L), and the amount of total tritium activity released was estimated to be 2.4E-06 curies (Duke Energy 2021-TN8897). Monitoring results from two wells downgradient of the release (A-13 and A-14) did not indicate any significant changes to tritium concentrations in groundwater (Duke Energy 2022-TN8946).

3.5.2.3.3 History of Tritium in Groundwater

Beginning in January 2008, elevated tritium levels were detected in five onsite GWPI monitoring wells: GM-2R, GM-2DR, GM-7, GM-7R, GM-7DR, shown in Figure 3-5 (Duke Energy 2022-TN8948). Maximum tritium concentrations were reported in wells GM-7R (28,000 pCi/L; April 2010) and GM-7DR (35,400 pCi/L; January 2010) (Duke Energy 2022-TN8948). Duke Energy determined the probable source of the elevated tritium concentrations to be inadvertent discharges from the turbine building to the CPT-3 tail race through the east yard drainage system (Duke Energy 2023-TN8947, Attachment 7). The discharges through this pathway were ceased in 2008 (Duke Energy 2023-TN8947, Attachment 7).

The current remediation of tritium-affected groundwater was initiated in November 2010 with the installation of recovery well (RW)-1, shown in Figure 3-5 (Duke Energy 2021-TN8897). Groundwater extraction from RW-1 began in February 2011, and by April 2016, more than 25 million gal (95 million L) of water had been extracted from the well (Duke Energy 2021-TN8897). Groundwater recovered from RW-1 is discharged through dedicated piping to CTP-3 (Duke Energy 2023-TN9227). Combined with the dewatering activity around the standby shutdown facility, the NRC staff calculated the average groundwater withdrawal from the site between 2011 and 2016 to have been 29.06 gpm. As a result of the extraction at RW-1, tritium concentrations in the target monitoring wells have decreased below the EPA's safe drinking water standard (20,000 pCi/L) (EPA 1980-TN8950). In 2022, the maximum tritium concentration reported in onsite GWPI wells was 3,990 pCi/L at GM-17R. (Duke Energy 2023-TN8947, Attachment 7).

The NRC staff reviewed tritium concentration trends in onsite GWPI wells reported in Attachment 7 of the Annual Radiological Effluent Release Reports between 2018 and 2023 (Duke Energy 2019-TN8943, Duke Energy 2020-TN8944, Duke Energy 2021-TN8945, Duke Energy 2022-TN8946, Duke Energy 2023-TN8947). Overall, tritium concentrations in onsite wells are consistent or decreasing with time. However, an increase in sampled tritium concentrations was observed in well GM-17R between the second and fourth quarter sampling events in 2020 (no samples were collected during the third quarter of 2020) (Duke Energy 2021-TN8945, Attachment 7). Concentrations increased from 1,008 pCi/L to a maximum of 4,600 pCi/L in 2020. Sample frequency was increased from semiannually to quarterly at GM-17R following 2020, and concentrations have remained consistent between 2021 and 2022 with an average concentration of 3,700 pCi/L (Duke Energy 2022-TN8946, Duke Energy 2023-

TN8947). Well GM-17R is located hydraulically upgradient of abstraction well RW-1 and approximately 150 ft (46 m) east of the south end of the turbine building.

3.5.2.3.4 Monitoring of Other Radionuclides

GWPI wells are regularly analyzed for tritium and gamma emitters, and select wells are analyzed for difficult-to-detect radionuclides (Duke Energy 2022-TN8946). No gamma or difficult-to-detect radionuclides were detected in the groundwater between 2018 and 2021 (Duke Energy 2019-TN8943, Duke Energy 2020-TN8944, Duke Energy 2021-TN8945, Duke Energy 2022-TN8946).

3.5.2.3.5 NPDES and Landfill Groundwater Monitoring

As part of the site NPDES permit monitoring requirements, eight wells are monitored semiannually for copper, barium, gamma emitters, difficult-to-detect radionuclides, tritium, nitrate, sulfate, and ammonia (Duke Energy 2021-TN8897). These wells monitor effluent from the three onsite chemical treatment ponds. No violations of the site NPDES permit (SC0000515) were identified in 2022 (EPA 2023-TN8953).

Leachate from the closed onsite Class 2 landfill is collected and discharged to CPT-3 through internal nuclear power plant Outfall 006 (Duke Energy 2021-TN8897). Monitored parameters at the outfall include biochemical oxygen demand, nitrate and nitrite as total nitrogen, total organic carbon, total recoverable selenium, total recoverable zinc, and total recoverable copper (Duke Energy 2021-TN8897). Eleven groundwater wells situated around the landfill (shown in Figure 3-5) are also monitored for a variety of parameters including inorganic and organic compounds, alpha and beta particles, gamma-emitting isotopes, and tritium (Duke Energy 2022-TN9012). Results are reported annually to SCDHEC (Duke Energy 2022-TN9012). Results are compared to maximum and secondary contaminant levels from State Primary Drinking Regulations. Adverse impacts on groundwater in the proximity of the Class 2 Landfill have not been identified from 2020–2023 (Duke Energy 2020-TN9151, Duke Energy 2021-TN9152, Duke Energy 2022-TN9012).

3.5.3 Proposed Action

The following sections address the site-specific environmental impacts of the Oconee Station SLR on the environmental issues related to surface water and groundwater in accordance with Commission direction in CLI-22-02 and CLI-22-03.

3.5.3.1 Surface Water Resources

The following sections address the site-specific environmental impacts of Oconee Station SLR on the environmental issues identified in Table 3-1 that relate to surface water resources. No other surface water resource-related issues apply to Oconee Station (see Table 3-1).

3.5.3.1.1 Surface Water Use and Quality (Non-Cooling System Impacts)

During the SLR term, surface water may be used at nuclear power plants for non-cooling systems (e.g., during refurbishment activities for concrete preparation, dust suppression, washing equipment, facility cleaning). Discharges to surface water bodies can occur from stormwater runoff that may be affected by refurbishment-related land-disturbing activities and potential spills of chemicals and fuels.

Surface water use and quality are discussed and evaluated in Sections 3.6.3.1 and 3.6.4.1, respectively, of Duke Energy's ER (Duke Energy 2021-TN8897). Instead of relying on surface water, Oconee Station uses public domestic water to meet its potable and sanitary water demand, which reduces non-cooling water consumption at the plant. Non-cooling water withdrawals are mostly limited to plant activities such as facility and equipment cleaning. Because a public domestic water supply is used, the volume of water needed for non-cooling purposes is negligible compared to the volume used for cooling purposes.

Oconee Station discharges wastewater to Lake Keowee and the Keowee River in accordance with its NPDES permit. Duke Energy submitted a permit renewal application in 2013 by, but the SCDHEC has not yet issued a permit. Oconee Station NPDES Permit No. SC0000515 is administratively continued (Duke Energy 2022-TN8948: Response to RCI SW-1). The plant operates in compliance with the NPDES general industrial stormwater permit, which addresses compliance with stormwater regulations, obtaining necessary stormwater permits, developing SWPPPs, and implementing BMPs (both structural and non-structural). Moreover, Oconee Station has a spill prevention, control and countermeasure (SPCC) plan and a chemical control program to minimize oil spills and mitigate risks from hazardous and toxic chemicals. During the proposed SLR term, these plans, programs, and procedures will remain in place and will be updated as necessary (Duke Energy 2022-TN8899: ER Supplement 2). Duke Energy confirmed that no reportable inadvertent releases or spills of nonradioactive contaminants have occurred since Duke Energy's Environmental Report Supplement 2 was submitted on November 7, 2022 (Duke Energy 2023-TN8952: Response to RCI GEN-3).

The NRC staff has not identified new and significant information related to surface water use and quality (non-cooling system impacts) during the audit, scoping process, and review of available information cited in this EIS. Compliance with the current NPDES permit and stormwater regulatory requirements and permit conditions, and implementation of the SWPPP, SPCC plan, and other BMPs will minimize the impacts on water quality. The NRC staff concludes that the impacts on surface water use and quality from non-cooling water systems during the proposed SLR term would be SMALL.

3.5.3.1.2 Altered Current Patterns at Intake and Discharge Structures

During the SLR term, flow rates associated with cooling system intake and discharge have the potential to alter current patterns in a surface water body. The degree of the alterations depends on the characteristics of the surface water body, the design of the intake and discharge structures, and the flow rates.

The main hydrologic features, including the lakes, rivers, and impoundments that influence Oconee Station, are discussed in Section 3.6.1 of Duke Energy's ER (Duke Energy 2021-TN8897). The ER also includes details of the intake and discharge structures. Lake Keowee was formed by impounding the Keowee and Little Rivers and serves as the cooling water source for Oconee Station. Oconee Station withdraws cooling water from the Little River arm of Lake Keowee and discharges to the Keowee River arm. Duke Energy anticipates no modifications in the operation of the plant's cooling system associated with the proposed SLR term that may change the existing current patterns at the intake and discharge structures (Duke Energy 2022-TN8899).

The NRC staff has not identified any new and significant information related to altered current patterns. The NRC staff finds that existing current patterns at intake and discharge structures will remain the same during the proposed SLR term. The NRC staff concludes that the impacts on altered current patterns at intake and discharge structures for the proposed SLR term would be SMALL.

3.5.3.1.3 Altered Thermal Stratification of Lakes

Because cooling systems typically withdraw from the deeper, cooler portion of the water column of lakes or reservoirs and discharge to the surface, they have the ability to alter the thermal stratification of a surface water body with relatively stagnant waters (e.g., a lake). The heated discharge creates a thermal plume in the receiving water body and cools by losing heat to the atmosphere and to ambient water.

Oconee Station withdraws cooling water from the Little River arm of Lake Keowee and discharges to the Keowee River arm. The thermal effect on stratification from Oconee Station, which has a once-through heat dissipation system (see Section 2.2.3 of Duke Energy 2021-TN8897), is examined through the NPDES permit process. Duke Energy's NPDES permit establishes a thermal discharge limit in accordance with the CWA 316(a), and Oconee Station operates in compliance with that limit. A license renewal application for the permit was submitted in 2013, which resulted in an administrative extension of the permit.

Since 2000, Duke Energy has monitored water temperatures below Keowee Dam. The results demonstrate that temperature standards have not been exceeded and suggest that a stable pattern has been established (Duke Energy 2021-TN8897). Temperature monitoring of the Little River suggests negligible migration of the Oconee Station thermal plume into the Little River watershed (Duke Energy 2022-TN8899). Oconee Station also conducts CWA Section 316(a) studies that requires temperature recording. These studies demonstrate that the thermal discharge limits established in the NPDES permit protects the Lake Keowee fishery because the extent of the resulting thermal plume is limited. The 2019 through 2021 monthly average temperatures at the intake and discharge have remained within the year-to-year variation for 2014–2018 previously reported in the ER (Duke Energy 2023-TN8952: Response to RCI SW-1).

The NRC staff has not identified any new and significant information related to altered thermal stratification during the audit, scoping process, and review of available information cited in this EIS. Because no modifications to the Oconee Station intake and discharge are planned during the proposed SLR term, the NRC staff concludes that the impacts of thermal stratification of Lake Keowee would be SMALL.

3.5.3.1.4 Scouring Caused by Discharged Cooling Water

The high flow rate of water from a cooling system discharge structure has the potential to scour sediments and redeposit them elsewhere. The degree of scouring depends on the design of the discharge structure, the discharge flow rate, and the sediment characteristics. Scouring is expected to occur only in the vicinity of the discharge structures where flow rates may be high. While scouring is possible during reactor startup, operational periods would typically have negligible scouring.

The withdrawal and discharge of water to and from the Keowee Lake is discussed in Section 2.2.3 of Duke Energy's ER (Duke Energy 2021-TN8897). Oconee Station withdraws cooling water from the Little River arm of Lake Keowee and discharges to the Keowee River arm. No scouring impacts from discharged cooling water have been observed at Oconee Station (Duke Energy 2022-TN8899). Scour impacts would continue to be negligible with continued compliance with regulatory, permit, and license requirements (Duke Energy 2022-

TN8899). No modifications are planned for the Oconee Station cooling system that would alter discharge patterns during the SLR term (Duke Energy 2022-TN8899).

The NRC staff identified no new and significant information related to the Oconee Station cooling system during the audit, through the scoping process, and review of available information cited in this EIS. Because no changes in existing current patterns are expected, changes in scouring impacts are also not anticipated. The NRC staff concludes that the impacts on scouring caused by discharged cooling water for the proposed SLR term would be SMALL.

3.5.3.1.5 Discharge of Metals in Cooling System Effluent

Heavy metals such as copper, zinc, and chromium can be leached from condenser tubing and other components of the heat exchange system by circulating cooling water. These metals are normally addressed in NPDES permits because high concentrations of them can be toxic to aquatic organisms.

The chemical additives approved by the SCDHEC that are used at Oconee Station to control pH, scale, and corrosion are described in Section 3.6.1.2.1 of Duke Energy's ER (Duke Energy 2021-TN8897). Oconee Station's NPDES permit does not have a metals limit or require monitoring for metals at the circulating condenser cooling water outfall.

In response to a SCDHEC review evaluating the need to include a copper limit in the NPDES permit, Duke Energy conducted 16 sampling events from 2005 to 2009. The results of these sampling events indicated that the copper concentrations in the lake at the intake and the outfall were consistently the same (Duke Energy 2022-TN8899). In their analysis, SCDHEC concluded that there is no reasonable potential for copper or other metals to result in a water quality violation (Duke Energy 2022-TN8899).

The NRC staff has not identified any new and significant information related to discharge of metals in cooling system effluent during the audit, scoping process, and review of available information cited in this EIS. Based on compliance with current NPDES regulatory requirements, and permit conditions, the NRC staff concludes that the potential impacts from the discharge of metals in the cooling system effluent for the proposed SLR term would be SMALL.

3.5.3.1.6 Discharge of Biocides, Sanitary Wastes, and Minor Chemical Spills

The use of biocides and other water treatment chemicals is common and is required to control biofouling and nuisance organisms in plant cooling systems. However, the types of chemicals, their amounts or concentrations, and the frequency of their use may vary. Residual biocides used in cooling systems are discharged with cooling system effluents. The discharge of treated sanitary waste may occur via onsite wastewater treatment facilities, via an onsite septic field, or through a connection to a municipal sewage system. Each of these factors represents a potential impact on surface water quality.

The chemical additives approved by the SCDHEC that are used at Oconee Station to control pH, scale, and corrosion in the circulating water system, and to control biofouling of plant equipment are discussed in Section 3.6.1.2.1 of Duke Energy's ER (Duke Energy 2021-TN8897) and Section 4.5.11.2 of ER Supplement 2 (Duke Energy 2022-TN8899). The addition of biocides is governed by Oconee Station's NPDES permit, which requires SCDHEC approval. The NPDES permit also addresses the use of other additives and water treatment chemicals.

Since 2010, Oconee Station has been connected to a municipal sewage treatment system and no longer discharges treated wastewater (Duke Energy 2021-TN8897).

Oconee Station has an SPCC plan in place that identifies and describes the procedures, materials, equipment, and facilities used to minimize the frequency and severity of oil spills. There is also a chemical control program that manages storage areas and assesses and mitigates risk from hazardous and toxic chemicals (Duke Energy 2022-TN8899).

The NRC staff has found records of two spills reported to the National Response Center from 2014 through 2020, as indicated in Section 9.5.3.6 in Duke Energy's ER (Duke Energy 2021-TN8897). These spills were related to lubricating oil and hydraulic oil releases at/near the Keowee Hydro Station. Since 2020, two sewage spills have occurred, both of which were reported to the SCDHEC. Oconee Station has environmental protection programs in place to address the non-radiological hazards of plant operations. These programs focus on ensuring adherence to environmental permits and requirements at the State and local levels. The following corrective actions were taken by Duke Energy in response to the four spills (Duke Energy 2023-TN8952: Response to RCI SW-2):

- On July 20, 2014, a lubricating oil spill of approximately 5 gal (19 L) was released from the Keowee Hydro Station to the Keowee tailrace. The source of the oil was stopped. The spill reached the station sump. Two temporary booms were deployed below the station in the Keowee River. Oil was removed from the sumps, and the station sumps were cleaned of oil residue. SCDHEC was notified of the release.
- On February 8, 2018, approximately 4 ounces (118 mL) of hydraulic oil leaked while testing a submersible hydraulic pump adjacent to the Keowee Hydro Station spillway. Boom and absorbent sheets were placed in the lake to contain and remove the approximately 1 ft by 2 ft (0.3 m by 0.6 m) oil sheen. The National Response Center and the SCDHEC were notified of the release. The pump was removed from service. The oil sheen was removed from the lake.
- On November 21, 2021, a polyvinyl chloride pipe cracked, spraying approximately 3–5 gal (11-19 L) of sewage from an air ejector into the Unit 1 and 2 turbine building sump. The polyvinyl chloride pipe was repaired. A janitorial contractor cleaned and disinfected the equipment and the floor area where the spill occurred. The spill was reported to the SCDHEC.
- On August 15, 2022, sewage air ejectors failed, causing a 50 gal (189 L) sewage spill into the Keowee River. A janitorial contractor cleaned and disinfected the areas where the spill occurred. The sewage air ejectors were repaired, and Duke Energy notified the SCDHEC of the incident via ePermitting and a courtesy call to the Anderson, South Carolina, regional office.

The NRC staff has not identified any new and significant information related to discharge of biocides, sanitary wastes, and minor chemical spills. The NRC staff concludes that compliance with current NPDES regulatory requirements and permit conditions along with the implementation of the SPCC plan, SWPPP, and BMPs will mitigate impacts from wastewater and stormwater discharges. The NRC staff concludes that impacts from discharges of biocides, sanitary wastes, and minor chemical spills would be SMALL during the SLR term.

3.5.3.1.7 Surface Water Use Conflicts (Plants with Once-through Cooling Systems)

Nuclear power plant cooling systems may compete with other users relying on surface water resources, including downstream municipal, agricultural, or industrial users. As reported by Dieter et al. (2018-TN6681), thermoelectric plant once-through cooling systems return most of their withdrawn water to the same surface water body, and experience evaporative losses of approximately 1 percent of the withdrawal amount. Consumptive use by plants with once-through cooling systems during the license renewal term is not expected to change unless power uprates, with associated increases in water use, are proposed.

The surface water withdrawals and returns at Oconee Station are discussed in Section 3.6.3.1 of Duke Energy's ER (Duke Energy 2021-TN8897). Oconee Station returns nearly all the surface water withdrawals (99 percent) to Lake Keowee, as reported in Section 2.2.3.5 of Duke Energy's ER (Duke Energy 2021-TN8897). Duke Energy owns and operates the Keowee Development (Lake Keowee and Keowee Hydroelectric Station), the Jocassee Development (Lake Jocassee and the Jocassee Pumped Storage Station), and the Bad Creek Pumped Storage Project (Bad Creek Reservoir and the Bad Creek Pumped Storage Station) in coordination with the USACE, such that the power generating requirements of federally owned hydroelectric projects (J. Strom Thurmond, Richard B. Russell, and Hartwell projects) are not adversely affected (USACE 2014-TN9153). The operating agreement takes into account the 2014 USACE assessment of future water availability within the Savannah River Basin, including Lake Keowee (USACE 2014-TN9153).

The average surface water withdrawal rates by Oconee Station from 2014 through 2021 are reported in Section 3.6.3.1 in Duke Energy's ER and Section 4.5.12.2 in ER Supplement 2 (Duke Energy 2021-TN8897, Duke Energy 2022-TN8899). For 2014 through 2021, average Oconee Station water withdrawal from Lake Keowee was 2,628.2 mgd or 79,829 million gallons per month. From 2017 through 2021 (the last 5 years), the average withdrawal was 2,648 mgd. The reported rates indicate that the withdrawal rates have been consistent throughout the period and were within the permit limits (currently permitted withdrawal is a maximum of 94,885 million gallons per month [Duke Energy 2021-TN8897]).

The NRC staff has not identified any new and significant information related to surface water conflicts during the audit, scoping process, and review of available information cited in this EIS. Moreover, continued compliance with the USACE operating agreement mitigates water use impacts by protecting downstream users and ecological communities. Hence, the NRC staff concludes that the surface water use conflicts for the proposed SLR term would be SMALL.

3.5.3.1.8 Effects of Dredging on Surface Water Quality

Dredging in the vicinity of surface water intakes, canals, and discharge structures is undertaken by some nuclear power plant licensees to remove deposited sediment and maintain the function of plant cooling systems. Dredging may also be needed to maintain barge shipping lanes. Whether accomplished by mechanical, suction, or other methods, dredging disturbs sediments in the surface water body and affects surface water quality by temporarily increasing the turbidity of the water column. In areas affected by industries, dredging can also mobilize heavy metals, polychlorinated biphenyls, or other contaminants in the sediments.

Oconee Station does not periodically dredge at Lake Keowee and does not anticipate dredging during the proposed SLR term (Duke Energy 2022-TN8899). If any dredging needs arise during the SLR term, Duke Energy would be required to obtain Federal and State permits.

The NRC staff has not identified any new and significant information related to the effects of dredging on surface water quality during the audit, scoping process, and review of available information cited in this EIS. The NRC staff also recognizes that any dredging operations would be performed under permits issued by USACE and possibly State agencies. The NRC staff concludes that the impacts of dredging on surface water quality for the proposed SLR term would be SMALL.

3.5.3.1.9 Temperature Effects on Sediment Transport Capacity

Increased temperature and the resulting decreased viscosity have been hypothesized to change the sediment transport capacity of water, leading to potential sedimentation problems, altered turbidity of rivers, and changes in riverbed configuration.

Oconee Station discharges heated cooling water to Lake Keowee in accordance with their NPDES permit. Compliance with the permit requires Oconee Station to monitor surface temperature and water column temperature at sampling points in Lake Keowee. The recorded temperature is reviewed by SCDHEC during each NPDES permit renewal, as part of the SCDHEC-approved CWA Section 316(a) study plan. Any concern SCDHEC may have related to this issue would be addressed through the NPDES permitting process (Duke Energy 2022-TN8899).

Duke Energy has not observed any sediment transport impacts resulting from cooling system discharge temperature (Duke Energy 2022-TN8899). Because no change in operation of the cooling system is expected during the proposed SLR term, no change in the effects of sediment transport capacity is anticipated.

The NRC staff has not identified any new and significant information related to temperature effects on sediment transport capacity during the audit, scoping process, and review of available information cited in this EIS. The NRC staff expects that because Oconee Station discharges to an impounded, rather than a free-flowing, river, little incoming sediment would be available and could be subsequently deposited due to decreased transport capacity. The NRC staff concludes that the temperature effects on sediment transport capacity for the proposed SLR term would be SMALL.

3.5.3.2 Groundwater Resources

The following sections address the site-specific environmental impacts of Oconee Station SLR on the environmental issues identified in Table 3-1 that relate to groundwater resources.

3.5.3.2.1 Groundwater Contamination and Use (Non-cooling System Impacts)

Onsite groundwater use is discussed and evaluated in Section 3.6.3.2 of Duke Energy’s ER (Duke Energy 2021-TN8897). Withdrawals from nuclear power plant dewatering operations and tritium plume control are much less than 100 gpm and are unlikely to affect regional groundwater availability based on the hydrogeological setting of the site (see Sections 3.5.2.2 and 3.5.2.3 of this EIS). Groundwater contour maps (Figure 3-5) indicate the radius of influence of the combined abstractions does not extend offsite, and the relatively high storativity of the regolith further reduces impacts on potential users of domestic wells within the vicinity of Oconee Station (USGS 1990-TN6648).

According to Section 3.6.4.2 of Duke Energy's ER, industrial practices at the site generally involve the use of chemicals associated with maintenance activities for plant, equipment, buildings, and water treatment. Management of the chemicals is governed by Duke Energy procedures and site-specific prevention plans (Duke Energy 2021-TN8897).

The NRC staff have not identified new and significant information during the audit, scoping process, and review of available information cited in this EIS. The NRC staff has concluded that, over the period of extended operation, potential groundwater contamination would likely remain onsite, and no offsite wells are expected be affected. Oconee Station has implemented a groundwater protection program to identify and monitor leaks through the installed monitoring well network and adheres to the appropriate State pollution prevention permits. With a robust sampling strategy, potential future releases of contamination into the groundwater would be readily detected. Dewatering systems are not expected to increase significantly in discharge volume, so an incremental effect on groundwater availability over that which has taken place is unlikely. Therefore, the NRC staff concludes that the non-cooling system impacts on groundwater contamination and use during the SLR term would be SMALL.

3.5.3.2.2 Groundwater Use Conflicts (Nuclear Power Plants that Withdraw Less than 100 Gallons per Minute)

According to Duke Energy's ER (Section 3.6.3.2), no active groundwater supply wells are installed on the station's property. Potable water for the nuclear power plant is supplied by Seneca Light & Water. Potential impacts of dewatering and tritium plume control are discussed above in Section 3.5.3.2.1. Local and regional water consumption is discussed in Section 3.5.2.3 of this EIS.

When evaluating the potential impacts resulting from groundwater use conflicts associated with SLR, the NRC staff uses the existing groundwater resource conditions described in Section 3.5.2 of this EIS as its baseline. These baseline conditions encompass the existing hydrogeologic framework and conditions (including aquifers) potentially affected by continued operations, as well as the nature and magnitude of groundwater withdrawals compared to relevant appropriation and permitting standards. The baseline also considers other potentially affected uses and users of the groundwater resources affected by the continued operation of the nuclear power plant. Future activities related to SLR at the Oconee Station site are neither expected to require withdrawal of more than 100 gpm, nor are these activities expected to lower groundwater levels beyond the nuclear power plant boundary. Therefore, the NRC staff concludes that for this issue during the SLR term, impacts would be SMALL.

3.5.3.2.3 Radionuclides Released to Groundwater

This issue was added for consideration as part of the groundwater review for license renewal in the 2013 LR GEIS revision (NRC 2013-TN2654) because of the accidental releases of liquids containing radioactive material into the groundwater at a number of nuclear power plants. In 2006, the NRC released a report documenting lessons learned from a review of these incidents that ultimately concluded that these releases had not adversely affected public health and safety (Liquid Radioactive Release Lessons Learned Task Force Report; NRC 2006-TN1000). This report concluded, in general, that affected groundwater is expected to remain onsite, but instances of offsite migration have occurred. The LR GEIS (NRC 2013-TN2654) determined that impacts on groundwater quality from the release of radionuclides could be SMALL or MODERATE, depending on the magnitude of the leak, the radionuclides involved, hydrogeologic factors, distance to receptors, and response time of nuclear power plant personnel to identify and stop the leak in a timely fashion. As a result, this issue is considered to be Category 2, thus requiring a site-specific evaluation.

This issue was discussed and evaluated in Sections 3.6.4.2 and 4.5.5 of Duke Energy's ER (Duke Energy 2021-TN8897). Oconee Station personnel monitor groundwater for inadvertent releases as part of its groundwater protection program, which was implemented in 2007 under NEI 07-07 and in conjunction with 10 CFR 20.1501TN283. Tritium is the only radionuclide that has been historically detected in the regolith and weathered/fractured bedrock above the minimum detectable concentration. As a result of remediation being implemented, recent measurements of tritium in the groundwater are well below the EPA safe drinking water standard of 20,000 pCi/L (40 CFR Part 141-TN4456). Site hydrogeologic evaluations indicate that the affected groundwater is migrating southeast toward CTP-3 and the conveyance. There is no indication that the affected groundwater is migrating beyond the Oconee Station site boundary or affecting offsite water uses and users.

The NRC staff has evaluated this information as part of its review. In addition, the staff has identified no new and significant information during the audit, scoping process, and review of available information cited in this EIS. The NRC staff has concluded that over the period of extended operation, potential groundwater contamination would likely remain onsite and no offsite wells should be affected. Oconee Station has implemented a groundwater protection program to identify and monitor leaks through the installed monitoring well network. With a robust sampling strategy, potential future releases of tritium into the groundwater would be readily detected. Therefore, the NRC staff concludes that the impacts on groundwater use and quality related to the inadvertent release of radionuclides to groundwater during the SLR term would be SMALL.

3.5.4 No-Action Alternative

3.5.4.1 Surface Water Resources

Under the no-action alternative, surface water withdrawals would greatly decrease and eventually cease. Stormwater would continue to be discharged from the site, but wastewater discharges would be reduced considerably. As a result, shutdown of Oconee Station would reduce the overall impacts on surface water use and quality by reducing the pollutants discharged and thermal loading to receiving waters, including Lake Keowee. Therefore, the NRC staff concludes that the impact of the no-action alternative on surface water resources would remain SMALL.

3.5.4.2 Groundwater Resources

With the cessation of operations, there would be a reduction in onsite groundwater abstraction and little or no additional impacts on groundwater quality. Therefore, the NRC staff concludes that the impact of the no-action alternative on groundwater resources would be SMALL.

3.5.5 Replacement Power Alternatives: Common Impacts

3.5.5.1 Surface Water Resources

<u>Construction</u>

Construction activities associated with replacement power alternatives may cause temporary impacts on surface water quality by increasing sediment loading to water bodies and waterways. Construction activities also may affect surface water quality through pollutants in stormwater runoff from disturbed areas and excavations, spills, and leaks from construction equipment; and from sediment and other pollutants disturbed by associated dredge and fill activities. These pollutants could be detrimental to downstream surface water quality, where applicable, and to ambient water quality in waterways near work sites.

Facility construction activities might alter surface water drainage features within the construction footprints of replacement power facilities, including any wetland areas. Potential hydrologic impacts would vary depending on the nature and acreage of land area disturbed and the intensity of excavation work.

The NRC staff assumes that construction contractors would implement BMPs for soil erosion and sediment control to minimize water quality impacts in accordance with applicable Federal, State, and local permitting requirements. These measures would include spill prevention and response procedures, such as measures to avoid and respond to spills and leaks of fuels and other materials from construction equipment and activities.

For example, land clearing and related site construction activities would need to be conducted under an SCDHEC-issued NPDES General Permit for Stormwater Discharges from Construction Activities (SCR100000), if more than 1 ac (0.4 ha) of land would be disturbed (SCDHEC 2019-TN9154). In accordance with the NPDES general permit, Duke Energy and its contractors would need to develop and implement erosion and sediment controls, stormwater pollution prevention, and spill prevention and response practices to prevent or minimize any surface water quality impacts during construction. The permit also requires a post-construction stormwater management plan to be developed and implemented (Duke Energy 2021-TN8897).

In addition, deep excavation work required to construct the power block associated with the thermoelectric components of replacement power alternatives could require groundwater dewatering (see Section 3.5.5.2). Water pumped from excavations would be managed and discharged in accordance with applicable NPDES requirements. As a result, the NRC staff expects that dewatering would not affect surface water quality.

To the maximum extent possible, after any necessary modification, the existing Oconee Station surface water intake and discharge infrastructure would be used for replacement power components located on or adjacent to the existing Oconee Station site. This would reduce the potential water quality impacts associated with the construction of new structures at the site.

Construction activities that would be conducted by Duke Energy and its contractors in and adjacent to waterways, wetlands, and any nearshore areas would be subject to review and approval by applicable Federal and State regulatory agencies. For example, the discharge of dredged or fill material in waterways, at any stream crossings, and placement of structures in navigable waters would be subject to USACE permit provisions under CWA Section 404 and Section 10 of the Rivers and Harbors Appropriation Act of 1899, respectively (33 CFR Part 322-TN4484 and 33 CFR Part 323-TN4827). Additionally, any potential impacts on State wetlands and adjacent waterways would be subject to regulation and permitting by the SCDHEC (SCDHEC 2019-TN9264).

The NRC staff does not expect that any surface water would be diverted or withdrawn to support replacement power facility construction. It is more likely that where necessary, water would be supplied by a temporary water tap from a municipal source and transported to the point of use, or onsite groundwater could be used. The likely use of ready-mix concrete would also reduce the need for onsite use of nearby water sources to support facility construction.

Sanitary water use and wastewater generation would generally be limited to the construction workforce and would likely be accommodated with portable restroom facilities.

Operation

The thermoelectric power generating components of the replacement power alternatives would use closed-cycle cooling with mechanical draft cooling towers. For the facilities located on the Oconee Station site, make-up water would be obtained from Lake Keowee (Duke Energy 2021-TN8897). Nuclear power plants using closed-cycle cooling systems with cooling towers withdraw substantially less water for condenser cooling than a thermoelectric power plant using a once-through system. However, the relative percentage of consumptive water use is greater in closed-cycle nuclear power plants because of evaporative and drift losses during cooling tower operation (NRC 2013-TN2654). Surface water withdrawals would be subject to the South Carolina surface water withdrawal permitting and registration regulations (SCR 61-119, TN9007).

In addition, closed-cycle cooling systems typically require chemical treatment, such as biocide injections to control biofouling (NRC 2013-TN2654). Residual concentrations of these chemical additives would be present in the cooling tower blowdown discharged to receiving waters. However, chemical additions would be accounted for in the operation and permitting of liquid effluents. All effluent discharges from the thermoelectric power generation components would be subject to State-administered NPDES permit requirements for the discharge of wastewater and industrial stormwater to State waters. NPDES permit conditions require the permit holder to develop and implement an SWPPP and associated BMPs and procedures, which would help reduce surface water quality impacts during facility operation.

During operation of renewable energy facilities (i.e., solar PV farms and wind turbine installations), only very small amounts of water normally would be needed by facility personnel to periodically clean solar panels and turbine blades and motors, respectively, as part of routine servicing. Some water also may be used for dust control. The NRC staff assumes that water would be supplied from a municipal utility, onsite groundwater, or trucked to the point of use and procured from nearby sources.

Stormwater runoff from solar farm and wind turbine installations would normally be limited to uncontaminated rainfall and snowmelt from facility surfaces, roads, and pad sites. The NRC staff assumes that all renewable energy sites would be designed and constructed with appropriate drainage and stormwater management controls to minimize offsite water quality impacts in accordance with applicable State and local regulations.

3.5.5.2 Groundwater Resources

Construction

Excavation dewatering for foundations and substructures during construction of replacement power generation facilities, as applicable, may be required to stabilize slopes and permit placement of foundations and substructures below the water table. Groundwater levels in the immediate area surrounding an excavation may be temporarily affected, depending on the duration of dewatering and the methods (e.g., cofferdams, sheet piling, sumps, and dewatering wells) used for dewatering. The NRC staff expects that any impacts on groundwater flow and quality caused by dewatering would be highly localized and short in duration and would cause no effects on other groundwater users. Discharges resulting from dewatering operations would be released in accordance with applicable State and local permits.

Although foundations, substructures, and backfill may alter onsite groundwater flow patterns, local and regional trends would remain unaffected. Construction of replacement power generating facilities may contribute to onsite changes in groundwater infiltration and quality due to removal of vegetation and construction of buildings, parking lots, and other impervious surfaces. The potential impacts of increased runoff and subsurface pollutant infiltration or discharge to nearby water bodies would be prevented or mitigated through implementation of BMPs and an SWPPP.

In addition to construction dewatering, onsite groundwater could be used to support construction activities (e.g., dust abatement, soil compaction, and water for concrete batch plants). Groundwater withdrawal during construction could have a temporary impact on local water tables or groundwater flow, and these withdrawals and resulting discharges would be subject to applicable permitting requirements.

<u>Operation</u>

Dewatering for building foundations and substructures may be required during the operational life of the replacement power facility. Operational dewatering rates, if required, are assumed to be similar to the current dewatering rate for Oconee Station of less than 100 gpm and can be managed subject to applicable permitting requirements. Dewatering discharges and treatment would be properly managed in accordance with applicable NPDES permitting requirements. The NRC staff expects that any impacts on groundwater flow and quality affected by dewatering at a rate of less than 100 gpm would be localized, and that there would be no effects on other groundwater users due to their distance from the site location.

Effluent discharges (e.g., cooling water, sanitary wastewater, and stormwater) from a facility are subject to applicable Federal, State, and other permits specifying discharge standards and monitoring requirements. Adherence by replacement power facility operators to proper procedures during all material, chemical, and waste handling and conveyance activities would reduce the potential for any releases to the environment, including releases to the subsurface and groundwater.

For replacement power alternatives, groundwater use during operation is assumed to be similar to current nuclear power plant use, where a groundwater drawdown system and tritium plume control abstracts less than 100 gpm. Onsite groundwater withdrawals would be subject to applicable State water appropriation, permitting, and registration requirements. Site groundwater use was determined by the NRC staff to have no impact on surrounding groundwater use or quality, as described in Section 3.5.3.2. Therefore, the NRC staff determined the groundwater use during operation of a replacement power alternative to result in a SMALL impact.

3.5.6 New Nuclear (Advanced Light-Water Reactor and Small Modular Reactor) Alternative

3.5.6.1 Surface Water Resources

The hydrologic and water quality assumptions and implications for construction and operations described in Section 3.5.5.1 as being common to all replacement power alternatives also apply to this alternative. The impacts on surface water resources encompassing water quality and water use from construction and operations associated with the new nuclear alternative would likely be similar to, but of overall greater magnitude than, those described and assumed to be common to all alternatives in Section 3.5.5.1.

For the ALWR component of this alternative, the NRC evaluated the impacts of construction and operations on surface water use and water quality in its 2013 final EIS for the proposed W.S. Lee Nuclear Station, Units 1 and 2 (NUREG–2111) (NRC 2013-TN6435). As described in NUREG–2111, the NRC staff concluded that the overall impacts would be SMALL. The NRC staff found that the impact of construction and preconstruction on surface water would be of limited duration, and peak water demands would represent a small portion of the available water. The ALWR component could affect more than 3,000 ac (1,200 ha) of land. Regarding the operational impacts of the ALWR, the staff determined in NUREG–2111 that consumptive water use by Units 1 and 2 (i.e., 36 mgd [135 mLd]), through cooling-tower evaporation and drift, would be only a small proportion of available flow in the make-up water body (i.e., Broad River). Additionally, the NRC staff determined that blowdown and other wastewater discharges from the ALWR would represent a very small proportion of the receiving water's flow, and that all effluent discharges would be subject to NPDES permitting.

Construction-related impacts of the SMR component at Oconee Station would be similar but smaller in comparison to those of the ALWR component because of the smaller size of the SMR component that would need a smaller footprint and workforce. For operation of the SMR unit at the Oconee Station site, the closed-cycle cooling system would withdraw approximately 13.3 mgd (50 mLd) of make-up water, with consumptive use of approximately 9.2 mgd (35 mLd). This withdrawal would be a small fraction of the volume of water that Oconee Station currently withdraws from Lake Keowee and less than Oconee Station's estimated consumptive water use (see Section 3.5.1.2). In addition, the smaller volume of cooling water (primarily cooling tower blowdown) returned to Lake Keowee would have a smaller thermal impact on receiving waters than the current once-through cooling system. Based on these considerations, the NRC staff concludes that the total impacts on surface water resources from construction and operations under the new nuclear alternative would be SMALL.

3.5.6.2 Groundwater Resources

The hydrologic and water quality assumptions and implications for construction and operations described in Section 3.5.5.2 as being common to all replacement power alternatives also apply to this alternative. The NRC staff did not identify any impacts on groundwater resources for this alternative beyond those discussed above as being common to all replacement power alternatives. In addition, the NRC staff recognizes that water demand could be decreased for new nuclear alternatives. Therefore, the NRC staff concludes that the impacts on groundwater resources from construction and operation of a new SMR nuclear power plant complex would be SMALL.

3.5.7 Natural Gas Combined-Cycle Alternative

3.5.7.1 Surface Water Resources

The hydrologic and water quality assumptions and implications for construction and operations described in Section 3.5.5.1 as being common to all replacement power alternatives also apply to this alternative. Additionally, a new gas pipeline would be required to connect the new gas-fired facility to existing service located approximately 21 mi (34 km) from Oconee Station. Pipeline construction would have the potential for additional hydrologic impacts. However, water quality impacts would be minimized by the application of BMPs and by compliance with the State NPDES permitting requirements for construction activities and USACE Section 404 permits that would regulate construction of the pipeline in waterways and wetlands.

Operation of a natural gas alternative using closed-cycle cooling would withdraw approximately 18 mgd (68 mLd) of water from Lake Keowee, with consumptive water use of approximately 14 mgd (53 mLd). These impacts would be significantly less than Oconee Station's current average surface water withdrawals and associated consumptive use rates (see Section 3.5.1.2). In addition, the total volume of cooling water (blowdown) and comingled effluents discharged to the lake would be significantly less than under the proposed action, although there would be some differences in chemical constituents.

Based on this analysis, the NRC staff concludes the overall impacts on surface water resources from construction and operation under the natural gas alternative would be SMALL.

3.5.7.2 Groundwater Resources

The hydrologic and water quality assumptions and implications for construction and operations described in Section 3.5.5.2 as being common to all replacement power alternatives also apply to this alternative. The NRC staff did not identify any impacts on groundwater resources for this alternative beyond those discussed above as being common to all replacement power alternatives. Therefore, the NRC staff concludes that the impacts on groundwater resources from construction and operations under the natural gas combined cycle alternative would be SMALL.

3.5.8 Combination Alternative (Solar PV, Offshore Wind, Small Modular Reactor, and Demand-Side Management)

3.5.8.1 Surface Water Resources

The hydrologic and water quality assumptions and implications for construction and operations described in Section 3.5.5.1 as being common to all replacement power alternatives also apply to this alternative, except as clarified below.

For the new nuclear component (SMR) of this alternative, the overall construction and operational impacts on surface water resources would be substantially less than those described in Section 3.5.6.1 for the standalone new nuclear alternative, consisting of the offsite ALWR and the onsite SMR components. However, the onsite SMR component of this alternative would consist of three SMR units instead of one. As a result, the potential construction and operational effects on surface water resources would be proportionally larger. Specifically, for operation of the SMR units at the Oconee Station site, the closed-cycle cooling system would withdraw approximately 40 mgd (150 mLd) of make-up water, with consumptive use of approximately 28 mgd (110 mLd). This withdrawal would still be a small fraction of the volume of water that Oconee Station currently withdraws from Lake Keowee, and consumptive water use would be similar to that of Oconee Station's current once-through cooling system (see Section 3.5.1.2). Collectively, the discharge of effluents and cooling tower blowdown would be substantially less under this alternative.

Installation of utility-scale solar PV plants with battery storage would require the construction of pad sites, access roads, and possibly transmission lines or substation improvements (i.e., for sites that have no current access to transmission line or sufficient substation infrastructure), and potentially would require the alteration of surface water drainages at numerous sites across

Duke Energy's service area, potentially affecting 10,000 ac (4,000 ha). As discussed in Section 3.5.5.1 of this EIS, the NRC staff expects that all such construction activities would be conducted in accordance with applicable permits and approvals requiring the implementation of BMPs and procedures to minimize hydrologic and water quality impacts. Completed solar PV plants would have little to no operational impacts on water resources.

Construction of offshore wind turbine generator (WTG) facilities, including support infrastructure would disturb and erode marine sediments and temporarily deteriorate water quality in the marine environment over an area of some 6,300 ac (2,500 ha) during pile driving, cable laying, and positioning of construction vessels and vessel anchors. The area of marine environment that would be permanently disturbed would total approximately 66 ac (26 ha). The potential also exists for the discharge of petroleum, oil, and lubricants to marine waters from construction equipment and vessels (BOEM 2015-TN9066). The NRC staff expects that all marine construction activities would be conducted in accordance with applicable regulations governing erosion control, oil spill prevention and response (i.e., 40 CFR Part 110-TN8485 and 40 CFR Part 112-TN1041), and marine trash and debris plans and procedures, including U.S. Coast Guard pollution prevention requirements regarding at-sea discharges (BOEM 2015-TN9066). Excavation work to emplace submarine cabling to interconnect the WTG installations and connect the WTGs with onshore electric transmission and battery storage infrastructure would result in additional land and seafloor disturbance.

Once constructed, the area surrounding each WTG installation would be protected from further erosion, scour, and current action by a pad of rock armor, 3 to 6 ft (1 to 2 m) thick and covering an area of approximately 1 ac (0.4 ha) around each installation. The WTG facilities would likely result in alteration of water currents, but the changes would be localized. To minimize the potential for operational water quality impacts, the NRC staff presumes that each WTG installation would be designed with built-in spill containment to retain any spills of oil or cooling fluids (BOEM 2015-TN9066, BOEM 2018-TN8428).

The operation of WTG installations would be unlikely to have any impacts on marine waters because they are self-contained and do not produce discharges during normal operations (BOEM 2018-TN8428).

The NRC staff does not expect implementation of the demand-side management component of this combination alternative to result in incremental impacts on surface water use and quality.

Based on the cited information, as discussed above, the NRC staff concludes that the overall impacts on surface water resources from construction and operation under the combination alternative would range from SMALL to MODERATE.

3.5.8.2 Groundwater Resources

The hydrologic and water quality assumptions and implications for construction and operations described in Section 3.5.5.2 as being common to all replacement power alternatives also apply to this alternative. The NRC staff did not identify any impacts on groundwater resources for this alternative beyond those discussed above as being common to all replacement power alternatives. Therefore, the NRC staff concludes that the impacts on groundwater resources from construction and operations under the combination alternative would be SMALL.

3.6 Terrestrial Resources

This section describes the terrestrial resources of the Oconee Station site and surrounding landscape. After the description, the NRC staff analyzes potential impacts on terrestrial resources from the proposed action (SLR) and alternatives to the proposed action.

3.6.1 Ecoregion

Oconee Station lies within the Piedmont ecoregion (Duke Energy 2021-TN8897: ER Section 3.7.2.2). The EPA describes the Piedmont ecoregion (Level III Ecoregion 45) as a transitional area between mountainous ecoregions of the Appalachian Mountains to the northwest and the relatively flat coastal plain to the southeast (Griffith et al. 2002-TN9270). Much of the region near Oconee Station was cleared and converted for cotton production in the late 1800s but was abandoned by the 1930s (NRC 1999-TN8942). Now, much of the forested portions of the region are either second-growth forests of planted pine or successional pine and hardwood woodlands. Dominant conifers are various pine species, such as loblolly, shortleaf, and Virginia pines; and common hardwoods include red and white oak, hickory, and tulip poplar (NRC 1999-TN8942).

Duke Energy's ER (TN8897: ER Section 3.7.2.2) includes descriptions of several regional ecosystems in the landscape near the Oconee Station site, including the following:

- Southern Piedmont Mesic Forest
- Southern Piedmont Dry Oak (Pine) Forest
- Southern Piedmont Cliff
- Southern Piedmont Small Floodplain and Riparian Forest

The descriptions, presented in Duke Energy's ER (TN8897: Appendix E, pp. 3-113 through 3-114) characterize the tree canopy, shrub, and herbaceous strata of each plant community and are incorporated here by reference.

The USACE defines wetlands as areas either inundated or saturated by surface or groundwater at a frequency and duration sufficient to support—and that under normal circumstances do support—a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas (33 CFR 328.3(c)(4)) (TN1683). Duke Energy presents a map of wetland features in the landscape surrounding Oconee Station in Figure 3.7-1 of the ER (Duke Energy 2021-TN8897: Appendix E, pp. 3-158), which the NRC staff incorporates here by reference.

Using the U.S. Fish and Wildlife Service's (FWS) National Wetlands Inventory, Duke Energy mapped and estimated that there are approximately 976 ac (395 ha) of wetlands in addition to 13,950 ac (5,645 ha) of lake surface within a 6 mi (10 km) radius of the Oconee Station site (Duke Energy 2021-TN8897), which include the following:

- freshwater emergent wetlands—102 ac (41 ha)
- freshwater forested/shrub wetlands—321 ac (130 ha)
- freshwater ponds—102 ac (41 ha)
- lakes—13,950 ac (5,645 ha)
- riverine waters—450 ac (182 ha)

3.6.2 Oconee Station Site

The Oconee Station site lies in a forested valley with Lake Keowee, which was created to provide cooling water for the nuclear power plant, occupying its northern boundary. Nearly 61 percent of the site is developed and consists of mostly generation and maintenance facilities, laydown areas, parking, and mowed grass. Another 17.4 percent of the site is forested. Approximately 8 percent of the site is pasture/hay, and 6 percent is grassland/herbaceous. The remaining 0.9 percent of land is equal parts barren land, woody wetlands, and emergent herbaceous wetlands. Plant communities include those typical in the southern Piedmont dry oak-pine forest. This is a successional forest dominated by oak species, such as red and white oaks (*Quercus rubra, Q. alba*. Respectively) and pines, such as the loblolly pine and Virginia pine (*Pinus taeda, P. virginiana*, respectively) (Duke Energy 2021-TN8897).

According to the National Wetlands Inventory, Oconee Station site boundaries include a total of 77 ac (31.2 ha) of wetlands, lakes, ponds, and riverine waters (Duke Energy 2021-TN8897). Table 3-5 identifies wetlands and surface water features on the Oconee Station site.

Table 3-5 Wetlands and Surface Water Features on the Oconee Station Site

Wetland or Water Feature	Area	Percent of Onsite Wetland Habitat
Freshwater emergent wetlands	12 ac (4.9 ha)	18%
Freshwater ponds	4 ac (1.6 ha)	6%
Lakes	48 ac (19.4 ha)	71%
Riverine waters	13 ac (5.3 ha)	5%

ac = acre(s); ha = hectare(s).
Source: Duke Energy 2021-TN8897.

Figure 3-6 shows the location of National Wetlands Inventory wetlands on the Oconee Station site.

The wildlife species occurring at Oconee Station are representative of those typically found in the southern Appalachian Mountains. Common mammals likely include the northern racoon (*Procyon lotor*), white-tailed deer (*Odocoileus virginianus*), Virginia opossum (*Didelphis virginiana*), eastern gray squirrel (*Sciurus carolinensis*), skunk (*Mephitis, Spilogale putorius*), woodchuck (*Marmota monax*), and eastern cottontail rabbit (*Sylvilagus floridanus*). Table 3.7-4 in the Duke Energy ER presents a list of terrestrial wildlife species likely to be observed in Oconee or Pickens Counties within a 6 mi (10 km) radius of the Oconee Station site, and the NRC staff incorporates it here by reference (Duke Energy 2021-TN8897: Appendix E, pp. 3-145 through 3-157).

The Oconee Station site offers bird habitats for year-round residents, seasonal residents, and transients (birds stopping briefly during migration). Oconee Station is located within the Atlantic flyway, a major migratory bird route that extends from the Gulf of Mexico to Canada, including along the East Coast of the United States. Migrant birds seek suitable habitats called stopovers to feed, rest, and avoid predators. Lake Keowee and the surrounding area provide stopover habitat for migrating birds, especially waterfowl (Duke Energy 2021-TN8897).

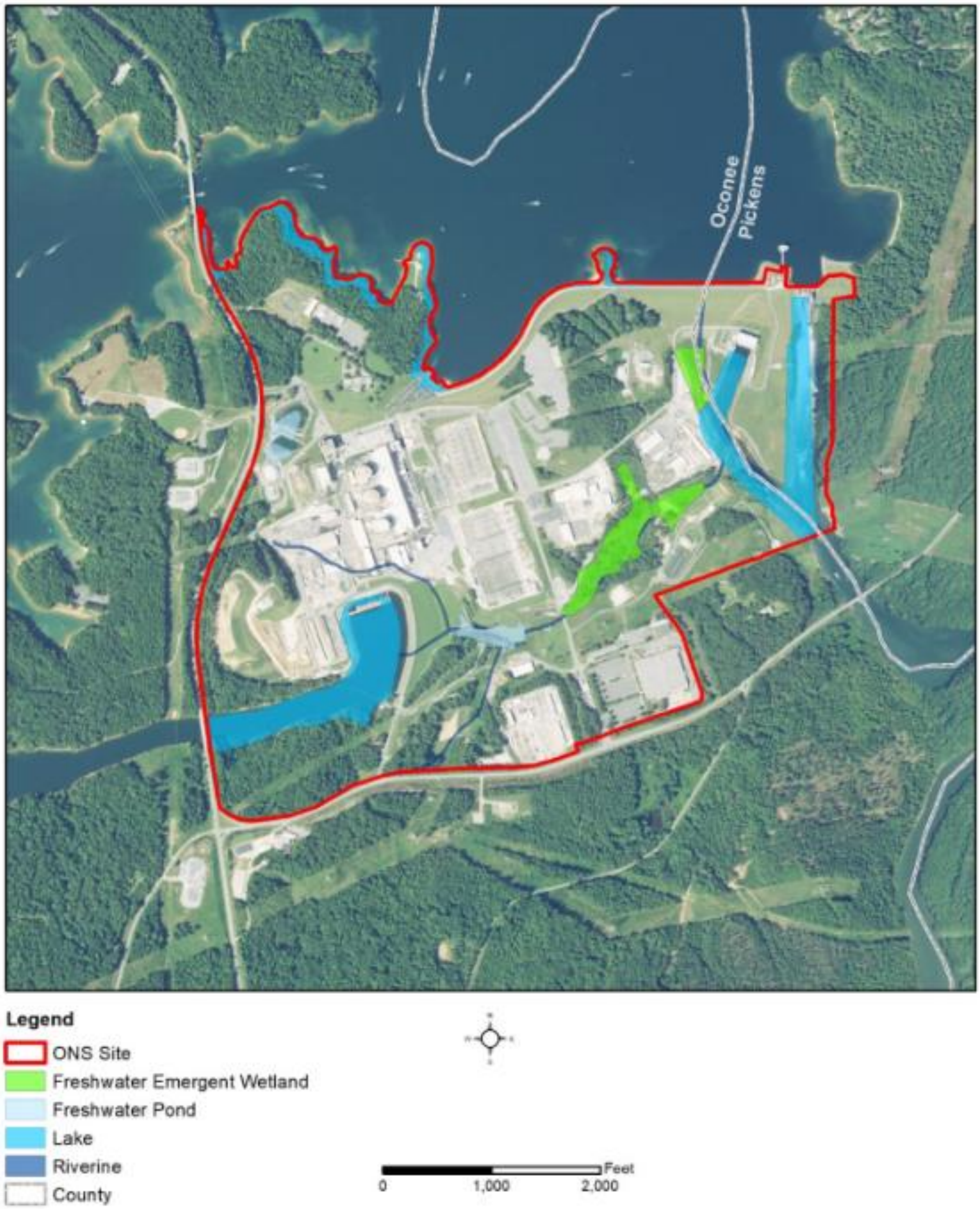

Figure 3-6 National Wetlands Inventory Wetlands on the Oconee Station Site. Source: Duke Energy 2021-TN8897: Appendix E, Figure 3.7-2.

3.6.3 Important Species and Habitats

3.6.3.1 Federally Listed Species

For a discussion of terrestrial species and habitats that are federally protected under the Endangered Species Act of 1973, as amended, see Section 3.8, "Special Status Species and Habitats," in this EIS.

3.6.3.2 State-Listed Species

Duke Energy (TN8897) identified eight State-listed species known to occur or potentially occur in Oconee or Pickens counties. Of these eight State-listed species, two species (the Indiana bat and the bog turtle) are also federally listed as threatened or endangered. As explained in Section 3.6.3.1 above, the NRC staff address federally listed species in Section 3.8 of this EIS. Table 3-6 below shows the six State-listed species for Oconee and Pickens counties that are not also federally listed. These six State-listed species include three birds, two mammals (all bats), and one reptile. The descriptions of the following State-listed species in Duke Energy's ER (TN8897: Appendix E, pp. 3-133 through-3-137) are incorporated here by reference.

Table 3-6 State-Listed Species for Oconee or Pickens Counties, South Carolina, Potentially Occurring in the Oconee Station Vicinity (That Are Not Also Federally Listed)

Common Name	Scientific Name	Class	State Legal Status
American Peregrine Falcon	*Falco peregrinus anatum*	bird	State-Threatened
Bewick's Wren	*Thryomanes bewick*	bird	State-Threatened
Bald Eagle	*Haliaeetus leucocephalus*	bird	State-Threatened
Eastern Small-Footed Myotis	*Myotis leibii*	mammal	State-Threatened
Rafinesque's Big-Eared Bat	*Corynorhinus rafinesquii*	mammal	State-Endangered
Southern Coal Skink	*Plestiodon anthracinus pluvialis*	reptile	State-Threatened

Source: Duke Energy 2021-TN8897

The three State-listed bird species include the American peregrine falcon (*Falco peregrinus anatum*), Bewick's wren (*Thryomanes bewick*), and the bald eagle (*Haliaeetus leucocephalus*). Potential habitat for all three birds exists in the vicinity of the Oconee Station site. These three bird species, like most birds, are also protected under the Migratory Bird Treaty Act (16 U.S.C. 703 et seq. TN3331). In addition, the bald eagle is protected by the Bald and Golden Eagle Protection Act (for more discussion of the bald eagle, see Section 3.6.3.3 in this EIS). The American peregrine falcon was once widespread. Duke Energy maintains an avian protection plan that addresses every avian incident. The plan includes employee and contractor training, guidance for reducing avian interactions with nuclear power plant infrastructure, procedures for responding to and required reporting of avian incidents to the FWS, and associated corrective actions.

The two State-listed mammal species are bats—the eastern small-footed myotis (*Myotis leibii*) and Rafinesque's big-eared bat (*Corynorhinus rafinesquii*). In 2015, a Duke Energy contractor conducted acoustic bat surveys prior to timber removal and construction for an ISFSI expansion. The survey was intended to determine whether the federally threatened northern long-eared bat was present onsite. The survey identified five bat species occurring onsite, but they did not include the northern long-eared bat or any of the two State-listed bat species. Bat acoustic surveys conducted around Lake Keowee and Oconee Station by Duke Energy in 2012 as part of an environmental assessment documented nine bat species, including two State-listed species: the eastern small-footed myotis, and Rafinesque's big-eared bat. The eastern small-footed myotis is a small bat, only about 3.5 in. (8.9 cm) long. Threats to this bat include habitat destruction, disturbance of roosting and hibernation sites, and white-nose syndrome (a fungal disease first documented in the United States in 2006 which has since killed millions of bats). Rafinesque's big-eared bat is a slightly larger species. Duke Energy protects summer roosting habitat for the Rafinesque's big-eared bat by protecting snag trees and mature hardwood communities (Duke Energy 2021-TN8897).

The southern coal skink (*Plestiodon anthracinus pluvialis*) is a reptile that is State-listed as threatened. The typical habitat is moist forests and riparian areas, and individuals are often found under rocks and logs (Duke Energy 2021-TN8897, Appendix E, Section 3.7.8.2.6). Based on 2012 surveys, the southern coal skink is known to occur in the region but not known to occur onsite. However, potential habitat for the southern coal skink occurs on the Oconee Station site and in the vicinity.

3.6.3.3 Species Protected under the Bald and Golden Eagle Protection Act

The Bald and Golden Eagle Protection Act (16 U.S.C. 668-668d et seq.-TN1447) extends regulatory protections to the bald eagle and golden eagle (*Aquila chrysaetos*). The Act prohibits anyone without a permit from the Secretary of the Interior from "taking" eagles, including their parts, nests, or eggs. In addition, the bald eagle is protected under South Carolina State law as a State-threatened species. The South Carolina Department of Natural Resources (SCDNR) conducts nesting season aerial flight surveys for eagle nests and makes the data public through an online resource (SCDNR 2020-TN9272).

Bald eagles nest throughout South Carolina, although most of them are found along the coast. The closest known active bald eagle nests are at a northern tributary of Lake Hartwell approximately 14 mi (23 km) south of the Oconee Station site as well as the northern end of Lake Jocassee approximately 17 mi (27 km) from Oconee Station. In addition, the Oconee Station vicinity contains suitable bald eagle nesting habitat, and bald eagles are known to use the area. However, bald eagles are not known to nest on the Oconee Station site. Duke Energy expects to maintain compliance with all Federal and State requirements for protecting eagles through its licensed life of Oconee Station.

3.6.3.4 Species Protected under the Migratory Bird Treaty Act

The Migratory Bird Treaty Act makes it illegal for anyone to take, possess, import, export, transport, sell, purchase, barter, or offer for sale, purchase, or barter, any migratory bird, or the parts, nests, or eggs of such a bird except under the terms of a valid permit issued pursuant to Federal regulations.

Several migratory birds that are species of conservation concern can occur within the vicinity of Oconee Station. These migratory birds include the blue-winged warbler *(Vermivora cyanoptera*), Bachman's sparrow (*Peucaea aestivalis*), eastern whip-poor-will (*Antrostomus vociferus*), Kentucky warbler (*Geothlypis formosa*), king rail (*Rallus elegans*), prairie warbler (*Setophaga discolor*), prothonotary warbler (*Protonotaria citrea*), red-headed woodpecker (*Melanerpes erythrocephalus*), and wood thrush (*Hylocichla mustelina*) (Duke Energy 2021-TN8897). Duke Energy monitors avian mortality at Oconee Station and reports incidents to the Duke Energy migratory bird hotline (Duke Energy 2021-TN8897: ER Section 3.7.7.2; Duke Energy 2018-TN9691). Duke Energy complies with regulatory requirements to conduct studies and monitoring—for example, before land clearing and new construction.

Duke Energy maintains a special purpose utility permit (MB000257-0) from the FWS to collect, transport, and temporarily possess migratory birds (other than eagles or threatened or engendered species) found dead on the property, structures, and ROWs (Duke Energy 2021-TN8897: ER Section 3.7.8.1.1). Oconee Station also has a migratory bird depredation permit (MB48760D-0) from FWS authorizing the taking of black vultures and turkey vultures for depredation control purposes.

3.6.3.5 Invasive Species

Invasive species are defined as alien species whose introduction causes or is likely to cause economic or environmental harm, or harm to human health (Executive Order (EO) 13112, Section 1(f)). EO 13112 (64 FR 6183-TN4477) directs Federal agencies to not authorize, fund, or carry out actions likely to cause or promote the introduction or spread of invasive species, unless they determine that the benefits of the action clearly outweigh the harm from invasive species, and that all feasible and prudent measures to minimize risk of harm are taken (EO 13112, Section 2). Duke Energy maintains an herbicide/pesticide management plan to combat invasive plant and insect species, and also uses mechanical removal methods, such as mowing (Duke Energy 2021-TN8897: ER Section 3.7.5).

Duke Energy identified 10 important invasive terrestrial plant species and one important invasive terrestrial animal species (Duke Energy 2021-TN8897: ER Sections 3.7.5.3 and 3.7.5.4) as potential threats. These species are listed below, and their descriptions in the ER are incorporated here by reference.

- invasive terrestrial plant species—trees: mimosa (*Albizia julibrissin*), princess tree (*Paulownia tomentosa*), and autumn olive (*Elaeagnus umbellata*)
- invasive terrestrial plant species—shrubs and forbs: Chinese privet (*Ligustrum sinense*), Japanese knotweed (*Fallopia japonica*), multiflora rose (*Rosa multiflora*), Japanese honeysuckle (*Lonicera japonica*), kudzu (*Pueraria montana*), Nepalese browntop (*Microstegium vimineum*), and sericea lespedeza (*Lespedeza cuneata*)
- invasive terrestrial animal species: emerald ash borer (*Agrilus planipennis*), a serious forest pest native to northeastern Asia. Adult insects lay eggs on ash trees, and when they hatch, larvae bore into the tree to feed on phloem. When the infestation is large enough, the tree dies.

3.6.3.6 Important Habitats

Important habitats include any wildlife sanctuaries, refuges, preserves, or habitats identified by State or Federal agencies as unique, rare, or of priority for protection; wetlands and floodplains; and land areas identified as being critical habitat for species listed by the FWS as threatened or endangered.

Important habitats on and surrounding the Oconee Station site include wetlands (discussed above in Sections 3.6.1 and 3.6.2) and the Keowee Wildlife Management Area.

3.6.4 Proposed Action

The following sections address the site-specific environmental impacts of the Oconee Station SLR on the environmental issues related to terrestrial resources in accordance with Commission direction in CLI-22-02 and CLI-22-03.

3.6.4.1 Effects on Terrestrial Resources (Non-cooling System Impacts)

According to the LR GEIS, the impacts of non-cooling system activities on terrestrial resources can include impacts that result from continued operation (e.g., site and landscape maintenance activities, stormwater management, elevated noise levels, and other ongoing operations and maintenance activities) as well as refurbishment activities that would occur during the license renewal period on and near a nuclear power plant site. The NRC staff based its analysis in this section on information from Duke Energy's ER (TN8897), unless otherwise cited. Duke Energy has not identified any refurbishment activities during the proposed subsequent relicensing term (Duke Energy 2021-TN8897). Therefore, no further analysis of potential impacts from refurbishment activities is needed.

In its ER, Duke Energy (TN8897) states that it would conduct ongoing operational and maintenance activities at Oconee Station throughout the SLR term, including landscape maintenance activities, stormwater management, piping installation, and fencing. The NRC staff expects that physical disturbance would be limited to paved or disturbed areas or to areas of mowed grass or early successional vegetation and would not encroach into wetlands or remaining areas of mixed forest. The NRC staff concludes that the anticipated continued operation activities would have only minimal effects on terrestrial resources based upon the information presented in the applicant's ER and the staff's independent analysis. Duke Energy (Duke Energy 2021-TN8897) states that it has administrative controls in place at Oconee Station to ensure that it reviews operational changes or construction activities and minimizes environmental impacts through best management practices (BMPs), permit modifications, or new permits, as needed. Duke Energy (TN8897) further states that regulatory programs for issues like stormwater management, spill prevention, dredging, and herbicides further minimize impacts on terrestrial resources (Duke Energy 2021-TN8897). The NRC staff concludes that continued adherence to environmental management practices and BMPs already established for Oconee Station would continue to protect terrestrial resources during the SLR period.

The NRC staff presumes that Duke Energy would continue to comply with applicable requirements of the State of South Carolina's regulatory programs. Furthermore, the staff presumes that if appropriate, Duke Energy would obtain required incidental take permits for impacts on bald eagles, black vultures, turkey vultures, or other protected bird species such as migratory birds.

Operational noise from Oconee Station facilities extends into the remaining natural areas on the site. However, Oconee Station has exposed these habitats to similar operational noise levels since it began construction approximately 55 years ago. The NRC staff therefore expects that wildlife in the affected habitats have long ago acclimated to the noise and human activity of Oconee Station operations and adjusted behavior patterns accordingly. Extending the same level of operational noise levels during the 20-year SLR period is therefore unlikely to noticeably change the patterns of wildlife movement and habitat use.

Based on its independent review, the NRC staff concludes that the impacts of continued operation (e.g., landscape maintenance, stormwater management, elevated noise levels, and other ongoing operations and maintenance activities that Duke Energy might undertake) during the subsequent license renewal term would primarily be confined to already disturbed areas of the Oconee Station site. These activities would neither have noticeable effects on terrestrial resources nor would they destabilize any important attribute of the terrestrial resources on or in the vicinity of the site. Accordingly, the NRC staff concludes that impacts on terrestrial resources from non-cooling system activities during the subsequent license renewal term would be SMALL.

3.6.4.2 Exposure of Terrestrial Organisms to Radionuclides

This issue concerns the potential impacts on terrestrial organisms from exposure to radionuclides from routine radiological effluent releases. The NRC staff will first summarize how this issue has been addressed historically, and then provide a site-specific evaluation of the issue for the Oconee Station SLR term.

Radionuclides may be released from nuclear power plants into the environment through several pathways. During normal operations, nuclear power plants can release gaseous emissions that deposit small amounts of radioactive particulates in the surrounding environment. Gaseous emissions typically include krypton, xenon, and argon (which may or may not be radioactive), tritium, isotopes of iodine, and cesium. Emissions also may include strontium, cobalt, and chromium. Radionuclides may also be released into water as liquid effluents. Terrestrial plant roots can absorb radionuclides that enter shallow groundwater or surface waters. Animals may experience exposure to ionizing radiation through inhalation, direct contact (with air, water, or other media), inhalation, or ingestion (of contaminated food, water, or soil).

The 1996 LR GEIS (NRC 1996-TN288) did not address this issue of the exposure of terrestrial organisms to radionuclides released from routine plant operations during license renewal. In 2007, the International Commission on Radiation Protection (ICRP) issued revised recommendations for a system of protection to control exposure from radiation sources (ICRP 2007-TN422). The recommendations included a section about the protection of the environment in which the ICRP found that a clearer framework for assessing non-human organisms was warranted. The ICRP indicated that it would develop a set of reference animals and plants as the basis for relating exposure to dose, and dose to radiation effects. This information would then provide a basis from which agencies and responsible organizations could make policy and management decisions. Subsequently, the ICRP developed and published a set of 12 reference animals and plants including a large and a small terrestrial mammal, an aquatic bird, a large and a small terrestrial plant, and several other species (ICRP 2008-TN7530, ICRP 2009-TN7531). The ICRP also issues publications and information related to radiological effects and radiosensitivity in non-human biota (Adam-Guillermin et al. 2018-TN7972).

In 2009, after the NRC staff conducted a review of the ICRP’s 2007 recommendations, the Commission found that there was no evidence that the NRC’s current (as of 2009) set of radiation protection controls was not protective of the environment (NRC 2009-TN6651). For this reason, the Commission determined that the NRC staff should not develop separate radiation protection regulations for plant and animal species (NRC 2009-TN6651). The Commission charged the NRC staff with continuing to monitor international developments on this issue and to keep the Commission informed. Nonetheless, the NRC addressed the radiological exposure of non-human organisms in the 2013 LR GEIS (NRC 2013-TN2654) due to public concern about these impacts at some nuclear power plants.

In the 2013 LR GEIS (NRC 2013-TN2654), the NRC staff adopted the DOE standard for a graded approach for evaluating radiation doses to terrestrial and aquatic biota (DOE 2019-TN6817). This DOE standard provides methods, models, and guidance that can be used to characterize radiation doses to terrestrial and aquatic biota exposed to radioactive material (DOE 2019-TN6817). The following DOE guidance dose rates are the levels below which no adverse effects to resident populations are expected:

- riparian animal: 0.1 radiation-absorbed dose per day (rad/day) (0.001 Gray per day (Gy/day))

- terrestrial animal: 0.1 rad/day (0.001 Gy/day)
- terrestrial plant: 1 rad/day (0.01 Gy/day)
- aquatic animal: 1 rad/day (0.01 Gy/day)

The NRC staff notes that in 1992, the International Atomic Energy Agency (IAEA 1992-TN712) had concluded that chronic dose rates of 0.1 rad/day (0.001 Gy/day) or less do not appear to cause observable changes in terrestrial animal populations. The United Nations Scientific Committee on the Effects of Atomic Radiation concluded in 1996 and reaffirmed in 2008 that chronic dose rates of less than 0.1 mGy/hr (0.24 rad/day or 0.0024 Gy/day) to the most highly exposed individuals would be unlikely to have significant effects on most terrestrial communities (UNSCEAR 2010-TN7974).

In the 2013 LR GEIS (NRC 2013-TN2654), the NRC estimated the total radiological dose that four non-human receptors (riparian animal, terrestrial animal, terrestrial plant, and aquatic animal) would be expected to receive during normal nuclear power plant operations based on plant-specific radionuclide concentrations in water, sediment, and soils at 15 operating nuclear power plants. The NRC found that total calculated dose rates for all terrestrial receptors at all 15 plants were significantly less than the DOE guideline values. As a result, the NRC anticipated in the 2013 LR GEIS that normal operations of these facilities would not result in negative effects on terrestrial organisms from radionuclide release. The 2013 LR GEIS concluded that the impact of radionuclides on terrestrial biota from past operations would be SMALL for all nuclear plants and would not be expected to change appreciably during the initial license renewal period.

In the following discussion, the NRC staff analyzes the impact of radionuclides on terrestrial organisms on a site-specific basis for the Oconee Station SLR term, in accordance with CLI-22-02 and CLI-22-03 (NRC 2022-TN8182, NRC 2022-TN8272).

As discussed in Section 2.1.4 of this EIS, the NRC requires nuclear power plants to maintain a radiological environmental monitoring program (REMP) in accordance with NRC regulations at 10 CFR Part 50, Appendix I (TN249); 10 CFR Part 20 (TN283); and 10 CFR Part 72 (TN4884); through plant-specific technical specifications; and through the guidance in Regulatory Guide 4.1 (NRC 2009-TN3802). These regulations collectively require that licensees establish and implement a REMP to obtain data on measurable levels of radiation and radioactive material. REMP monitoring ensures that radiation is below regulatory limits and any changes are detected and addressed.

Duke Energy’s REMP measures the terrestrial, aquatic, and atmospheric environment for ambient radiation and radioactivity. Duke Energy conducts monitoring for the following: direct radiation, air, precipitation, well water, river water, surface water, milk, food products and vegetation (such as edible broad leaf vegetation), fish, silt, and shoreline sediment. The REMP also measures background radiation (i.e., cosmic sources, global fallout, and naturally occurring radioactive material, including radon. As part of its environmental review, the NRC staff reviewed the past 5 years of Oconee REMP reports (Duke Energy 2017-TN9157, TN9158, TN9159, TN9160, TN9160), assuming that a 5-year period provides adequate coverage to evaluate a broad range of Oconee Station operational and maintenance activities that could influence the generation and release of radionuclides. The NRC staff looked for indications of adverse trends (i.e., increasing radioactivity levels) over the REMP review period.

As discussed in Section 2.1.4 of this EIS, over the 5-year REMP review period, NRC staff found no apparent increasing trend in concentration or pattern indicating either a new inadvertent release or persistently high tritium or other radionuclide concentration indicating a potential ongoing inadvertent release from Oconee Station. The groundwater monitoring program data at Oconee Station showed that Duke Energy monitors, characterizes, and actively remediates spills, and that there were no significant radiological impacts to the environment from operations at Oconee Station over the 5-year period.

Oconee Station operations during the SLR term would continue current operating conditions, site management controls, and environmental stressors rather than introduce entirely new impacts. Therefore, the impacts of current operations and SLR term operations on radionuclide exposure to terrestrial organisms would be similar. For these reasons, the effects of radionuclide exposure would likely be minor and would neither destabilize nor noticeably alter any important attribute of this resource during the SLR term. The NRC staff concludes that the impacts of radionuclides on terrestrial organisms during the Oconee Station SLR term would be SMALL.

3.6.4.3 Cooling System Impacts on Terrestrial Resources (Plants with Once-Through Cooling Systems or Cooling Ponds)

This issue concerns the potential impacts of once-through cooling systems and cooling ponds at nuclear power plants on terrestrial resources. Cooling system operation can alter the ecological environment in a manner that affects terrestrial resources. Such alterations may include thermal effluent additions to receiving water bodies, chemical effluent additions to surface water or groundwater, impingement of waterfowl, disturbance of terrestrial plants and wetlands associated with maintenance dredging, disposal of dredged material, and erosion of shoreline habitat. In the following discussion, the NRC staff summarizes the manner in which this issue has been addressed historically, and then presents a site-specific evaluation of the issue for Oconee Station SLR.

The 2013 LR GEIS (NRC 2013-TN2654) summarizes that many of the effects of cooling system operations on terrestrial resources have only been identified at a small number of nuclear power plants, and these plants have since modified their operations to reduce or eliminate the effects. For instance, in a study of eight nuclear power plants with copper alloys in their cooling systems, elevated concentrations of copper were discharged into the cooling systems from condenser tubing. At one plant, copper released from the cooling system increased deformities and reduced reproductive capacity in the resident bluegill sunfish population (*Lepomis macrochirus*) (Harrison 1985-TN7579); At another plant, abalone (*Haliotis* species) mortality was attributed to copper exposure in plant effluents (NRC 1996-TN288). Terrestrial wildlife such as migratory birds that feed on these aquatic organisms also could have been exposed to elevated copper levels and could have also experienced adverse effects. However, these eight nuclear power plants subsequently replaced their copper alloy condenser tubes with tubes made of different materials (e.g., titanium), which eliminated these impacts. This issue has not since been reported at any other nuclear power plants.

In the following discussion, the NRC staff analyzes the effects of cooling system operations on terrestrial resources on a site-specific basis for the Oconee Station SLR term, in accordance with CLI-22-02 and CLI-22-03 (NRC 2022-TN8182, NRC 2022-TN8272).

Duke Energy’s NPDES permit SC0000515, issued by the SCDHEC, authorizes discharge of non-contact cooling water, stormwater, and other operations-related waters to Lake Keowee and the Keowee River from Oconee Station (Duke Energy 2021-TN8897). This permit is administratively extended; the renewal application was submitted and received in 2013. Duke

Energy reports no cooling discharge impacts in violation of the Oconee Station NPDES permit over the last 5 years regarding water temperature or water availability in discharge. Duke Energy reports two violations regarding contaminants (oil and grease) over the last 5 years: one in 2017 and one in 2020. SCDHEC later rescinded the 2017 violation, finding that the exceedance event did not result from a release by NPDES Outfall 007. In 2020, the SCDHEC issued a notice of violation for oil and grease exceedance for Outfall 002. Duke Energy investigated the site for contributing issues or conditions, found none, and collected four additional follow-up samples. The follow-up samples were below detectable limits, and the SCDHEC required no additional actions.

Between 2014 and 2022, none of the recorded bird deaths and injuries at Oconee Station were attributed to impingement on intake screens (Duke Energy 2021-TN8897). The intake structure does not have features that would encourage birds to forage at the intake structures, which would increase risk for impingement. Intake screens are routinely maintained to remove debris and biofouling, reducing the likelihood of attracting birds to forage. At Oconee Station, Duke Energy uses BMPs to protect wetlands and streams from stormwater runoff and erosion (Duke Energy 2021-TN8897). Development, construction, and erosion control measures along the Lake Keowee shoreline are subject to requirements defined in the Shoreline Management Plan for the Keowee-Toxaway Project (Duke Energy 2014-TN9131). No wetlands or riparian habitats are present near the Oconee Station intake and discharge structures. Duke Energy does not periodically dredge Lake Keowee (Duke Energy 2022-TN8899: Appendix E, Supplement 2, Section 4.5.13.2), and no dredging is anticipated during the SLR term. If any dredging needs arise, Duke Energy would obtain applicable Federal and State permits.

Duke Energy has not identified any construction or change in cooling system operations during the SLR period. Therefore, the impacts of continued cooling system operations at Oconee Station would be similar to current operational impacts. The NRC staff concludes that the potential for cooling system impacts on terrestrial organisms during the Oconee Station SLR term would be SMALL.

3.6.4.4 Bird Collisions with Plant Structures and Transmission Lines

Bird collisions and the potential for bird mortality are associated with tall structures such as cooling towers, transmission structures, meteorological towers, and other nuclear power plant infrastructure. Bird mortality is of concern if the resulting reduction in population numbers threatens the stability of the species or significantly impairs its function within the ecosystem. In the LR GEIS (NRC 2013-TN2654), the NRC staff found that the available data on bird collision mortality associated with nuclear power plant cooling towers and other structures suggest that the number of bird mortality collisions at nuclear power plants is small and they primarily occur during the spring and fall migration of songbirds at night. In the following discussion, the NRC staff analyzes the impact of bird collisions on a site-specific basis for the Oconee Station SLR term, in accordance with CLI-22-02 and CLI-22-03 (NRC 2022-TN8182, NRC 2022-TN8272).

In its environmental report, Duke Energy states that it plans no new construction of tall structures, such as buildings or transmission lines, during the Oconee Station SLR term. Therefore, this site-specific analysis addresses potential impacts of bird collisions with existing Oconee structures and transmission lines during the SLR term. Duke Energy’s ER describes existing buildings, structures, and meteorological towers (Section 2.2.1–2.2.4), in-scope transmission lines (Section 2.2.5), and provides a map of the Oconee Station plant layout (Figure 3.1-1) and location of in-scope transmission lines (Figure 2.2-4). According to the ER (Duke Energy 2021-TN8897: Appendix E, Section 3.2.3), the tallest structures on the Oconee

Station site are the reactor containment buildings, which are 191 ft (58.2 m) tall. The two meteorological towers are 60 m (197 ft) and 10 m (33 ft) tall, respectively. In-scope transmission lines are those that connect the Oconee Station turbine building to the 230 kV and the 525 kV switchyards.

Duke Energy's corporate avian protection plan adheres to the Avian Power Line Interaction Committee and FWS guidelines regarding electricity and birds (Duke Energy 2021-TN8897, Appendix E, Section 2.2.5.3). In addition, Duke Energy's avian protection plan provides construction design standards for avian-safe structures, mortality reporting to FWS and State agencies, and mortality reduction measures. Between 2014 and 2022, 35 avian deaths occurred at Oconee Station. Most were caused by collisions (Duke Energy 2023-TN8952). This low number over 9 years suggests avian mortality at Oconee Station is generally low and does not have the potential to adversely affect bird species at the population or ecological level.

The Oconee Station SLR would extend current operating conditions and environmental stressors on birds for 20 additional years rather than introduce new conditions and stressors. Because bird collision rates at Oconee Station are generally low under current operating conditions, it stands to reason that bird collision rates will also be low during the SLR term. Therefore, the impacts of current operations and SLR on bird collisions would be similar. For these reasons, the effects of bird collisions with plant structures and transmission lines would be minor and would neither destabilize nor noticeably alter any important attribute of bird populations during the SLR term. The NRC staff concludes that the impacts of bird collisions with plant structures or transmission lines during the Oconee Station SLR term would be SMALL.

3.6.4.5 Transmission Line Right-of-Way (ROW) Management Impacts on Terrestrial Resources

This issue concerns the effects of transmission line ROW management on terrestrial plants and animals. Utilities maintain transmission line ROWs so that the ground cover is composed of low-growing herbaceous or shrubby vegetation and grasses. Generally, ROWs are initially established by clear-cutting during transmission line construction and are subsequently maintained by physical (e.g., mowing and cutting) and chemical (e.g., herbicides or pesticides) means. These activities alter the composition and diversity of plant communities and generally result in lower-quality habitat for wildlife. Heavy equipment used for ROW maintenance can crush vegetation and compact soils, which can affect soil quality and reduce infiltration to shallow groundwater. This is especially of concern in sensitive habitats, such as wetlands. Chemical herbicides can be transported to neighboring undisturbed habitats through precipitation and runoff. Disturbed habitats often favor non-native or nuisance species and can lead to their proliferation. Noise and general human disturbance during ROW management can temporarily disturb wildlife and affect their behaviors, and the presence of ROWs can favor wildlife species that prefer edge or early successional habitats.

Both the 1996 LR GEIS (NRC 1996-TN288) and the 2013 LR GEIS (NRC 2013-TN2654) concluded that the impacts of transmission line ROW management on terrestrial resources would be SMALL during the initial license renewal term. In the 1999 Oconee Station LR Supplemental EIS (NRC 1999-TN8942), the NRC staff found no new and significant information concerning this issue and adopted the 1996 LR GEIS's conclusion of SMALL impacts.

In the following discussion, the NRC staff analyzes this issue on a site-specific basis for the Oconee Station SLR term, in accordance with CLI-22-02 and CLI-22-03 (NRC 2022-TN8182, NRC 2022-TN8272).

Duke Energy proposes no additional transmission line expansion or construction under the proposed action. Therefore, during the SLR term, in-scope transmission line ROWs would be the same as the current ROWs that connect the Oconee Station turbine building to the 230 kV and the 525 kV switchyards (Duke Energy 2021-TN8897: Appendix E, Section 2.2.5.1, Figure 2.2-4). In-scope transmission lines cross the Oconee Station industrial area, where impervious surfaces and sparse vegetation require minimal vegetation management. Mechanical mowing and selective herbicide applications are the main methods for ROW vegetation management. Duke Energy maintains a herbicide/pesticide management plan to combat invasive plant and insect species (Duke Energy 2021-TN8897). In-scope transmission lines do not cross any designated critical habitat (see Section 3.8 of this report) or important terrestrial habitats (see Section 3.6.3 of this report).

During the SLR term, Duke Energy would continue to maintain onsite transmission line ROWs in accordance with North American Electric Reliability Corporation standards (NERC 2023-TN9156). SLR would continue current operating conditions and environmental stressors rather than introduce entirely new impacts. Therefore, the impacts of current operations and SLR on transmission ROW maintenance impacts on terrestrial resources would be similar. For these reasons, the effects of transmission ROW maintenance impacts would be minor and would neither destabilize nor noticeably alter any important attribute of this resource during the SLR term. The NRC staff concludes that the impacts of transmission line ROW maintenance on terrestrial resources during the Oconee Station SLR term would be SMALL.

3.6.4.6 Electromagnetic Fields on Flora and Fauna (Plants, Agricultural Crops, Honeybees, Wildlife, Livestock)

This issue concerns the effects of electromagnetic fields (EMFs) on terrestrial plants and animals, including agricultural crops, honeybees, wildlife, and livestock. Operating transmission lines, such as those at nuclear power plants, produce electric and magnetic fields, collectively referred to as EMFs. EMF strength at the ground level varies greatly but is generally stronger for higher-voltage lines. Corona is the electrical discharge occurring in air from EMFs; it can be detected adjacent to phase conductors. Corona generally is not an issue for transmission lines of 345 kV or less. Corona results in audible noise, radio and television interference, energy losses, and ozone and nitrogen oxide production. For the purpose of license renewal, in-scope transmission lines include lines that connect the plant to the first substation that feeds into the regional power distribution system. The first substation usually (but not always) is on plant property.

In the LR GEIS (2013-TN2654), the NRC staff found that, with the exception of honeybee hives, terrestrial biota located under and near the in-scope transmission lines do not experience biologically or economically (in the case of agriculture) significant adverse effects from EMFs during license renewal. Plant foliage and buds can sustain minor damage that reduces upward and outward growth, but the damage does not interfere with overall plant growth or the health of the lower parts of the plant (Miller 1983-TN1328). Studies on crop plants grown in electric fields have shown either no effect or small reductions in germination or yield (NRC 2013-TN2654). The generation of EMF from operating transmission lines is generally stronger from voltage lines greater than 345 kV. However, even operating at up to 1,100 kV, there have been no studies reporting significant ecological impacts from EMF generated by transmission lines (with the potential exception of honeybees in hives under transmission lines). Adverse effects to honeybee hives under transmission lines include reduced growth, greater irritability, increased production of propolis (a resin compound used as a sealant), and increased mortality. These adverse effects can be reduced by shielding hives with a grounded metal screen or moving hives so that they are no longer near transmission lines.

In the following discussion, the NRC staff analyzes the issue of EMF on a site-specific basis for the Oconee Station SLR term, in accordance with CLI-22-02 and CLI-22-03 (NRC 2022-TN8182, NRC 2022-TN8272). As stated in the previous section, Duke Energy will not build additional transmission lines under the proposed action of subsequent license renewal. Therefore, during the SLR term, the in-scope transmission lines would be the same as those that currently connect the Oconee Station turbine building to the 230 kV and the 525 kV switchyards (Duke Energy 2021-TN8897: Appendix E, Section 2.2.5.1, Figure 2.2-4). The existing transmission line ROWs mostly cross impervious paved surfaces or cleared land with sparse vegetation; they do not cross agricultural fields, pastures, or other habitats important for native wildlife or livestock. Therefore, simply because of the current route of the transmission line ROW, during the SLR term, the EMF exposure of most terrestrial flora and fauna at Oconee Station would be minimal and incidental. In the spring of 2022, Duke Energy staff discovered a swarm of honeybees on the Power Circuit Breaker 54 in the 525-kV switchyard. As discussed in the previous paragraph, honeybees are the only terrestrial species shown to experience significant effects from EMF exposure. Duke Energy staff notified Nuclear Environmental Field Support of the honeybee discovery (Duke Energy 2021-TN8897). Nuclear Environmental Field Support contacted a qualified beekeeper, who relocated the swarm offsite to a beekeeper farm. Considering the relocation of the honeybee hive and the mostly paved area under the transmission line ROW, the potential for EMF impacts on terrestrial resources during the SLR term is not likely to be noticeable. In addition, any terrestrial plants or animals in the vicinity of operating in-scope transmission lines are most likely already habituated to the existing EMF exposure.

During the SLR term, Oconee Station would continue current operating conditions, site management controls, and environmental stressors rather than introduce entirely new impacts. Therefore, the EMF impacts of operations during the SLR period on terrestrial resources would be similar to current impacts. For these reasons, the effects of EMF would be minor and would neither destabilize nor noticeably alter any important attribute of this resource during the SLR term. The NRC staff concludes that the impacts of EMF on terrestrial resources during the Oconee Station SLR term would be SMALL.

3.6.5 No-Action Alternative

Under the no-action alternative, the NRC would not issue a subsequent renewed license, and Oconee Station would shut down on or before the expiration of the current facility operating licenses. Much of the operational noise and human activity at Oconee Station would cease, thereby reducing disturbance to wildlife in forest cover and other natural vegetation on and near the site. However, some continued maintenance of Oconee Station would still be necessary. Thus, some human activity, noise, and herbicide application would continue at the site with possible impacts resembling, but perhaps of a lower magnitude than, those described for the proposed action. Shutdown itself is unlikely to noticeably alter terrestrial resources. Reduced human activity and frequency of operational noise may constitute minor beneficial effects on wildlife inhabiting nearby natural habitats. The NRC staff therefore concludes that the impacts of the no-action alternative on terrestrial resources during the proposed SLR term would be SMALL.

3.6.6 Replacement Power Alternatives: Common Impacts

Each of the replacement power alternatives located onsite at Oconee Station could use two available onsite parcels of land located south and east of the 525 kV switchyard. In addition, the natural gas alternative could use an adjacent offsite parcel immediately south of highway SC 183 also owned by Duke Energy. Additional land would likely be temporarily disturbed for construction and laydown areas. If not already previously disturbed, the licensee could later revegetate temporarily disturbed land. The natural gas alternative and the combination alternative would also involve construction on developed or undeveloped lands outside the vicinity of the Oconee Station site with indeterminate loss of offsite forest or wetlands.

Loss of habitat and increased noise generation during construction and operation of the new facilities could cause terrestrial wildlife to move into other habitats in the surrounding landscape, increasing demands on those habitats and competing with other wildlife. Erosion and sedimentation from clearing, leveling, and excavating land could affect adjacent riparian and wetland habitats. However, implementation of appropriate BMPs and revegetation of temporarily disturbed lands would minimize impacts.

In the LR GEIS (NRC 2013-TN2654), the NRC staff concluded that many of the terrestrial impacts from the operation of nuclear power plants and fossil fuel-fired plants would be essentially similar and include cooling tower salt drift, noise, bird collisions with nuclear power plant structures and transmission lines, impacts associated with herbicide application and landscape management, and potential water use conflicts associated with cooling water withdrawals. A new SMR or natural gas replacement plant would add tall mechanical cooling towers to the Oconee Station site, which currently does not have them. Adding mechanical cooling towers to the site would increase the number of tall structures on the site (potentially increasing the bird and bat collision risk) and could expose terrestrial habitats and wildlife to cooling tower salt drift. Fossil fuel alternatives would also expose terrestrial habitats and wildlife to air emissions of criteria pollutants.

3.6.7 New Nuclear (Advanced Light-Water Reactor and Small Modular Reactor) Alternative

For the new nuclear alternative, the NRC staff assumes that Duke Energy would replace the generating capacity of Oconee Station Units 1, 2, and 3 with a combination of (1) two ALWRs at the proposed W.S. Lee Nuclear Station in Cherokee County, South Carolina, and (2) a single-unit SMR at the Oconee Station site.

For the ALWR portion of the alternative, more than 3,000 ac (1,200 ha) of land would be temporarily and permanently disturbed in three separate areas: (1) onsite at the proposed W.S. Lee Nuclear Station, (2) at the cooling water make-up pond site (1,100 ac [450 ha] disturbed (1,047 ac [423.7 ha] permanently), and (3) in the transmission line corridors (990 ac [400 ha] permanently disturbed) (NRC 2013-TN6435; Duke Energy 2021-TN8897). Most of the terrestrial impacts of the proposed W.S. Lee Nuclear Station would result from site preparation and construction activities as opposed to operations (NRC 2013-TN6435). Onsite at the proposed W.S. Lee Nuclear Station, impacts on terrestrial resources would be mitigated by the fact that much of the land there is low-quality habitat previously disturbed as the former proposed Cherokee nuclear plant site. In contrast, construction of the transmission line corridors would permanently disturb 690 ac (280 ha) of upland-forest habitat and 1.15 ac (0.47 ha) of wetlands as well as further fragment forest communities. Site preparation and inundation for the cooling water make-up pond would affect 545 ac (221 ha) of undisturbed forest and inundate seven significant natural areas, four noteworthy State ecological associations of concern, and 3.55 ac (1.4 ha) of wetlands. In the final EIS for the W.S. Lee Nuclear Station (NRC 2013-TN6435), the NRC staff concluded that the construction and preconstruction impacts on terrestrial resources would be MODERATE, largely because of the transmission lines and cooling water make-up pond.

For the SMR portion of the new nuclear alternative, the NRC staff assumes the applicant would build a single-unit SMR on 36 ac (15 ha) on the Oconee Station site. Duke Energy (TN8897) identified more than 107 ac (43 ha) of previously developed and undeveloped land spread across two parcels on the site available for siting a new nuclear replacement alternative. These two parcels include 72 ac (29 ha) of land south of the Oconee Station 525 kV switchyard and 35 ac (14 ha) of land east of the switchyard. The 72 ac (29 ha) onsite parcel contains a large, forested area to the west, and pasture/hay, grassland/herbaceous, and developed lands (including the nuclear power plant entrance area and the steam generator retirement facility). The 35 ac (14 ha) onsite parcel is more open and contains a mix of forest, pasture/hay, grassland/herbaceous, and developed land. Because only 36 ac (15 ha) are required to operate the single-unit SMR and 107 ac (43 ha) are available, the site could be chosen to avoid forested areas and reuse previously developed areas. The continued use of previously developed areas would not significantly change the impact on terrestrial resources because the land use would remain developed. Wildlife present in the available 107 ac (43 ha) would be concentrated in the forested areas and include species typically found at Oconee Station and in similar habitats in South Carolina. Clearing forested area would displace wildlife and some mortality would be inevitable. However, before tree removal, Duke Energy states it would conduct wildlife surveys to identify protected species and habitat and craft avoidance and minimization measures (Duke Energy 2021-TN8897).

A review of Figure 3.7-2 of the ER shows a possible wetland area (i.e., freshwater pond) either in or directly adjacent to the 72 ac (29 ha) parcel and a possible freshwater emergent wetland in the 35 ac (14 ha) parcel (Duke Energy 2021-TN8897). If Duke Energy is not able to avoid these areas for construction, it would have to perform wetland delineations of affected lands and apply for permits for any wetland fill from the USACE and the SCDNR. The NRC staff expects that any Federal or State permits authorizing wetland impacts would require mitigation.

The NRC staff recognizes that the affected land provides habitat for the terrestrial wildlife listed in Section 3.6 of this EIS, and it is possible that some of the important State-listed or otherwise protected species described in Section 3.6.3 may occur onsite. Construction noise could affect wildlife in nearby forested areas and wetlands. Operational noise from the new cooling towers could also affect wildlife.

Because the new nuclear SMR facility on the Oconee Station site would use existing Oconee Station transmission lines, the NRC staff expects no increased potential for wildlife injury by transmission lines. However, the SMR will require adding new, tall structures to the landscape, including mechanical draft cooling towers 65 ft (20 m) in height, and a power block 160 ft (50 m) in height. These mechanical draft cooling towers could result in avian (bird) collisions. In addition, bats, including bats of the federally and State-listed protected species noted in Sections 3.6.3 and 3.8.1, could collide with the towers and die. However, the NRC staff expects that bird and bat populations would eventually become accustomed to the presence of the towers and avoid them. Once the new SMR is built, operational impacts on terrestrial resources would likely remain as expected for the proposed action. The NRC staff concludes that the impacts on terrestrial resources from the SMR portion of the new nuclear option would be SMALL.

Based on the preceding analysis, the NRC staff concludes that impacts on terrestrial resources from the new nuclear option of two ALWRs at the W.S. Lee Nuclear Power Station and one SMR at Oconee Station would be MODERATE because of the ALWR portion of the alternative.

3.6.8 Natural Gas Combined-Cycle Alternative

The natural gas combined-cycle alternative assumes that Duke Energy would build a new natural gas facility on the Oconee Station site on two available onsite land parcels and an adjacent Duke Energy-owned property directly south across Highway SC 183. An additional 191 ac (77 ha) of offsite land would be required for a ROW to build a 21 mi (34 km) natural gas pipeline to Centerville, South Carolina. This impact would be partially offset by the elimination of land used for uranium mining to supply fuel to Oconee Station.

The NRC staff assumes the natural gas facility would require 130 ac (53 ha) of land. Duke Energy (TN8897) identified more than 107 ac (43 ha) of previously developed and undeveloped land spread across two parcels on the site available for siting a natural gas replacement alternative. These two parcels include 72 ac (29 ha) of land south of the Oconee Station 525 kV switchyard and 35 ac (14 ha) of land east of the switchyard. For the remaining land needed, the applicant could use a 28 ac (11 ha) parcel of Duke Energy-owned land directly south across SC 183. The 35 ac (14 ha) parcel east of the switchyard is more cleared and contains a mix of grassland and pasture areas, developed areas, smaller areas of forest, and possibly some wetland along the northern end of the parcel. The 72 ac (29 ha) parcel south of the switchyard contains a large area of deciduous and mixed forest at the western end as well as a mix of grassland, pasture, cleared areas, and developed areas (Duke Energy 2021-TN8897: Appendix E, Figure 3.2-1). The continued use of developed areas would not significantly change the impact on terrestrial resources. Wildlife present in the onsite land would be concentrated in the forested areas and would include species typically found at Oconee Station and in similar habitats in South Carolina. Clearing forested area would displace wildlife. While some wildlife could disperse to adjacent undisturbed habitats, such as the undisturbed forest across SC 183, some mortality would be inevitable. However, before tree removal, Duke Energy states it would conduct wildlife surveys to identify protected species and habitat, and craft avoidance and minimization measures (Duke Energy 2021-TN8897).

Greater terrestrial impacts would result from clearing and construction in the 28 ac (11 ha) Duke Energy-owned parcel directly south of the Oconee Station site across SC 183. Unlike the onsite Oconee Station parcels, the third parcel area has not been part of an industrial site. It is largely forested and contains previously undisturbed habitat. However, Duke Energy stated that it could avoid higher-quality wildlife habitat of hardwood and mixed hardwood forests. In the final EIS for the W.S. Lee Nuclear Power Station, the NRC staff reviewed the environmental impacts of constructing two nuclear units at what is called the Keowee site, as an alternative. The Keowee site includes the Duke Energy-owned 450 ac (180 ha) area adjacent to Oconee Station of which this 28 ac (11 ha) parcel is a small part. In the final EIS for W.S. Lee Nuclear Station (NRC 2013-TN6435), the NRC staff determined the impacts on terrestrial resources from constructing two nuclear units on the 450 ac (180 ha) Duke Energy-owned Keowee site would be MODERATE. However, the area of land disturbed for the Oconee Station's natural gas alternative would be much smaller than the area of land disturbed for the W.S. Lee Nuclear Station two nuclear unit alternative. For the Oconee Station natural gas alternative, most disturbed land would be in the previous industrial Oconee Station site with only 28 ac (11 ha) in the adjacent undisturbed area.

The construction of the 191 ac (77 ha) ROW and 21 mi (34 km) natural gas pipeline would have a greater effect on the terrestrial resources in and near the ROW. Once the pipeline route is chosen, Duke Energy would have to perform wetland delineations of affected lands and apply for permits for any wetland fill from USACE and the SCDNR. Terrestrial species could experience habitat loss or fragmentation, loss of food resources, and altered behavior due to noise- and construction-related disturbances. Erosion and sedimentation from clearing and excavating land to create the ROW and lay the pipeline could affect nearby riparian and wetland habitats. The use of BMPs would minimize such effects.

The LR GEIS (NRC 2013-TN2654: pp. 4119) concludes that many of the impacts on terrestrial resources from the operation of fossil-fuel energy alternatives would be essentially similar to those from continued operation of the nuclear power plant. However, some impacts particular to a natural gas plant would be from air emissions of GHGs, such as nitrogen oxide, CO_2, and methane. Such GHGs can lead to consequences like climate change. Section 3.14.3.1 in this EIS discusses the effects of climate change on terrestrial resources. Despite these emissions, operating the natural gas alternative power plant would not likely destabilize any important attribute of the terrestrial environment.

Because the natural gas facility would use existing Oconee Station transmission lines, the NRC staff expects no increase in potential wildlife injury from transmission lines. However, the natural gas plant would require adding new, tall structures to the landscape, including mechanical draft cooling towers 70 ft (20 m) in height, and a power block 150 ft (46 m) in height. These could result in avian (bird) collisions. In addition, bats, including bats of the State-listed protected species noted in Section 3.6.3 of this EIS, could collide with the towers and die. However, the NRC staff expects that bird and bat populations would eventually become accustomed to the presence of the towers and avoid them. Once the natural gas facility is built, operational impacts on terrestrial resources would likely remain as expected for the proposed action. Based on the preceding analysis, the NRC staff concludes that impacts on terrestrial resources from the natural gas alternative would be SMALL to MODERATE, primarily because of the possible loss and fragmentation of forested habitat and wetlands caused by the construction and maintenance of a new natural gas pipeline and ROW.

3.6.9 Combination Alternative (Solar PV, Offshore Wind, Small Modular Reactor, and Demand-Side Management)

New Nuclear (Small Modular Reactor)

The terrestrial impacts of the construction and operation of three SMRs as part of the combination alternative would be similar to but greater than the terrestrial impacts described above (in Section 3.6.7) for the single-unit SMR portion of the new nuclear alternative. The operation of three SMRs would require a larger footprint of 110 ac (45 ha), but as with the single-unit SMR, all construction and operation would be confined to the Oconee Station site. Wildlife and habitat would be temporarily or permanently disturbed during construction, especially in forested areas. However, Duke Energy states that before removing any trees it would conduct wildlife surveys, identify protected species and habitat, and use avoidance and minimization measures. Construction of new tall structures at Oconee Station—namely, a new mechanical cooling tower and power block—would result in increased avian (birds) and bat collisions. Noise from the operation of the cooling tower could also disturb wildlife. Based on the above information and the conclusion reached in the SMR portion of Section 3.6.7 of this EIS, the NRC staff concludes that terrestrial impacts from construction and operation of three SMRs as part of the combination alternative would be SMALL.

Solar PV

Impacts on terrestrial habitats and biota from the construction and operation of solar PV plants would depend largely on the amount of land required and its location. The NRC staff estimates that the solar PV portion of the alternative would require 9,600 ac (3,900 ha) of cleared land for 12 utility-scale solar PV plants in the Oconee Station ROI. If the lands chosen for the plants were previously cleared and used for industrial activity, the impacts on terrestrial resources would be less significant than if the lands were virgin forest containing important species and habitats. Vegetation clearing and tree removal would displace wildlife to nearby habitats, but some species would return at the end of construction when temporarily disturbed land is restored. Once in operation, solar PV plants pose special hazards to birds through collisions with PV equipment and transmission lines, electrocution by substation and distribution lines, and predation when injured after collision (Hathcock 2019-TN8470). Another less understood cause of bird collisions is known as the lake effect theory. Birds, especially migrating waterfowl and shorebirds, perceive the horizontally polarized light of PV solar panels as bodies of water and are injured or killed when they attempt to land on the panels as if they were water (Horvath et al. 2009-TN897). Water-seeking insects can also collide with the panels for the same reasons. In large enough numbers, such insect deaths may affect food webs. The Multiagency Avian-Solar Collaborative Working Group is a collection of Federal and State agencies identifying information needs and best practices for reducing the avian impacts of solar energy. Collaboration with government agencies on best practices in the construction and siting of the solar installations can mitigate their impacts on birds. The NRC staff concludes that the impacts on terrestrial resources would be MODERATE to LARGE because the solar PV plants require large areas of land and clearing the land could result in the significant loss of wildlife, habitats, and vegetation.

Offshore Wind

During construction of an offshore wind facility, terrestrial habitats and biota may be affected by onshore activities, such as installation of interconnection cables, fiber-optic cables, and switch cabinets, and construction of interconnection stations. Species may experience habitat loss directly from excavation or indirectly from pollutants from drilling fluids. Wildlife could be disturbed by drilling and other operational noise and human activity during the construction period. In addition, the NRC staff assumes the offshore wind portion of the combination alternative would connect to an onshore battery storage system requiring 60 ac (24 ha) of land. If the lands chosen for the battery storage system were previously cleared and used for industrial activity, the impacts on terrestrial resources would be less significant than if the lands were undeveloped and contained important species and habitats. Vegetation clearing and tree removal would displace wildlife to nearby habitats, but some species would return at the end of construction when temporarily disturbed land is restored. Regulations in the South Carolina, North Carolina, and Virginia coastal zone management programs would mitigate effects on sensitive coastal resources.

During operations, offshore wind turbines can affect terrestrial resources largely through the collision of bats and birds with rotating turbine blades. The NRC staff estimates that the combination alternative would require 66 offshore wind turbines to generate the needed replacement power. Concerning bat collisions, in the Mid-Atlantic Ocean, bat activity declines after 12.4 mi (20 km) from shore (Sjollema et al. 2014-TN8472). The offshore wind turbines would be placed in a BOEM-identified area 10 to 24 nautical miles off the coast. It is possible that some migratory tree bats may pass through the turbine sites during migration. Compared to bats, impacts on birds from the operations of offshore wind turbines are an issue of greater concern.

Avian mortality rates at onshore wind turbines have been extensively studied and are estimated to amount to an average of 5.3 birds killed per turbine per year (Loss et al. 2013-TN8489). Avian mortality from offshore turbines is difficult to accurately quantify because downed individuals sink or are swept away by the ocean where they cannot be easily collected and counted. The Atlantic Flyway, a major migratory route for birds protected under the Migratory Bird Treaty Act (MBTA), spans the Atlantic coast, including the BOEM-identified waters off the North and South Carolina coasts. The MBTA makes it illegal to take any migratory bird (or parts, nests, or eggs) except under a valid permit issued under Federal regulations. The utility would likely need to commission avian impact studies and obtain a permit for take of MBTA-protected bird species. In addition to direct bird mortality from collisions, offshore wind farms, in general, can disrupt bird flight formations and create barriers between areas that are ecologically linked, such as between roosting sites and feeding sites, breeding sites and wintering sites, and migration route points (Exo et al. 2003-TN8488). The maintenance and repair of turbines will increase boat activity in the area, which can be very disruptive to some bird species that will change course to avoid boats by as much as several kilometers (Exo et al. 2003-TN8488).

Birds protected under the Bald and Golden Eagle Protection Act would not likely occur near the turbines. In the United States, golden eagles nest primarily in Western states and typically migrate along the Appalachian Mountain ridgelines; bald eagles do not occur in the open ocean (BOEM 2015-TN9066).

Based on the above analysis, NRC staff concludes that the impact on terrestrial resources from construction and operation of an offshore wind facility as part of the combination alternative would be MODERATE.

Demand-Side Management

The NRC staff has not identified any impacts on terrestrial resources associated with demand-side management.

Combination Alternative Conclusion

Based on the above discussion of SMR, solar, offshore wind, and demand-side management, the NRC staff concludes that the overall impacts on terrestrial resources from the combination alternative could range from MODERATE to LARGE, mainly because of the large area of land and the types of land that could be used for the solar PV portion and the operational impacts on birds and bats for the offshore wind portion of the alternative.

3.7 Aquatic Resources

This section describes the aquatic resources of the affected environment, including Lake Keowee, Lake Jocassee, and Keowee Dam tailwaters of the Keowee River. The NRC staff previously characterized aquatic resources in Section 2.2.5 of the final Supplemental EIS that analyzed the initial license renewal (NRC 1999-TN8942: pp. 2-19). Sections 3.7.1, 3.7.4, and 3.7.7.1 of Duke Energy's ER (Duke Energy 2021-TN8897: Appendix E, pp. 3-107 to 3-111, 3-120 to 3-122, and 3-126 to 3-127, respectively) also describe aquatic resources. This information is incorporated herein by reference, with key, new, and updated information summarized below in the following subsections. Following the description of the aquatic environment, the staff analyzes the potential impacts of the proposed action (i.e., SLR) and alternatives on these resources.

3.7.1 Lake Keowee

Lake Keowee is an 18,357 ac (7,429 ha) humanmade reservoir located in the Savannah River Basin. It was created in 1971 by the damming of the Keowee and Little Rivers to provide a source of cooling water for Oconee Station and a source of hydropower generation for the Keowee-Toxaway Hydroelectric Project. Lake Keowee also is used for public recreation and serves as a drinking water source for the City of Greenville and surrounding communities. Duke Energy owns and operates the reservoir.

3.7.1.1 Biological Communities of Lake Keowee

Lake Keowee is a relatively deep, monomictic reservoir. During the annual warming period in the spring and summer, vertical stratification develops. During the annual cooling period in the fall and winter, the lake exhibits homogenous mixing. The shoreline and shallow water region of the lake includes numerous residential piers, and riprap comprises 33 percent of shallow water substrate (FERC 2016-TN8967). Clay (25 percent) and cobble (13 percent) comprise the remaining shallow water substrates (FERC 2016-TN8967).

Lake Keowee’s biological community is typical of southeastern reservoirs. It primarily supports warmwater species, and the lake is considered to have low to medium productivity. The trophic structure of Lake Keowee includes primary producers (i.e., plankton, macrophytes, and periphyton), primary consumers (i.e., zooplankton and benthic macroinvertebrates), and bottom-feeding, planktivorous, and piscivorous fish that serve as secondary and tertiary consumers. Primary producers are organisms that capture solar energy and synthesize organic compounds from inorganic chemicals. They form the trophic structure’s foundation by producing the organic nutrients and energy used by consumers. Primary producers in lake systems include phytoplankton, aquatic macrophytes, and periphyton. Of the three, phytoplankton are the major producers in all but very shallow lakes. Figure 3-7 illustrates the trophic structure of Lake Keowee.

<u>Plankton</u>

Plankton are small and often microscopic organisms that drift or float in the water column. Phytoplankton are single-celled plant plankton and include diatoms (single-celled yellow algae) and dinoflagellates (a single-celled organism with two flagella). Phytoplankton live suspended in the water column and occur in the limnetic (open water) zone of a lake. Nine genera of phytoplankton comprising 207 taxa are known to occur in Lake Keowee (see Table 3.7-1 of Duke Energy’s ER [Duke Energy 2021-TN8897] for a complete list of taxa). More than two-thirds of Lake Keowee’s plankton population is comprised of green algae (Chlorophyta) and diatoms (Bacillariophyta).

Zooplankton are animals that either spend their entire lives as plankton (holoplankton) or exist as plankton for a short time during development (meroplankton). Zooplankton include rotifers, isopods, protozoans, marine gastropods, polychaetes, small crustaceans, and the eggs and larval stages of insects and other aquatic animals. The zooplankton community in Lake Keowee consists entirely of microcrustaceans (copepods and cladocerans) and rotifers. In studies conducted from 2006 to 2011, researchers identified four zooplankton taxonomic classes and 47 species from the lake (see Table 3.7-2 of Duke Energy’s ER [Duke Energy 2021-TN8897] for a complete list of taxa).

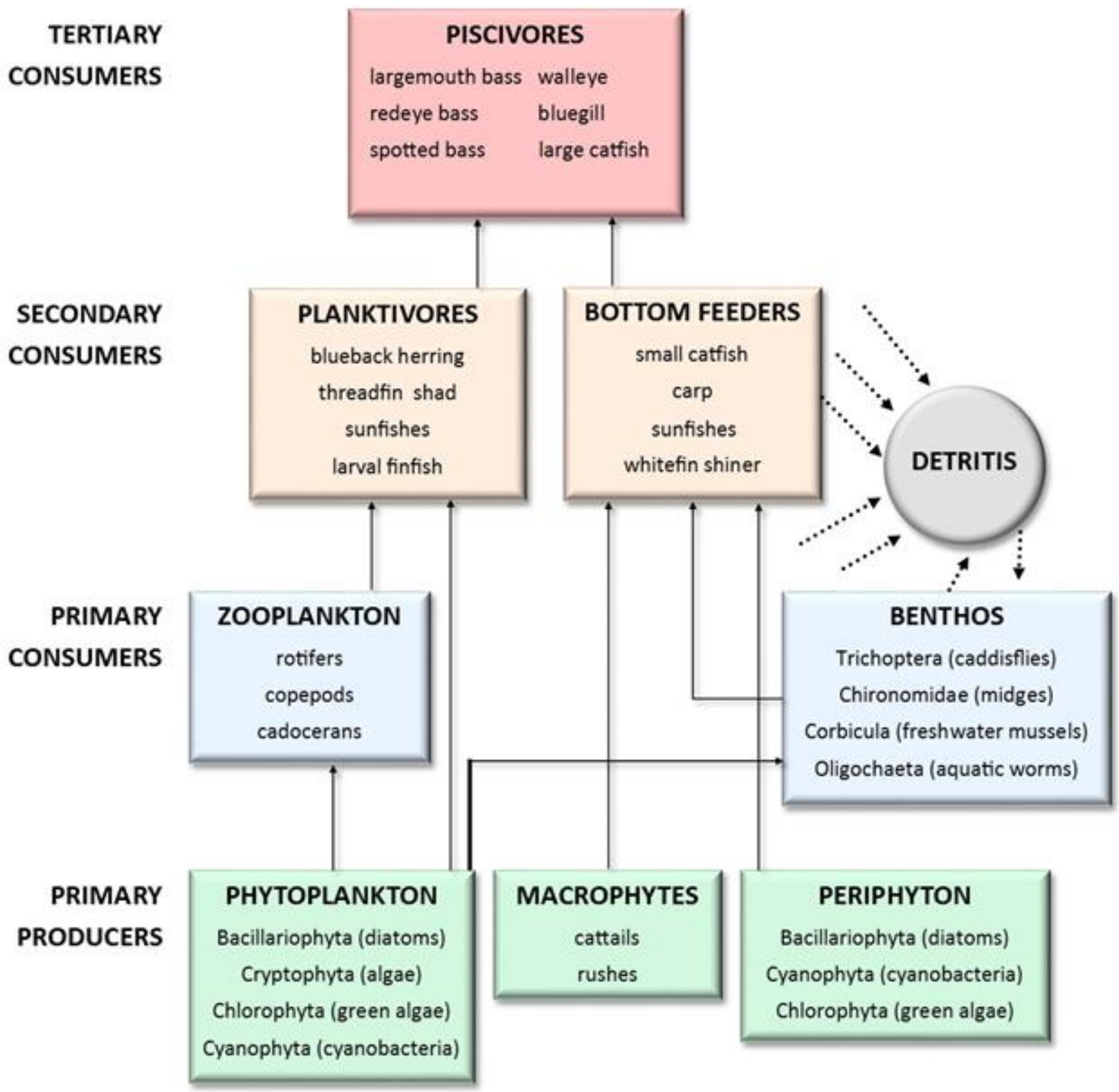

Figure 3-7 Trophic Structure of Lake Keowee

<u>Macrophytes and Periphyton</u>

Aquatic macrophytes are large plants, both emergent and submerged, that inhabit shallow water areas. Periphyton consists of single-celled or filamentous species of algae that attach to benthic or macrophytic surfaces. Macrophytes and periphyton occur in the littoral (near-shore and shallow) zone. They tend to be highly productive because they have more access to nutrients through their roots than phytoplankton. Macrophytes within Lake Keowee are minimal because water level fluctuations prevent establishment of native aquatic plants (FERC 2016-TN8967).

<u>Benthic Invertebrates</u>

Benthic invertebrates inhabit the bottom of the water column and its substrates. They include macroinvertebrates (clams, crabs, oysters, and other shellfish) as well as certain zooplankton, such as polychaetes (described previously). Benthic invertebrates, especially freshwater mussels, are an important indicator of the health of an aquatic system.

In a 2005–2008 survey of Lake Keowee associated with the Keowee-Toxaway Hydroelectric Project relicensing, researchers collected only three species of freshwater mussels: eastern floater (*Anodonta cataracta*) (80 individuals), paper pondshell (*Utterbackia imbecillis*) (62 individuals), and Florida pondhorn (*Uniomerus carolinianus*) (20 individuals) (FERC 2016-TN8967). Florida pondshell occurred in only the middle reaches of the lake, while the other two species were documented throughout the lake. The lack of freshwater mussel diversity in Lake Keowee may be attributable to the lake being an impoundment with limited habitat types. Greater diversity would be expected in a free-flowing river with more varied substrates and microhabitats. The Asian clam (*Corbicula fluminea*) also is present in Lake Keowee. This species, which is described further below, can contribute to native species declines by outcompeting other species for limited resources.

<u>Finfish</u>

Centrarchids, especially bluegill (*Lepomis macrochirus*) and redbreast sunfish (*L. ertici*), dominate Lake Keowee's fish community. The lake also hosts green sunfish (*L. cyanellus*), warmouth (*L. gulosus*), redear sunfish (*L. microlophus*), largemouth bass (*Micropterus salmoides*), spotted bass (*M. punctulatus*), and redeye bass (*M. coosae*). Blueback herring (*Alosa aestivalis*) and threadfin shad (*Dorosoma petenense*) dominate the open water areas of the lake.

Since creation of the lake, Duke Energy, as well as State agencies and other organizations, have monitored Lake Keowee's fish populations. Most recently, Duke Energy conducted sampling in 2006 and 2013 by way of electrofishing, purse seine, and hydroacoustic methods. Across all gear types, researchers collected 30 species (see Table 3-7). Electrofishing results indicate a diverse littoral fish population that includes 18 species and 2 hybrid species. Centrarchids, bluegill, and sunfish were the most abundant taxa in these samples. Between the two sampling years, largemouth bass and redeye bass populations exhibited slight decreases, while the spotted bass population exhibited an increase (Duke Energy 2021-TN8897; FERC 2016-TN8967).

Pelagic samples in 2006 and 2013 were primarily composed of threadfin shad and blueback herring (FERC 2016-TN8967). Threadfin shad generally inhabit larger rivers and reservoirs and commonly school in the middle of the water column of open water areas of the reservoir (Rohde et al. 2009-TN9015). This species prefers warmer waters and has a lower lethal temperature limit of approximately 41 to 45°F (5 to 7°C) (Parsons and Kimsey 1954-TN9020). Threadfin shad spawn from April to July during brief time intervals between first light to sunrise, near the shoreline, over aquatic plants and other submerged objects (Rohde et al. 2009-TN9015). Although the life span of threadfin shad can be 2 to 3 years, individuals rarely live past 1 year in large reservoirs and may not grow more than 3 to 4 in. (8 to 10 cm) (SCDNR 2015-TN9021). Native blueback herring populations are typically anadromous; however, introduced landlocked populations, such as the one in Lake Keowee, will reside in open water areas of reservoirs and spawn close to shore in the spring (Rohde et al. 2009-TN9015). Blueback herring tolerate temperatures as low as 36°F (2.2°C) (Pardue 1983-TN9023). In southeastern reservoirs, the species generally prefer cool (55 to 75°F [12.8 to 23.9°C]), deep water (FERC 2016-TN8967). Individuals generally mature at age 3 or 4 and can live to age 8 (Rohde et al. 2009-TN9015). Lake Keowee's threadfin shad and blueback herring populations tend to show variable seasonal abundance with higher and more variable abundances in the fall than in the spring (FERC 2016-TN8967).

Table 3-7 Fish Species Reported from Lake Keowee, South Carolina

Family	Scientific Name	Common Name
Centrarchidae	*Lepomis macrochirus*	bluegill
Centrarchidae	*Lepomis auritus*	redbreast sunfish
Centrarchidae	*Lepomis cyanellus*	green sunfish
Centrarchidae	*Lepomis gulosus*	warmouth
Centrarchidae	*Lepomis microlophus*	redear sunfish
Centrarchidae	*Micropterus coosae*	redeye bass
Centrarchidae	*Micropterus dolomieu*	smallmouth bass
Centrarchidae	*Micropterus punctulatus*	spotted bass
Centrarchidae	*Micropterus salmoides*	largemouth bass
Centrarchidae	*Pomoxis nigromaculatus*	black crappie
Cyprinidae	*Cyprinella nivea*	whitefin shiner
Cyprinidae	*Cyprinus carpio*	common carp
Cyprinidae	*Notemigonus crysoleucas*	golden shiner
Cyprinidae	*Notropis hudsonius*	spottail shiner
Cyprinidae	*Luxilus albeolus*	white shiner
Clupeidae	*Alosa aestivalis*	blueback herring
Clupeidae	*Dorosoma petenense*	threadfin shad
Ictaluridae	*Ameiurus brunneus*	snail bullhead
Ictaluridae	*Pylodictis olivaris*	flathead catfish
Ictaluridae	*Ameiurus platycephalus*	flat bullhead
Ictaluridae	*Ictalurus punctatus*	channel catfish
Ictaluridae	*Ameiurus catus*	white catfish
Percidae	*Percina nigrofasciata*	blackbanded darter
Poeciliidae	*Gambusia holbrooki*	eastern mosquitofish
Catostomidae	*Hypentelium nigricans*	northern hog sucker
Catostomidae	*Minytrema melanops*	spotted sucker
Catostomidae	*Moxostoma collapsum*	notchlip redhorse
Catostomidae	*Moxostoma spp.*	Brassy jumprock
Salmonidae	*Oncorhynchus mykiss*	rainbow trout
Salmonidae	*Salmo trutta*	brown trout

Sources: Duke Energy 2021-TN8897, FERC 2016-TN8967.

3.7.1.2 Important Species and Habitats of Lake Keowee

This section summarizes important fisheries of Lake Keowee as well as State-protected and other special status species. Section 3.8 discusses federally listed species separately; however, none occur in Lake Keowee.

<u>Commercially Important Fisheries</u>

Commercial fishing is not permitted on Lake Keowee. Thus, there are no commercially important fisheries.

Recreationally Important Fisheries

Lake Keowee is a popular angling destination. The lake experiences moderate fishing pressure for its size. Species most sought by anglers include largemouth bass, smallmouth bass (*Micopterus dolomieu*), spotted bass, redeye bass, bluegill, redear sunfish, redbreast sunfish, channel catfish (*Ictalurus punctatus*), and flathead catfish (*Pylodictis olivaris*). Threadfin shad, gizzard shad (*Dorosoma cepedianum*), and blueback herring provide forage for these species and are, therefore, also important to the recreational fishery.

The SCDHEC has issued consumption advisories for certain fish because of mercury concentrations. As of late 2023, the SCDHEC (SCDHEC 2023-TN8971) recommends limiting consumption of largemouth bass and spotted bass to one meal per week.

State-Protected and Other Special Status Species

The State of South Carolina enacted the Nongame and Endangered Species Conservation Act (SC Code 50-15-10-TN9181) in 1976 to protect South Carolina-endemic species from possible extinction throughout all or a significant part of those species' native ranges. Under the authority of this act, the SCDNR lists animals as State-endangered or threatened. No State-listed species occur in Lake Keowee.

Under the South Carolina Wildlife Action Plan (WAP) (SCDNR 2015-TN9025), the SCDNR identifies many aquatic species as Species of Greatest Conservation Need. The distribution and abundance of such species are indicative of the greater diversity and health of wildlife within the State. In Lake Keowee, one aquatic species, blueback herring, is designated as a high-priority Species of Greatest Conservation Need. This species is given this designation primarily because of its ecological function within free-flowing waterways where it is a diadromous species. In Lake Keowee, blueback herring are unable to migrate as they would elsewhere and, therefore, do not have the same ecological value as individuals that occur in native rivers that flow to the Atlantic Ocean.

State Parks

The Keowee-Toxaway State Park lies at the north end of Lake Keowee. It was established through a partnership between Duke Energy and the State of South Carolina and includes 1,000 ac (400 ha) open to camping, fishing, boating, and other recreational amenities. The SCDNR manages 373 ac (151 ha) of the park as a wildlife preserve (SCSP 2023-TN9026).

3.7.1.3 Invasive and Nuisance Species of Lake Keowee

Nonnative species are those species that are present only because of introduction and that would not naturally occur either currently or historically in an ecosystem. Invasive species are nonnative organisms whose introduction causes or is likely to cause economic or environmental harm or harm to human, animal, or plant health (81 FR 88609-TN8375). For purposes of this discussion, nuisance species are nonnative species that alter the environment but do not rise to the level of invasive.

Invasive and nuisance aquatic species in Lake Keowee include common hornwort (*Ceratophyllum demersum*), parrot feather watermilfoil (*Myriophyllum aquaticum*), Asian clam, common carp (*Cyrpinus carpio*), green sunfish, spotted bass, and flathead catfish.

Aquatic plants primarily occur in the shallow water habitats of lakes and reservoirs where sunlight penetrates the water column. Although aquatic plants can be beneficial to fish and other aquatic organisms by providing habitat and refuge from predators, nonnative species can out-compete native aquatic plants and lead to habitat degradation and loss of recreation if not controlled. Duke Energy, in cooperation with the SCDNR, manages nuisance aquatic plants within Lake Keowee (FERC 2016-TN8967).

In general, aquatic vegetation is not abundant in Lake Keowee because of sediment characteristics and water level fluctuations, both of which prevent plants from establishing. In 2012 aquatic plant surveys, Duke Energy only observed small populations of common hornwort and parrot feather watermilfoil. Hydrilla (*Hydrilla verticillata*) historically occurred in the lake. However, through SCDNR's chemical and physical removal efforts, it has not been observed since 2002 (FERC 2016-TN8967).

The Asian clam, which is now ubiquitous in many major U.S. freshwater systems, can survive in relatively cold waters and reproduce rapidly. Once established, Asian clams can alter benthic substrates, out-compete other native benthic invertebrates, and cause the decline or local disappearance of native mussel and clam populations. Asian clams are particularly damaging to intake pipes for power and water facilities when large numbers of the clams, either dead or alive, clog the pipes. Individuals will also biofoul the pipes by attaching themselves to pipe walls where they incrementally obstruct more flow as they grow. Duke Energy monitors for Asian clams at the intake canal and skimmer wall near the Oconee Station pump pits. Duke Energy (TN8897) reports low-to-moderate potential for biofouling based on this monitoring.

Common carp, green sunfish, spotted bass, and flathead catfish, when invasive, all grow rapidly, prey on native species, alter habitats, or out-compete native species for limited resources. Common carp alter habitats by uprooting aquatic vegetation and disturbing sediment. Spotted bass, which were introduced into Lake Keowee in the 1980s, are a popular angling species. However, this species is displacing and hybridizing with native redeye bass.

3.7.2 Lake Jocassee

Lake Jocassee is a 7,565 ac (3,061 ha) humanmade reservoir that lies upstream and approximately 11 mi (18 km) north of Oconee Station. The lake was created in 1973 with the construction of the Jocassee Dam on the Keowee River to provide a source of hydropower generation for the Jocassee Hydroelectric Station. Water entering the Keowee watershed comes from Lake Jocassee, and the spillway from this lake drains into the Keowee River and Lake Keowee.

The SCDNR has designated Lake Jocassee as trout "put, grow, and take water" for recreational rainbow trout (*Oncorhynchus mykiss*) and brown trout (*Salmo trutta*) fisheries. Duke Energy monitors lake water temperature, dissolved oxygen, and other water quality metric to ensure that the required habitat for trout is available. The lake is also a recreational fishery resource for smallmouth and spotted bass.

Lake Jocassee is a deep, low-productivity reservoir that thermally stratifies annually. The shoreline is steeply sloped, and substrate is composed primarily of rocky outcrops with small areas of sand, clay, and cobble. Emergent vegetation is minimal due to water level fluctuations. A variety of warm, cool, and coldwater fish inhabit the lake. Warmwater centrarchids, such as redbreast sunfish, bluegill, and largemouth bass dominate the fish community and primarily inhabit the shallow water areas. Redeye bass is another abundant centrarchid, although it tends to occupy only cool waters. Within the pelagic zone, blueback herring and threadfin shad are abundant. Two coldwater species, rainbow trout and brown trout, occupy deeper, cooler, and well-oxygenated areas in the summer and fall and move into shallower open waters during cooler months. Natural reproduction of these two species is negligible in Lake Jocassee, but the SCDNR stocks these species annually to maintain fishable populations (FERC 2016-TN8967).

3.7.3 Keowee Dam Tailwaters

The tailwaters of the Keowee Dam are characterized by natural rock, clay, sand, woody debris, and riprap substrates. Centrarchids, particularly redbreast sunfish, bluegill, and redear sunfish, dominate the fish community. Striped bass (*Morone saxatilis*), which the SCDNR identifies as a moderate-priority Species of Greatest Conservation Need, inhabits the tailwaters. However, striped bass in this area originate from a stocked population downstream in Hartwell Lake and are not naturally occurring or self-sustained (FERC 2016-TN8967).

3.7.4 Proposed Action

The following sections address the site-specific environmental impacts of the Oconee Station SLR on the environmental issues related to aquatic resources in accordance with Commission direction in CLI-22-02 and CLI-22-03.

3.7.4.1 Impingement and Entrainment of Aquatic Organisms (Plants with Once-Through Cooling Systems or Cooling Ponds)

For nuclear power plants with once-through cooling systems or cooling ponds, such as Oconee Station, the NRC staff determined in the LR GEIS that impingement and entrainment of aquatic organisms is a Category 2 issue that requires site-specific evaluation (NRC 2013-TN2654). In 1999, the NRC staff evaluated the impacts of the Oconee Station initial license renewal on aquatic organisms as two issues: “impingement of fish and shellfish” and “entrainment of fish and shellfish in early life stages.” For both issues, the NRC staff determined that the impacts of continued operation of Oconee Station would be SMALL during the initial license renewal term (i.e., 2013–2033 for Units 1 and 2 and 2014–2034 for Unit 3) (NRC 1999-TN8942). In 2013, the NRC staff issued Revision 1 of the LR GEIS (NRC 2013-TN2654). In the revised LR GEIS, the NRC staff combined the two aquatic issues into a single site-specific issue: “impingement and entrainment of aquatic organisms (nuclear power plants with once-through cooling systems or cooling ponds).” This section evaluates this consolidated issue because it applies to the continued operation of Oconee Station for the proposed SLR term (i.e., 2033–2053 for Units 1 and 2 and 2034–2054 for Unit 3).

Impingement occurs when organisms are trapped against the outer part of an intake structure’s screening device (79 FR 48300-TN4488). The force of the intake water traps the organisms against the screen, and individuals are unable to escape. Impingement can kill organisms immediately or cause exhaustion, suffocation, injury, and other physical stresses that contribute to mortality later. The potential for injury or death is generally related to the amount of time an organism is impinged, its fragility (susceptibility to injury), and the physical characteristics of the screen wash and fish return systems of the intake structure. The EPA has found that impingement mortality is typically less than 100 percent if the cooling water intake system includes fish return or backwash systems (79 FR 48300-TN4488). Because impingeable organisms are typically fish with fully formed scales and skeletal structures, as well as well-developed survival traits such as behavioral responses to avoid danger, many impinged organisms can survive under proper conditions (79 FR 48300-TN4488).

Entrainment occurs when organisms pass through the screening device and travel through the entire cooling system, including the pumps, condenser or heat exchanger tubes, and discharge pipes (79 FR 48300-TN4488). Organisms susceptible to entrainment are of smaller size, such as ichthyoplankton, larval stages of shellfish and other macroinvertebrates, zooplankton, and phytoplankton. During travel through the cooling system, entrained organisms experience physical trauma and stress, pressure changes, excess heat, and exposure to chemicals (Mayhew et al. 2000-TN8458). Because entrainable organisms generally consist of fragile life stages (e.g., eggs, which exhibit poor survival after interacting with a cooling water intake structure; and early larvae, which lack a skeletal structure and swimming ability), the EPA has concluded that for purposes of assessing the impacts of a cooling water intake system on the aquatic environment, all entrained organisms are assumed to die (79 FR 48300-TN4488).

Entrainment susceptibility is highly dependent on life history characteristics. For example, broadcast spawners with non-adhesive, free-floating eggs that drift with the water current may become entrained in a cooling water intake system. Nest-building species or species with adhesive, demersal eggs are less likely to be entrained in early life stages. Susceptibility of larval life stages to entrainment depends on body morphometrics and swimming ability.

If several life stages of a species occupy the source water, that species can be susceptible to both impingement and entrainment. For instance, adults and juveniles of a given species of fish may be impinged against the intake screens, while larvae and eggs may pass through the screening device and be entrained through the cooling system. The susceptibility to either impingement or entrainment relates to the size of the individual relative to the size of the mesh on the screening device. The EPA considers aquatic organisms that can be collected or retained on a sieve with 0.56 in. (1.4 cm) diagonal openings to be susceptible to impingement (79 FR 48300-TN4488). This equates to screen device mesh openings of 0.5 in. × 0.25 in. (1.3 cm × 0.635 cm), which is slightly larger than the openings on the typical 0.375 in. (0.95 cm) square mesh found at many nuclear power plants. Organisms smaller than the 0.56 in. (1.4 cm) mesh are considered susceptible to entrainment.

The magnitude of the impact that impingement and entrainment create on the aquatic environment depends on the plant-specific characteristics of the cooling system as well as the local aquatic community. Relevant nuclear power plant-based characteristics include location of the cooling water intake structure, intake velocities, withdrawal volumes, screening device technologies, and the presence or absence of a fish return system. Relevant characteristics of the aquatic community include species present in the environment, life history characteristics, population abundances and distributions, special species statuses and designations, and regional management objectives.

<u>Oconee Station Cooling Water Intake System</u>

The Oconee Station cooling water intake system impinges and entrains aquatic organisms as it withdraws water from Lake Keowee. Section 2.1.3 of this EIS describes Oconee Station's cooling and auxiliary water systems in detail. This section summarizes features of these systems relevant to the impingement and entrainment analysis.

Lake Keowee water first interacts with Oconee Station's cooling water intake structure at a curtain wall located in the Little River arm of the reservoir. The curtain wall extends to a depth of approximately 65 ft (20 m) so that only hypolimnetic water at depths of 65 to 88.6 ft (20 to 27 m) is withdrawn from the source water. As Oconee Station withdraws water, fish and other aquatic organisms that cannot swim fast enough to escape the flow of water may be swept into the intake. Approach velocity at the curtain wall varies from 0.60 to 0.83 feet per second (fps) (0.18 to 0.25 meters per second [m/s]) depending on the number of pumps in operation (i.e., one to four pumps per unit) [4] (Duke Energy 2022-TN8948). Organisms within the source water that cannot resist or escape this flow are drawn into the cooling water intake structure along with the water.

Once drawn into the curtain wall, organisms enter a 5,860 ft (1,786 m)-long intake canal. The canal ranges in width from 500 to 1,800 ft (152 to 548 m), and water depths in the canal vary from 91 to 100 ft (28 to 30 m). Two barriers prevent large debris from traveling the length of the canal and entering the intake structure. First, a submerged underwater weir lies approximately 850 ft (260 m) downstream of the curtain wall near the entrance to the intake canal. The weir slopes on both the upstream and downstream sides. Second, a trash boom lies approximately 900 ft (274 m) upstream of the intake structure that funnels debris to the shoreline.

After traveling through the intake canal and past the large debris barriers, organisms in the source water encounter trash bars with 2.5 in. (6.4 cm) spacing followed by 10.75 ft (3.3 m) fixed panel mesh screens that are 10.75 ft (3.3 m) wide, 50 ft (15.2 m) tall, and have 0.375 in. (0.95 cm) square mesh. Organisms that are too large to pass through the fixed screen mesh, such as juvenile and adult fish and shellfish, become impinged on the screens. Through-bar velocity varies from 1.03 to 1.43 fps (0.31 to 0.44 m/s) and through-screen velocity varies from 2.08 to 2.90 fps (0.63 to 0.88 m/s) depending on pump operation[4] (Duke Energy 2022-TN8948). When differential pressure on the screens reaches 10 in. of mercury (in. of Hg, 254 mm of Hg), an alarm sounds to alert nuclear power plant personnel to lift and clean the screens of debris. Oconee Station does not have a fish return system, so all impinged organisms are either collected at the trash racks or on the traveling screens and disposed of as solid waste along with other debris.

Organisms small enough to pass through the fixed screen mesh, such as fish eggs, larvae, and other zooplankton, are entrained into the cooling water system. Entrained organisms pass through the entire cooling system and re-enter the Keowee River arm of Lake Keowee just above the Lake Keowee dam, along with heated effluent, through a submerged opening that is 25 to 40 ft (7.6 to 12 m) deep. During this process, entrained organisms are subject to mechanical, thermal, and toxic stresses.

Clean Water Act Section 316(b) Requirements for Existing Facilities

Section 316(b) of the CWA addresses the adverse environmental impacts caused by the intake of cooling water from waters of the United States. This section of the CWA grants the EPA the authority to regulate cooling water intake structures to minimize adverse impacts on the aquatic environment. Under CWA Section 316(b), the EPA has issued regulations for existing facilities, such as Oconee Station, at 40 CFR Part 122 (TN2769) and 40 CFR Part 125 (TN254), Subpart J. Existing facilities include power generation and manufacturing facilities that are not new facilities as defined at 40 CFR 125.83 and that withdraw more than 2 mgd (7.6 mLd) of water from waters of the United States and use at least 25 percent of the water they withdraw exclusively for cooling purposes.

[4] [HDR] HDR Engineering, Inc. 2020. *Oconee Nuclear Station, Oconee County, South Carolina, Clean Water Act §316(b) Compliance Submittal*. Prepared for Duke Energy Carolinas, LLC. November 10, 2020. 1198 p. ADAMS Accession No. ML22019A124. Attachment 1 in Duke Energy 2022-TN8948.

Under the CWA Section 316(b) regulations, the location, design, construction, and capacity of cooling water intake structures of regulated facilities must reflect the best technology available (BTA) for minimizing impingement mortality and entrainment. The EPA, or authorized States and Tribes, impose BTA requirements through NPDES permitting programs. In South Carolina, the SCDHEC administers the NPDES program and issues NPDES permits to regulated facilities.

With respect to impingement mortality (IM), the BTA standard requires that existing facilities comply with one of the following seven alternatives (40 CFR 125.94(c) (TN254):

1. operate a closed-cycle recirculating system, as defined at 40 CFR 125.92(c) (herein referred to as “IM Option 1”)
2. operate a cooling water intake structure that has a maximum through-screen design intake velocity of 0.5 fps (0.15 m/s)
3. operate a cooling water intake structure that has a maximum actual through-screen intake velocity of 0.5 fps (0.15 m/s)
4. operate an offshore velocity cap, as defined at 40 CFR 125.92(v), that was installed on or before October 14, 2014
5. operate a modified traveling screen that the NPDES Permit Director determines meets the definition at 40 CFR 125.92(s) and that the NPDES Permit Director determines is the BTA for impingement reduction at the site
6. operate any other combination of technologies, management practices, and operational measures that the NPDES Permit Director determines is the BTA for impingement reduction (herein referred to as “IM Option 6”)
7. achieve a 12-month impingement mortality performance standard of all life stages of fish and shellfish of no more than 24 percent mortality, including latent mortality, for all non-fragile species

Options (1), (2), and (4) above are essentially preapproved technologies requiring either no demonstration or only a minimal demonstration that the flow reduction and control measures are functioning as the EPA envisioned. Options (3), (5), and (6) require more detailed information to be submitted to the permitting authority before the permitting authority may specify it as BTA for a given facility. Under Option (7), the permitting authority may also review site-specific data and conclude that a de minimis rate of impingement exists; and, therefore, no additional controls are warranted to meet the BTA impingement mortality standard.

With respect to entrainment, the CWA Section 316(b) regulations do not prescribe a single nationally applicable entrainment performance standard, because the EPA did not identify a technology for reducing entrainment that is effective, widely available, feasible, and does not lead to unacceptable non-water-quality impacts (79 FR 48300-TN4488). Instead, the permitting authority must establish the BTA entrainment requirement for each facility on a site-specific basis. In establishing site-specific requirements, the regulations direct the permitting authority to consider the following factors (40 CFR 125.98(f)(2)):

1. numbers and types of organisms entrained, including, specifically, the numbers and species (or lowest taxonomic classification possible) of federally listed, threatened and endangered species, and designated critical habitat (e.g., prey base)

2. impact of changes in particulate emissions or other pollutants associated with entrainment technologies
3. land availability inasmuch as it relates to the feasibility of entrainment technology
4. remaining useful plant life
5. quantified and qualitative social benefits and costs of available entrainment technologies when such information on both benefits and costs is of sufficient rigor to make a decision

Analysis Approach

When available, the NRC staff relies on the expertise and authority of the NPDES permitting authority with respect to the impacts of impingement and entrainment. Therefore, if the NPDES permitting authority has made BTA determinations for a facility pursuant to CWA Section 316(b) in accordance with the current regulations specified in 40 CFR Part 122 (TN2769) and 40 CFR Part 125 (TN254), which were promulgated in 2014 (79 FR 48300-TN4488), and that facility has implemented any associated requirements or those requirements would be implemented before the proposed SLR period, then the NRC staff assumes that adverse impacts on the aquatic environment will be minimized (see 10 CFR 51.10(c); 10 CFR 51.53(c)(3)(ii)(B); and 10 CFR 51.71(d) [TN250]). In such cases, the NRC staff concludes that the impacts of either impingement, entrainment, or both would be SMALL for the proposed SLR term.

In cases in which the NPDES permitting authority has not made BTA determinations, the NRC staff analyzes the potential impacts of impingement, entrainment, or both using a weight-of-evidence approach. In this approach, the staff considers multiple lines of evidence to assess the presence or absence of ecological impairment (i.e., noticeable or detectable impact) on the aquatic environment. For instance, as its lines of evidence, the NRC staff might consider characteristics of the cooling water intake system design, the results of impingement and entrainment studies performed at the facility, and trends in fish and shellfish population abundance indices. The NRC staff then considers these lines of evidence together to predict the level of impact (SMALL, MODERATE, or LARGE) that the aquatic environment is likely to experience during the proposed SLR term.

Baseline Condition of the Resource

For the purposes of this analysis, the NRC staff assumes that the baseline condition of the resource is the Lake Keowee aquatic community as it occurs today, which is described in Section 3.7.1 of this EIS. While species richness, evenness, and diversity within the community may change or shift between now and when the proposed SLR period would begin, the NRC staff finds the present aquatic community to be a reasonable surrogate in the absence of fishery and species-specific projections.

3.7.4.1.1 *Impingement*

Impingement Mortality Best Technology Available

The SCDHEC has not made an impingement mortality BTA determination for Oconee Station. Oconee Station’s current NPDES permit was issued in 2010. Thus, the 2014 final rule establishing CWA Section 316(b) regulations for existing facilities had not yet been promulgated when the SCDHEC last renewed the permit. In March 2013, Duke Energy submitted a renewal application to the SCDHEC[5] (Duke Energy 2021-TN8898). That application is currently under SCDHEC review. Because Duke Energy submitted a timely renewal application, the 2010 NPDES permit remains in effect until the SCDHEC completes its review.

In November 2020, Duke Energy subsequently submitted information to the SCDHEC concerning impingement mortality and entrainment pursuant to CWA Section 316(b) requirements at 40 CFR 122.21(r)(2) through (13)[4] (Duke Energy 2022-TN8948). In that submittal, Duke Energy requested the SCDHEC's concurrence that Oconee Station meets the regulatory criteria for a closed-cycle recirculating system (i.e., IM Option 1). Duke Energy found that the design and operation of Oconee Station's cooling water intake system complies with IM Option 1 for the following reasons[4] (Duke Energy 2022-TN8948):

- Lake Keowee was constructed before October 14, 2014, the effective date of the 2014 CWA Section 316(b) final rule.
- Lake Keowee was created for the purpose of serving as part of Oconee Station's cooling water system. The lake serves as both a source of cooling water and a heat sink for Oconee Station; whereby, the facility withdraws water from one part of the impoundment and discharges the heated effluent back to the impoundment in another location to allow the heated water time to cool before reuse.
- Use of Lake Keowee requires no makeup water because precipitation and watershed runoff, including upstream releases from the Jocassee Development, replace water lost through evaporation, seepage, and downstream flow.

If the SCDHEC agrees with Duke Energy's determination, Oconee Station would be deemed in compliance with the impingement mortality BTA standard under IM Option 1, and no cooling water intake system modifications or upgrades would be necessary to reduce impingement mortality.

As an alternative compliance option, Duke Energy evaluated IM Option 6, a combination of technologies, management practices, and operational measures. Duke Energy found Oconee Station to also comply with this impingement mortality BTA compliance option for the following reasons[4] (Duke Energy 2022-TN8948):

- The curtain wall causes water to be withdrawn from the lower 23 ft (7 m) of Lake Keowee where dissolved oxygen is naturally lower and conditions are less favorable for fish. This withdrawal effectively reduces impingement by minimizing the number of organisms present in the portion of the water column withdrawn into the cooling water intake system.
- The submerged weir near the intake canal entrance and overhanging wall at the cooling water intake structure entrance further minimize the withdrawal zone.
- The actual intake flows withdrawn at the cooling water intake structure, as documented during a 5-year period (June 2014 through June 2019) is estimated to result in a 14.2 percent annual flow reduction and a 34 percent maximum seasonal flow reduction when compared to the design intake flow.

If the SCDHEC finds that this option is the BTA for reducing impingement mortality at Oconee Station, implementation would effectively be immediate because each of these features are

[5] Duke Energy. 2013. Duke Power Company/Oconee Nuclear Station Renewal Application for NPDES Permit #SC0000515, Oconee County, South Carolina. March 28, 2013. 393 p. ADAMS Accession No. ML21328A163. Attachment 3 in Duke Energy 2021-TN8898.

already in place and functioning to reduce impingement. No further system modifications or upgrades would be necessary. However, Duke Energy would be required to perform an impingement characterization study to evaluate the effectiveness of this option in accordance with 40 CFR 125.94(c)(7).

As one component of issuing a renewed NPDES permit, the SCDHEC will review the compliance options described above and make an impingement mortality BTA determination. When the SCDHEC makes this determination, it may impose additional requirements to reduce or mitigate the effects of impingement mortality at Oconee Station. Such requirements would be incorporated as conditions of the renewed NPDES permit, which would be issued and take effect before the SLR period. The NRC staff assumes that any additional requirements that the SCDHEC imposes would minimize the impacts of impingement mortality over the course of the proposed SLR term in accordance with CWA Section 316(b) requirements.

However, because the SCDHEC's impingement mortality BTA determination is currently pending, the NRC staff also considers other lines of evidence below, including the impingement area of influence (AOI) and results of impingement mortality studies, to more fully evaluate the magnitude of impact that impingement would represent during the proposed SLR period.

Impingement Area of Influence

In connection with Duke Energy's 2020 CWA Section 316(b) compliance submittal to the SCDHEC, HDR Engineering, Inc. (HDR) calculated the Oconee Station impingement AOI. The impingement AOI is the region extending outward from the intake screens in which impingeable-sized aquatic organisms (i.e., juvenile and adult fish and shellfish) would not be capable of overcoming the velocities created by water withdrawals at the cooling water intake structure and, thus, would have a higher probability of becoming impinged upon an intake screen. Conservatively, the AOI can be considered the area encompassed by the 0.5 fps (0.15 m/s) velocity contour at the cooling water intake system identified by 40 CFR 125.94(c) (TN254). At this boundary and beyond it, the potential for impingement is approximately zero; within this boundary, the potential increases with increasing proximity to the intake. Organisms within the AOI have a high probability of being impinged, but actual entrainment will be the product of physical and biological factors that vary over space, time, and species. For instance, because juvenile and adult fish have differing swimming abilities and differing preferred habitats, including those that involve natural water velocities above 0.5 fps (0.15 m/s), a particular organism within the 0.5 fps (0.15 m/s) velocity contour will vary in susceptibility to impingement.

The impingement AOI was calculated by HDR[4] (Duke Energy 2022-TN8948) based on Oconee Station's design intake flow and water depth at maximum drawdown water elevation in Lake Keowee. This water depth represents the most conservative (i.e., largest) AOI that may exist during Oconee Station operations. HDR found that the impingement AOI consists of a thin band directly in front of the intake, which is 328 linear ft (100 linear m) at maximum drawdown and 237 linear ft (72 linear m) at full pond elevation[4] (see Figure 3-6 in Duke Energy 2022-TN8948). The impingement AOI does not extend into the waterbody, and impingeable-sized organisms within the intake canal in the vicinity of the intake would experience velocities less than 0.5 fps (0.15 m/s). This means that only those fish and shellfish that leave the main body of Lake Keowee, pass through the curtain wall, and swim down the intake canal into the area directly in front of the intake would be susceptible to impingement. Duke Energy proposes no changes to the cooling system and no changes to the amount of cooling water withdrawals as part of SLR. Therefore, the NRC staff assume that the impingement AOI would remain the same during the proposed SLR term. The impingement AOI is considered further below as one component affecting the NRC staff's conclusion on impingement.

Impingement Studies

2006–2007 Impingement Mortality Characterization Study

ASA Analysis & Communication Inc. (ASA) conducted an impingement mortality characterization study at Oconee Station from September 2006 through August 2007. The results of this study are reported in Duke Energy's November 2020 CWA Section 316(b) compliance submittal to the SCDHEC[4] (Duke Energy 2022-TN8948), and the information in this section is derived from that source, unless otherwise cited.

During the study, researchers randomly sampled eight of Oconee Station's fixed screens during 24-hour periods for a total of 26 sampling events. Before sampling, the selected screens were raised and cleaned, then replaced and allowed to accumulate impinged fish during the sampling period. Researchers collected a total of 1,162 fish consisting of 11 species during the study. Threadfin shad was the most abundantly impinged species (849 individuals; 73.1 percent of the total impinged fish), followed by blueback herring (250 individuals; 21.5 percent) and bluegill (45 individuals; 3.9 percent). These three species accounted for approximately 98 percent of the total number of fish impinged. An additional 18 individuals of 8 species comprised the remaining 2 percent of the collections. Table 3-8 shows the taxa and relative abundance of fish collected during the study.

Table 3-8 Species Collected During Impingement Sampling at Oconee Station, South Carolina, 2006–2007

Taxa	Scientific Name	Common Name	Total Number	Percent Composition
Clupeidae	*Dorsoma petenense*	threadfin shad	849	73.1
Clupeidae	*Alosa aestivalis*	blueback herring	250	21.5
Centrarchidae	*Lepomis macrochirus*	bluegill	45	3.9
Centrarchidae	*Lepomis auritus*	redbreast sunfish	6	0.5
Centrarchidae	*Micropterus henshalli*	Alabama bass	4	0.3
Centrarchidae	*Micropterus coosae*	redeye bass	2	0.2
Centrarchidae	*Lepomis gulosus*	warmouth	1	0.1
Percidae	*Percina nigrofasciata*	blackbanded darter	2	0.2
Ictaluridae	*Ameiurus catus*	white catfish	1	0.1
Ictaluridae	*Pylodictis olivaris*	flathead catfish	1	0.1
Cyrprinidae	*Notemigonus crysoleucas*	golden shiner	1	0.1
Not Applicable	Not Applicable	**Total**	**1,162**	**100.0**

From its sampling results, ASA estimated annual impingement based on actual water withdrawals at Oconee Station. In 2016, estimated annual impingement was 46,437 fish; while in 2017, it was 45,399 fish. Approximately 95 percent of impingement mortality was of threadfin shad and blueback herring, both of which are fragile species according to the EPA's CWA 316(b) regulations. Excluding fragile species, impingement mortality was 2,037 fish in

2016 and 2,084 fish in 2017, or approximately 5.6 nonfragile fish per day in 2016 and 5.7 nonfragile fish per day in 2017.

Impingement rates did not appear to be influenced by water temperature, lake levels, or dissolved oxygen. Peak impingement occurred during a period of declining water temperatures from 83.1 to 61.8°F (28.4 to 16.6°C). Lake levels during peak impingement events were 3.5 to 4.3 ft (1 to 1.3 m) below full pond elevation.

The ASA assessed the impact of the study results in terms of "adverse environmental impact," which it defined as an unacceptable reduction in biological integrity as measured in terms of aquatic community species composition, diversity, and functional organization in Lake Keowee; or an unacceptable reduction in human use of the aquatic resources of Lake Keowee, especially fish opportunity or catch quantity or quality. ASA considered predicted future risks (prospective effects) and effects linked to present operation (retrospective effects) using a weight-of-evidence approach to determine the overall level of adverse environmental impact. ASA determined that Oconee Station operation is not causing adverse environmental impact in Lake Keowee based on the following[4] (Duke Energy 2022-TN8948):

- The number of fish lost to impingement is very small compared to the likely size of fish populations in Lake Keowee. For all but three species, impingement rates amounted to less than one fish per day. For bluegill, impingement rates were less than four fish per day, which is likely the daily harvest of a single recreational fisherman.
- The total recreational catch that could result from fish lost to impingement equates to an estimated 30 lb (14 kg) per year. Most of this lost catch would be composed of bluegill, and this level of harvest would be equivalent to the catch of a few fishermen.
- For threadfish shad and blueback herring—the two most abundant species—the total number impinged each year amounted to less than 0.7 percent of the lake population of each species. The total production foregone resulting from this loss was less than 1,600 lb (726 kg) per year of biomass. Threadfish shad and blueback herring are prolific spawners with high growth rates and short life spans, which allows each species to easily compensate for the relatively small impingement losses with no noticeable long-term effect.
- The estimated total economic value of fish impinged at Oconee Station is $369 per year. It is unlikely that the value exceeds $600 per year, with the uncertainty being taken into account. This value is extremely small in comparison to the total economic value of the recreational fishery in Lake Keowee.
- Species richness, species abundance, and trophic composition in Lake Keowee remain healthy and exhibit no long-term trends that can be attributed to Oconee Station operation.

Based on the above information, ASA concluded that there is no evidence of adverse environmental impact from impingement.

Historic Studies

In addition to the 2006–2007 impingement mortality characterization study, Duke Energy performed impingement studies from July 1974 through May 1975 and January through March 1990. These studies are described in the NRC staff's EIS for the initial license renewal of Oconee Station, and this information is incorporated herein by reference (NRC 1999-TN8942: Section 4.1.2, pp. 4-9–4-12). During that environmental review, the NRC staff found that impingement was not causing detectable population-level effects in Lake Keowee and that the impacts of impingement during the 20-year initial license renewal period would be SMALL.

With respect to shellfish, freshwater mussels do not appear to be susceptible to impingement at Oconee Station and have not been collected in any impingement studies. In the EIS for the initial license renewal of Oconee Station, the NRC staff (NRC 1999-TN8942) attributed this to a lack of endemic freshwater mussel populations in Lake Keowee.

Impingement Conclusion

The impingement AOI is an extremely small area, and only those impingeable-sized organisms that swim directly in front of the intake would experience intake velocities above 0.5 fps (0.15 m/s) where they would be susceptible to impingement.

Impingement mortality studies indicate that annual impingement at Oconee Station is low and confined to primarily three species. The two most abundantly impinged species, threadfish shad and blueback herring, are forage species whose populations are easily capable of recovering from losses caused by their prolific spawning and high growth rates. The third most abundantly impinged species is bluegill, which is recreationally important. However, impingement losses of bluegill equate to roughly the daily harvest of a single recreational fisherman. During the most recent impingement study conducted in 2006 and 2007, researchers identified no long-term trends in Lake Keowee's fish populations and no changes in the lake's species richness, species abundance, or trophic composition attributable to Oconee Station operation.

The impingement AOI, combined with the results of impingement mortality studies, do not reveal any noticeable or detectable impacts on the finfish populations of Lake Keowee attributable to impingement. Shellfish do not appear to be susceptible to impingement and are, therefore, unaffected by operation of the cooling water intake system.

Because water withdrawals, and the associated risk of impingement, would remain the same under the proposed action, the NRC staff anticipates similar (i.e., nondetectable) effects during the proposed SLR period. Further, the SCDHEC will make an impingement mortality BTA determination as part of issuing a renewed NPDES permit, which would likely be issued and take effect before the renewed operating license period begins. If the SCDHEC imposes any additional requirements beyond those contained in the current permit, those requirements would likely further reduce the impacts of impingement during the proposed SLR term, in accordance with CWA Section 316(b) requirements.

For the reasons described above, the NRC staff finds that the impacts of impingement of aquatic organisms resulting from the proposed SLR of Oconee Station would be SMALL.

3.7.4.1.2 Entrainment

Entrainment BTA

The SCDHEC has not made an entrainment BTA determination for Oconee Station. As discussed in Section 3.7.4.11 of this EIS, the SCDHEC is currently reviewing Duke Energy's 2013 renewal application along with its 2020 CWA Section 316(b) compliance submittal, so, the 2010 NPDES permit remains in effect until the SCDHEC completes its review.

As part of its 2020 CWA Section 316(b) compliance submittal, Duke Energy submitted to the SCDHEC analyses in support of a site-specific entrainment BTA determination. After considering the results of entrainment characterization studies and weighing the costs and benefits of certain entrainment reduction technologies, Duke Energy requested the SCDHEC's determination that the existing nuclear power plant configuration and operation is BTA for reducing entrainment. Duke Energy found the existing configuration to represent entrainment BTA for the following reasons:

- Entrainment under Oconee Station's current configuration with the existing curtain wall design is commensurate with entrainment reductions that might be achieved with installation of cooling towers.
- More than 98 percent of entrainment at Oconee Station is of fragile forage species in the Clupeidae family (e.g., blueback herring and threadfish shad), and entrainment primarily consist of blueback herring eggs. These species have high fecundity and high natural mortality, and entrainment is not expected to result in noticeable population-level impacts that would affect these species or other species that rely on them as prey.
- Fish community surveys document a balanced and indigenous fish community, and no federally threatened or endangered species or State-listed species occur in Lake Keowee.
- No freshwater mussels have been collected in entrainment studies, and entrainable-sized fish are not viable glochidia hosts. Therefore, entrainment has no effect on Lake Keowee's freshwater mussel populations.

As one component of issuing a renewed NPDES permit, the SCDHEC will make an entrainment BTA determination. If the SCDHEC finds that the current configuration of Oconee Station's cooling water intake structure is entrainment BTA, no further system modifications or upgrades would be necessary, and implementation would effectively be immediate. Alternatively, the SCDHEC may impose additional requirements to reduce or mitigate the effects of entrainment at Oconee Station. Such requirements would be incorporated as conditions of the renewed NPDES permit. The NRC staff assumes that any additional requirements that the SCDHEC imposes would minimize the impacts of entrainment over the course of the proposed SLR term in accordance with CWA Section 316(b) requirements.

However, because the SCDHEC's entrainment BTA determination is currently pending, the NRC staff also considers other lines of evidence below, including the entrainment AOI and results of entrainment studies, to more fully evaluate the magnitude of impact that entrainment would represent during the proposed SLR period.

Entrainment Area of Influence

In connection with Duke Energy's CWA Section 316(b) compliance submittal to the SCDHEC in 2020, HDR[4] (Duke Energy 2022-TN8948) evaluated the Oconee Station entrainment AOI. The entrainment AOI is the area within which plankton may be drawn into the intake rather than transported away in the ambient flow. For an organism to become entrained, it must enter the entrainment AOI of the cooling water intake system. Organisms within the AOI have a high probability of being withdrawn by the intake, but not all organisms within the AOI will be entrained. Actual entrainment will be the product of physical and biological factors that vary over space, time, and species. Physical and temporal factors that influence the AOI include (EPRI 2000-TN8459):

- speed, direction, and distribution of flow in the waters that surround the cooling water intake structure
- bathymetry of the surrounding waters
- intake flow rate and variability of flow to the intake
- design of the intake

Because of the the variability associated with these factors at Oconee Station, HDR[4] (Duke Energy 2022-TN8948) qualitatively, rather than quantitatively, evaluated the entrainment AOI. At Oconee Station, organisms first need to enter the intake canal to be susceptible to entrainment. As organisms travel down the intake canal, the likelihood of entrainment increases with proximity to the cooling water intake structure. However, the curtain wall installed at the entrance of the intake canal facilitates water withdrawal from the lower portion of the water column. Ichthyoplankton typically occur in the upper portion of the water column, so the curtain wall reduces the number of ichthyoplankton that enter the intake canal. An entrainment study conducted in 2016 and 2017 (discussed further below) found that ichthyoplankton densities on the intake side of the curtain wall were 76.6 percent lower than ichthyoplankton densities on the lake side. This indicates that the curtain wall is effective in limiting the number of Lake Keowee organisms susceptible to entrainment.

Entrainment Studies

2016–2017 Entrainment Characterization Study

The most recent entrainment characterization study at Oconee Station from March 2016 through October 2017 was conducted by HDR[4] (Duke Energy 2022-TN8948). During this period, researchers collected ichthyoplankton samples twice a month using a pumped sampling technique. Samples were collected on the upstream side of the cooling water intake structure at two depths: (1) just beneath the top of the curtain wall opening and (2) near the bottom of the intake. Samples were taken at 6-hour intervals to represent morning, day, evening, and night, for a total of four diel samples during each 24-hour sampling event. Each sample consisted of the organisms present in approximately 100 m^3 (3,500 ft^3) of water. In total, researchers collected 128 entrainment samples during 16 sampling events. All organisms in each sample were collected and preserved and then later processed in a laboratory for identification, enumeration, and further analysis.

A total of 176 ichthyoplankton from two taxonomic families: (1) Clupeidae (shads and (2) herrings) and Centrarchidae (sunfishes), were collected during the entrainment characterization study. Clupeidae species dominated samples from both years. In 2016, species belonging to family Clupeidae consisted of 98.8 percent of collected ichthyoplankton, and in 2017, Clupeidae consisted of 97.9 percent of collected ichthyoplankton. In both years, blueback herring was the species that dominated the total catch (92.7 and 78.7 percent of collected individuals in 2016 and 2017, respectively). The Clupeid group, identified as blueback herring, alewife, gizzard shad, or threadfin shad were the most prevalent taxa group, followed by the shad group, identified as gizzard shad or threadfin shad. A single sunfish identified to the genus *Lepomis* was collected in 2016. Samples collected in both years were predominantly eggs (92.7 and 86.2 percent in 2016 and 2017, respectively) followed by post yolk-sac larvae. Few yolk-sac and no young-of-year life stages were collected. Table 3-9 summarizes the composition and relative abundance of taxa collected during the study, and Table 3-10 summarizes the total numbers of ichthyoplankton collected by life stage.

Table 3-9 Composition and Relative Abundance of Taxa Collected in Entrainment Samples at Oconee Station, South Carolina, 2016–2017

Taxa	Common Name	Total No. Collected in 2016	Percent Total (for 2016)	Total No. Collected in 2017	Percent Total (for 2017)
Alosa aestivalis	blueback herring	76	92.7	74	78.7
Clupeidae	clupeid group[(a)]	3	3.7	12	12.8
Dorsoma spp.	Shad group[(b)]	2	2.4	6	6.4
Lepomis spp.	Sunfish species	1	1.2	–	–
unidentified species	unidentified species	–	–	2	2.1
Total	Not Applicable	**82**	**100**	**94**	**100**
Total Number of Unique Taxa Collected	Not Applicable	**3**	**100**	**2**	–

No table entry has been denoted by "–".
(a) Clupeid group consists of individuals identified as blueback herring, alewife or threadfin shad.
(b) Shad group consists of individuals identified as gizzard shad or threadfin shad.
Source: Duke Energy 2022-TN8948, Table 9-3.

Table 3-10 Total Number of Ichthyoplankton Collected by Life Stage in Entrainment Samples at Oconee Station, South Carolina, 2016–2017

Life Stage	Total No. Collected in 2016	Percent Total (for 2016)	Total No. Collected in 2017	Percent Total (for 2017)
egg	76	92.7	81	86.2
yolk-sac larvae	2	2.4	–	–
post yolk-sac larvae	2	2.4	8	8.5
unidentified larval stage	2	2.4	5	5.3
Total	**82**	**100**	**94**	**100**

No table entry has been denoted by "–".
Source: Duke Energy 2022-TN8948, Table 9-4.

In both sample years, most entrainment occurred in June and July. No entrainment occurred in March, April, May, or October 2016 or in September or October 2017. This seasonal pattern is consistent with other southeastern U.S. reservoirs containing landlocked blueback herring. Ichthyoplankton densities were highest during morning hours (0300–0900 hours) and lowest during the daytime (0900-1500 hours) in both sampling years. This pattern also likely correlates with the blueback herring spawning season. Females of this species broadcast spawn demersal, adhesive eggs at the surface of shallow, and fast-moving water along the shoreline of river tributaries. Blueback herring and other Clupeids have a relatively short egg incubation period and high fecundity (i.e., fertility). HDR found that the seasonal and diel collection distributions indicated that resident blueback herring likely occurred in the intake canal that were spawning near Oconee Station's intake. Any blueback herring in the intake canal are effectively lost to the population because they cannot reenter Lake Keowee once in the intake canal.

Estimates by HDR[4] (Duke Energy 2022-TN8948) showed that Oconee Station entrained an average of 36.8 million organisms annually based on actual withdrawal rates during the study period. Under maximum water withdrawal conditions, maximum average annual entrainment would be 37.5 million organisms. Based on these numbers, the NRC staff estimates that the loss of blueback herring eggs, which made up the majority of entrainment samples, would equate to the annual egg production of roughly 100 spawning females assuming a spawning rate of up to 350,000 eggs annually per female (FWS 2006-TN9698). The single sunfish ichthyoplankton sample collected in 2016 would equate to the loss of the annual egg production of roughly 16 spawning females per year assuming a spawning rate of up to 25,000 eggs annually per female (Morris et al. 2005-TN9697). As established in the discussion on impingement above, this would equate to approximately 4 days of a recreational fisherman's harvest (four fish per day). As a result of the study, HDR concluded that entrainment at Oconee Station is not anticipated to have an impact on population viability for any species in Lake Keowee.

2017 Curtain Wall Entrainment Reduction Performance Study

In connection with the entrainment characterization study, HDR[4] (Duke Energy 2022-TN8948) performed a curtain wall study from March through October 2017 to evaluate the extent to which the curtain wall reduces the number of economically valuable species and overall abundance of ichthyoplankton that enter the intake canal. Researchers collected ichthyoplankton samples from each side of the curtain wall once per month for a total of 64 samples. A total of 179 ichthyoplankton consisting of at least three distinct taxa representing two families were collected on both sides of the curtain wall. A higher number of ichthyoplankton were collected on the lake side (145 organisms) than on the intake side (34 organisms). Taxa on the lake side consisted of shads and herrings (81.4 percent), the shad group as either threadfin shad or gizzard shad (16.6 percent), and sunfishes (2 percent). The dominant taxa on the intake side were the herring group (61.7 percent), shads and herrings (26.4 percent), the shad group (5.9 percent), alewife (2.9 percent), and unidentified fish (2.9 percent). Only larval life stages were collected on the lake side, while eggs accounted for 65.0 percent of ichthyoplankton collected on the intake side. This indicates that spawning of resident fish within the intake canal are likely significant contributors to ichthyoplankton collected in this study and the entrainment study. Species diversity and life stages on both sides of the curtain wall were consistent with the results of the 2016–2017 entrainment characterization study. From the lake side of the curtain wall to the intake side of the curtain wall, HDR found that the curtain wall effectively reduced entrainment by 76 percent or more during the study period, and up to 89.7 percent during peak entrainment in April and May.

Historic Studies

The only other study that has been performed at Oconee Station to evaluate entrainment occurred in 1976. As with the study described above, this study evaluated the effectiveness of the curtain wall in reducing entrainment. The researchers concluded that the curtain wall was effective in reducing entrainment by excluding larval fish from entering the intake canal. The study found that the depth of the curtain wall opening in relation to the thermal and dissolved oxygen stratification in the source waterbody, was the key factor in reducing ichthyoplankton abundance on the intake side of the curtain wall. This study is described in the NRC staff's Supplemental EIS for the initial license renewal of Oconee Station, and this information is incorporated here by reference (NRC 1999-TN8942: Section 4.1.1, pp. 4-8 to 4-9).

Entrainment Conclusion

The entrainment AOI is confined to the intake canal. Organisms are not susceptible to entrainment until they pass through the curtain wall and enter the intake canal. As organisms travel through the intake canal, the likelihood of entrainment increases with proximity to the cooling water intake structure. Because the curtain wall causes the draw of water to be from the lower portion of the water column, it significantly limits susceptibility of Lake Keowee organisms to entrainment.

A study that examined the effectiveness of the curtain wall in reducing entrainment found that ichthyoplankton composition and density differs significantly from the lake side to the intake side of the curtain wall. The curtain wall effectively reduced entrainment by 76 percent or more during the study period, and up to 89.7 percent during peak entrainment in April and May. Only larval stages were collected on the lake side, while eggs predominated the collections on the intake side. This suggests that much of the entrainment occurring at Oconee Station is likely attributable to fish residing in the intake canal and that the curtain wall is effective at mitigating entrainment loss of ichthyoplankton from the lake itself. Fish within the intake canal cannot reenter the lake and are effectively lost to the population. Entrainment of ichthyoplankton originating from these individuals would therefore not affect Lake Keowee populations because there would be no way for these individuals or their offspring to interact with the lake population.

Entrainment studies indicate that a limited number of species are entrained at Oconee Station and that most entrainment is of blueback herring eggs. Estimated average annual losses of this species equate to the egg production of roughly 100 spawning females per year. Researchers attributed much of these losses to spawning females that inhabit the intake canal. As stated above, this entrainment would not affect the populations of this species in Lake Keowee. Ichthyoplankton of only one recreational taxa, a single individual in the sunfish family, appeared in entrainment study collections. Estimated average annual losses of sunfish equate to the egg production of roughly 16 spawning females per year. These losses are unlikely to noticeably affect sunfish populations within Lake Keowee.

The entrainment AOI, combined with the results of entrainment studies, do not reveal any noticeable or detectable impacts on the finfish populations of Lake Keowee attributable to impingement. Entrainable-sized fish are not viable glochidia hosts for freshwater mussels; therefore, entrainment has no effect on Lake Keowee’s shellfish populations.

Because water withdrawals, and the associated risk of entrainment, would remain the same under the proposed action, the NRC staff anticipates similar (i.e., non-detectable) effects during the proposed SLR period. Further, the SCDHEC will make an entrainment BTA determination as part of issuing a renewed NPDES permit. If the SCDHEC imposes any additional requirements beyond those contained in the current permit, those requirements would likely further reduce the impacts of entrainment over the course of the proposed SLR term, in accordance with CWA Section 316(b) requirements.

For the reasons described above, the NRC staff finds that the impacts of entrainment of aquatic organisms resulting from the proposed SLR of Oconee Station would be SMALL.

3.7.4.1.3 *Impingement and Entrainment Conclusion*

For the reasons summarized above under “Impingement Conclusion” and “Entrainment Conclusion,” the NRC staff concludes that the impacts of impingement and entrainment on aquatic organisms resulting from the proposed SLR of Oconee Station would be SMALL.

3.7.4.2 Entrainment of Phytoplankton and Zooplankton (All Plants)

This issue concerns entrainment of phytoplankton and zooplankton from cooling water withdrawal. Entrainment occurs when organisms pass through the cooling system's screening device and travel through the entire system, including the pumps, condenser or heat exchanger tubes, and discharge pipes (79 FR 48300-TN4488). Organisms susceptible to entrainment are of smaller size, such as ichthyoplankton, meriplankton, zooplankton, and phytoplankton. During travel through the cooling system, entrained organisms experience physical trauma and stress, pressure changes, excess heat, and exposure to chemicals (Mayhew et al. 2000-TN8458). Because entrainable organisms generally consist of fragile life stages (e.g., eggs, which exhibit poor survival after interacting with a cooling water intake structure, and early larvae, which lack a skeletal structure and swimming ability), the EPA has concluded that, for purposes of assessing the impacts of a cooling water intake system on the aquatic environment, all entrained organisms are assumed to die (79 FR 48300-TN4488). The NRC staff assesses the site-specific impacts of entrainment of fish and shellfish during the Oconee Station SLR term in Section 3.7.4.1 of this EIS.

Most nuclear power plants were required to monitor for entrainment effects during the initial years of operation. The effects of entrainment on phytoplankton and zooplankton are of SMALL significance if monitoring indicates no evidence that nuclear power plant operation has reduced or otherwise affected populations of these organisms in the source water body. The 2013 LR GEIS (NRC 2013-TN2654) summarizes the results of entrainment monitoring at several nuclear power plants. The 1996 LR GEIS (NRC 1996-TN288) and 2013 LR GEIS concluded that nuclear power plants had not noticeably altered phytoplankton or zooplankton abundance near these and other plants and that the impacts of initial license renewal would be similar and SMALL. In the 1999 Oconee Station LR Supplemental EIS (NRC 1999-TN8942), the NRC staff found no new and significant information concerning this issue, and the NRC staff adopted the 1996 LR GEIS's conclusion of SMALL for Oconee Station initial license renewal. In the following discussion, the NRC staff analyzes this issue on a site-specific basis for the Oconee Station SLR term, in accordance with CLI-22-02 and CLI-22-03.

Phytoplankton and zooplankton inhabiting Lake Keowee may be entrained into Oconee Station's once-through cooling water system. Section 3.7.4.1, subsection "Oconee Station Cooling Water Intake System" describes how entrainable organisms interact with the cooling system as Oconee Station withdraws water from the lake.

Researchers have conducted field studies to characterize the phytoplankton and zooplankton populations in Lake Keowee since 1973 (Duke Energy 2022-TN8899). In its environmental report, Duke Energy describes the most recent phytoplankton and zooplankton data, which researchers collected from 2006 through 2011. During this period, zooplankton densities and species diversity declined; however, Duke Energy attributed this shift to normal lake aging processes (Duke Energy 2021-TN8897; Duke Energy 2022-TN8899).

Entrainment AOI is an important factor in determining the potential impacts of entrainment on phytoplankton and zooplankton. As discussed in Section 3.7.4.1.2 the entrainment AOI is the area within which plankton may be drawn into the intake rather than transported away in the ambient flow. The design of Oconee Station's curtain wall, which lies at the entrance to the intake canal, causes the draw of water to be from the lower portion of the water column. Because phytoplankton reside in the upper water column to acquire light for photosynthesis, the curtain wall design is likely to significantly limit the number of phytoplankton that enter the intake canal and would then be susceptible to entrainment. Zooplankton, which prey on phytoplankton and each other, also typically occupy the upper water column and would, therefore, also be less likely to enter the intake canal where they would become entrained. The design of Oconee Station's cooling water intake structure would remain the same during the proposed SLR term. Therefore, the proportion of Lake Keowee's phytoplankton and zooplankton that would be susceptible to entrainment would remain very low.

Finfish monitoring also can provide insight into the health of Lake Keowee's phytoplankton and zooplankton communities. As described in Section 3.7.1.1, Duke Energy and State agencies periodically monitor Lake Keowee's fish populations. Results of this monitoring indicate that Lake Keowee's fish populations are healthy, and monitoring trends indicate no consistent upward or downward trends in finfish populations over several decades of monitoring. Although these studies do not directly gather information on phytoplankton and zooplankton, the NRC staff finds it reasonable to assume that entrainment is not affecting these communities to a degree that causes trophic cascade or monitoring would reveal downward trends of other shifts in the abundance and composition of finfish species that are primary consumers in the trophic structure.

The SLR would continue current operating conditions and environmental stressors conditions rather than introduce entirely new impacts. Therefore, the impacts of current operations and SLR on phytoplankton and zooplankton would be similar. For these reasons, the effects of entrainment of phytoplankton and zooplankton would be minor and would neither destabilize nor noticeably alter any important attribute of these populations during the SLR term. The NRC staff concludes that the impacts of entrainment of phytoplankton and zooplankton during the Oconee Station SLR term would be SMALL.

3.7.4.3 Thermal Impacts on Aquatic Organisms (Plants with Once-Through Cooling Systems or Cooling Ponds)

For nuclear power plants with once-through cooling systems, such as Oconee Station, the NRC has determined in the LR GEIS (NRC 2013-TN2654) that thermal impacts on aquatic organisms is a Category 2 issue that requires site-specific evaluation. In 1999, the NRC staff evaluated the thermal impacts of the Oconee Station initial license renewal on aquatic organisms under the issue "heat shock." The NRC staff determined that the impacts of continued operation of Oconee Station would be SMALL during the initial license renewal term (i.e., 2013–2033 for Units 1 and 2 and 2014–2034 for Unit 3) (NRC 1999-TN8942). In 2013, the NRC issued Revision 1 of the LR GEIS (NRC 2013-TN2654). In the revised LR GEIS, the staff renamed the issue of "heat shock" to "thermal impacts on aquatic organisms." The renaming did not affect the scope of the issue for license renewal. This section of the EIS evaluates thermal impacts on aquatic organisms as they apply to continued operation of Oconee Station during the proposed SLR term (i.e., 2033–2053 for Units 1 and 2 and 2034–2054 for Unit 3).

The primary form of thermal impact of concern at Oconee Station is heat shock. Heat shock occurs when water temperature meets or exceeds the thermal tolerance of an aquatic species for some duration of the exposure (NRC 2013-TN2654). In most situations, fish can avoid areas that exceed their thermal tolerance limits, although some aquatic species or life stages lack such mobility. Heat shock is typically observable only for fish because they tend to float when dead. In addition to heat shock, thermal plumes resulting from thermal effluent can create barriers to fish passage, which is of particular concern for migratory species. Thermal plumes can also reduce the available aquatic habitat or alter habitat characteristics in a manner that results in cascading effects on the local aquatic community.

Oconee Station Effluent Discharge

Oconee Station discharges heated effluent to the Keowee River arm of Lake Keowee just above the Lake Keowee dam through a submerged opening that is 25 to 40 ft (7.6 to 12 m) deep. Oconee Station's NPDES permit[6] (Duke Energy 2021-TN8897) designates this discharge point as Outfall 001. Discharges create a distinct but variable-sized thermal plume that is largest in the winter and smallest in the summer.

Duke Energy (2021-TN8898) monitors water temperatures at several Lake Keowee stations as part of its CWA Section 316(a) monitoring requirements imposed by the SCDHEC through the NPDES permit. The most recent CWA Section 316(a) demonstration report submitted to the SCDHEC covers the years 2006–2011. The closest station to the nuclear power plant's discharge is location 508, which is 656 ft (200 m) from Outfall 001. The annual maximum surface water temperatures at location 508 during this period ranged from 92.5°F (33.6°C) in 2009 to 94.8°F (34.9°C) in 2008. There were no instances when surface water temperatures exceeded the permitted thermal limits during the period and the reported surface water temperatures were similar to values reported in the previous two reports dated 1995 and 2007. Table 3-11 lists mean, median, minimum, and maximum recorded surface water temperatures at various Lake Keowee monitoring locations during the 2006–2011 period.

During the October 2021 environmental site audit, NRC staff reviewed interim surface water monitoring data for the period 2012–2019. Data from this period are similar to values reported during the 2006–2011 period.

Table 3-11 Lake Keowee Surface Water Temperature Characteristics by Location, 2006–2011

Location	Distance from Discharge (ft)	Distance from Keowee Dam (ft)	Mean Temperature (°F)	Median Temperature (°F)	Minimum Temperature (°F)	Maximum Temperature (°F)
508	656	984	78.3	74.8	57.4	94.8
504	2,625	656	76.5	73.9	57.6	93.7
504.5	2,953	1,312	73.6	73.8	57.7	91.8
505	14,764	15,748	74.5	73.8	54.1	91.6
502	16,076	17,717	72.3	72.1	50.0	89.2
506	33,465	32,808	73.8	73.9	52.3	90.3
501	46,916	48,556	70.9	71.6	46.8	89.2
507	50,525	49,869	68.4	70.5	48.4	85.6
500	65,617	67,257	70.7	71.2	46.4	89.2

°F = degree(s) Fahrenheit; ft = feet. To convert feet to meters, multiply by 0.3. To convert °F to degree(s) Celsius, subtract 32 and multiply by 5/9.
Source: Duke Energy 2021-TN8898, Table 2-4.

[6] [SCDHEC] South Carolina Department of Health and Environmental Control. 2010. National Pollutant Discharge Elimination System Permit for Discharge to Surface Waters, Duke Energy Carolinas LLC, Oconee Nuclear Station. Permit No.: SC0000515. Issued March 30, 2010. Effective May 1, 2010. 35 pp. In Attachment B of Duke Energy 2021-TN8897.

Clean Water Act of 1972 Section 316(a) Requirements for Point Source Discharges

CWA Section 316(a) addresses the adverse environmental impacts associated with thermal discharges into waters of the United States. This section of the act grants the EPA the authority to impose alternative, less-stringent, facility-specific effluent limits (called "variances") on the thermal component of point source discharges. To be eligible, facilities must demonstrate, to the satisfaction of the NPDES permitting authority, that facility-specific effluent limitations will ensure the protection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife in and on the receiving body of water. CWA Section 316(a) variances are valid for the term of the NPDES permit (i.e., 5 years). Facilities must reapply for variances with each NPDES permit renewal application. The EPA issued regulations under CWA Section 316(a) at 40 CFR 125, Subpart H (TN254).

Analysis Approach

When available, the NRC staff relies on the expertise and authority of the NPDES permitting authority with respect to thermal impacts on aquatic organisms. Therefore, if the NPDES permitting authority has made a determination under CWA Section 316(a) that thermal effluent limits are sufficiently stringent to ensure the protection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife in and on the receiving body of water, and the facility has implemented any associated requirements, then the NRC staff assumes that adverse impacts on the aquatic environment will be minimized (see 10 CFR 51.10(c) (TN250); 10 CFR 51.53(c)(3)(ii)(B); and 10 CFR 51.71(d)). In such cases, the NRC staff concludes that thermal impacts on aquatic organisms would be SMALL.

In cases in which the NPDES permitting authority has not granted a CWA Section 316(a) variance, the NRC staff analyzes the potential impacts of thermal discharges using a weight-of-evidence approach. In this approach, the staff considers multiple lines of evidence to assess the presence or absence of ecological impairment (i.e., noticeable or detectable impact) on the aquatic environment. For instance, as its lines of evidence, the staff might consider characteristics of the cooling water discharge system design, the results of thermal studies performed at the facility, and trends in fish and shellfish population abundance indices. The staff then considers these lines of evidence together to predict the level of impact (SMALL, MODERATE, or LARGE) that the aquatic environment is likely to experience during the proposed SLR term.

Baseline Condition of the Resource

For the purposes of this analysis, the NRC staff assumes that the baseline condition of the resource is the Lake Keowee aquatic community as it occurs today, which is described in Section 3.7.1 of this EIS. While species richness, evenness, and diversity within the community may change or shift between now and when the proposed SLR period would begin, the NRC staff finds the present aquatic community to be a reasonable surrogate in the absence of fishery and species-specific projections.

CWA 316(a) Thermal Variance

In 1977, Duke Energy submitted to the SCDHEC a comprehensive study that examined the effects of Oconee Station's heated effluent on the ecology of Lake Keowee. Based on the results of this study, the SCDHEC established alternative thermal limits to ensure the protection and propagation of a balanced, indigenous population of fish, shellfish, and wildlife in and on Lake Keowee. The SCDHEC incorporated the alternative thermal limits into the 1981 renewed NPDES permit (Duke Energy 2021-TN8897).

Since that time, Duke Energy has continued to collect physical, chemical, and biological monitoring data pursuant to NPDES permit requirements. Duke Energy has used this data to prepare CWA Section 316(a) demonstrations. The most recent CWA Section 316(a) demonstration[5] (Duke Energy 2021-TN8898) found that water quality and chemistry continued to provide a suitable aquatic habitat for a diverse biological community. Both phytoplankton and zooplankton populations remained diverse with no observable short- or long-term impacts attributable to Oconee Station operation. Fish species abundance and diversity did not differ between the thermal plume zone and other areas of the lake, indicating that thermal impacts on Lake Keowee's fish community are minimal.

With each NPDES permit renewal application, Duke Energy has requested, and the SCDHEC has granted, continuation of the CWA Section 316(a) variance. In the current NPDES permit[6] (Duke Energy 2021-TN8897), the CWA Section 316(a) variance appears in Part V, Condition E.9. The current NPDES permit also includes thermal limits for discharge from Outfall 001, the cooling system discharge, in Part III, Condition A.1. Table 3-12 summarizes these limits. The permit requires Duke Energy to sample temperatures at Outfall 001 hourly and report to the SCDHEC monthly. In its environmental report, Duke Energy states that the SCDHEC has issued no notices of violation concerning these thermal limits (Duke Energy 2021-TN8897).

In its 2013 NDPES permit renewal application[5] (Duke Energy 2021-TN8898), Duke Energy again requested continuance of the CWA Section 316(a) variance based on its 2013 CWA Section 316(a) demonstration[5] (Duke Energy 2021-TN8898), which concluded that "operation of Oconee Station appears to have little long-term impact on sportfish populations and that a balanced indigenous fish community exists in Lake Keowee." As part of its NPDES permit renewal application review, the SCDHEC will consider Duke Energy's request for continuance of the variance. The SCDHEC may determine that the original CWA Section 316(a) demonstration, paired with Duke Energy's continued temperature monitoring, is sufficient to ensure the protection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife in and on Lake Keowee. Alternately, the SCDHEC may require additional mitigation or monitoring in the renewed NPDES permit.

Table 3-12 Thermal Effluent Limitations at Oconee Station, South Carolina

Effluent Characteristics	Daily Maximum Temperature for Thermal Discharges
Temperature (effluent)[(a)]	100°F
Temperature (effluent)[(b)]	103°F
Temperature (difference)[(c)]	22°F

°F = degree(s) Fahrenheit. To convert °F to degree(s) Celsius, subtract 32 and multiply by 5/9.
(a) This limit applies, unless critical hydrological and meteorological conditions are combined with high customer demand, which cannot be met from other sources as determined by the System Operations Center.
(b) This limit applies only when critical hydrological and meteorological conditions are combined with high customer demand, which cannot be met from other sources as determined by the System Operations Center.
(c) This limit applies when the intake temperature is greater than 68°F. The temperature difference shall be determined by the effluent temperature minus the intake temperature.
Source: Duke Energy 2021-TN8897.[6]

<u>Thermal Impacts Conclusion</u>

Because the SCDHEC has granted Duke Energy multiple, sequential variances under CWA Section 316(a), the NRC staff finds that the adverse impacts on the aquatic environment associated thermal effluent are minimized. Because the characteristics of the thermal effluent would remain the same under the proposed action, the NRC staff anticipates similar effects during the proposed SLR period. Further, the SCDHEC will continue to review the CWA Section 316(a) variance with each successive NPDES permit renewal and may require additional mitigation or monitoring in a future renewed NPDES permit if it deems such actions to be appropriate to ensure the protection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife in and on Lake Keowee. The NRC staff assumes that any additional requirements that the SCDHEC imposes would further reduce the impacts of the Oconee Station thermal effluent during the proposed SLR term. For these reasons, the NRC staff finds that thermal impacts during the proposed SLR period would neither destabilize nor noticeably alter any important attribute of the aquatic environment and would, therefore, result in SMALL impacts on aquatic organisms.

3.7.4.4 Infrequently Reported Thermal Impacts (All Plants)

This issue concerns the infrequently reported effects of thermal effluents. These effects include cold shock, thermal migration barriers, accelerated maturation of freshwater aquatic insects, and proliferated growth of aquatic nuisance species.

Cold shock occurs when an organism has been acclimated to a specific water temperature or range of temperatures and is subsequently exposed to a rapid decrease in temperature. This can result in a cascade of physiological and behavioral responses and, in some cases, death (Donaldson et al. 2008-TN7515). Rapid temperature decreases may occur from either natural sources (e.g., thermocline temperature variation and storm events) or anthropogenic sources (e.g., thermal effluent discharges). The magnitude, duration, and frequency of the temperature change, as well as the initial acclimation temperatures of individuals, can influence the extent of the consequences of cold shock on fish and other aquatic organisms (Donaldson et al. 2008-TN7515). At nuclear power plants, cold shock could occur during refueling outages, reductions in power generation level, or other situations that would quickly reduce the amount of cooling capacity required at the nuclear power plant. Cold shock is most likely to be observable in the winter. The 1996 LR GEIS reports that cold shock events have only rarely occurred at nuclear power plants. Fish mortalities usually involved only a few fish and did not result in population-level effects. Gradual depowering or shutdown of nuclear power plant operations, especially in winter months, can mitigate the effects of cold shock.

Thermal effluents have the potential to create migration barriers if the thermal plume covers an extensive cross-sectional area of a river and temperatures within the plume exceed a species' physiological tolerance limit. This impact has been examined at several nuclear power plants, but it has not been determined to result in observable effects (NRC 1996-TN288, NRC 2013-TN2654).

The 1996 LR GEIS and 2013 LR GEIS also considered that the heated effluents of nuclear power plants could accelerate the maturation of aquatic insects in freshwater systems and cause premature emergence. The maturation and emergence of aquatic insects are often closely associated with water temperature regimes. If insects develop or emerge early in the season, they may be unable to feed or reproduce or they may die because the local climate is not warm enough to support them.

The 1996 LR GEIS and 2013 LR GEIS also considered that heated effluents could proliferate the growth of aquatic nuisance organisms. Aquatic nuisance species are organisms that disrupt the ecological stability of infested inland (e.g., rivers and lakes), estuarine, or marine waters (EPA 2022-TN7519). The LR GEISs discuss the zebra mussel (*Dreissena polymorpha*) and

Asiatic clam (*Corbicula fluminea*), two bivalves that are of particular concern in many freshwater systems because they can cause significant biofouling of industrial intake pipes at power and water facilities. These species are also of ecological concern because they outcompete and lead to the decline of native freshwater mussels. Nuclear power plants that withdraw water from water bodies in which these species are known to occur often periodically chlorinate intake pipes or have other procedures in place to mitigate the spread of these bivalves. There is no evidence, however, that thermal effluent leads to these species' proliferation.

The 1996 LR GEIS (NRC 1996-TN288) and the 2013 LR GEIS (NRC 2013-TN2654) concluded that these infrequently reported thermal impacts would be SMALL during the initial license renewal term. The 1996 LR GEIS evaluated these concerns as five issues; the 2013 LR GEIS consolidated them into one issue. In the 1999 Oconee Station LR Supplemental EIS (NRC 1999a), the NRC staff found no new and significant information concerning these issues, and the NRC staff adopted the 1996 LR GEIS's conclusion of SMALL for Oconee Station initial license renewal. In the following discussion, the NRC staff analyzes this issue on a site-specific basis for the Oconee Station SLR term, in accordance with CLI-22-02 and CLI-22-03.

With respect to cold shock, no such events have been reported at Oconee Station (Duke Energy 2022-TN8899). Therefore, cold shock is not expected to be of concern for the Oconee Station SLR term.

With respect to thermal migration barriers, this issue is not relevant to Oconee Station because Oconee Station's thermal effluent discharges to a lake. While there is a distinct thermal plume (see Section 3.7.4.3), the NRC staff do not expect it to negatively impact migration of fish because the plume only occurs within a small area of Lake Keowee (i.e., diameter of about 3 mi [about 5 km]) and fish can freely swim around and away from the thermal plume.

Regarding accelerated maturation of freshwater aquatic insects or proliferated growth of aquatic nuisance species, the 2013 LR GEIS describes that in the early 1980s, oligochaete numbers increased in the vicinity of Oconee Station's thermal effluent discharge; however, researchers were unable to directly link these changes with increased water temperatures near the discharge. In its environmental report, Duke Energy (Duke Energy 2022-TN8899) reports that while nuisance species exist in Lake Keowee (e.g., Asian clams, hydrilla, common carp, or green sunfish), none have proliferated to levels requiring Duke Energy to take invasive species control actions. Additionally, the NRC staff identified no information indicating that Oconee Station's thermal effluent may specifically contribute to the enhanced growth or survival of these species.

The SLR term would continue current operating conditions and environmental stressors rather than introduce entirely new impacts. Therefore, the impacts of current operations and SLR would be similar. For these reasons, infrequently reported thermal impacts would be minor and would neither destabilize nor noticeably alter any important attribute of aquatic ecosystems during the SLR term. The NRC staff concludes that infrequently reported thermal impacts on aquatic resources during the Oconee Station SLR term would be SMALL.

3.7.4.5 Effects of Cooling Water Discharge on Dissolved Oxygen, Gas Supersaturation, and Eutrophication

This issue concerns the effects of thermal effluents on dissolved oxygen, gas supersaturation, and eutrophication. Because nuclear power plant effluents are heated, discharged water can change certain biological conditions in the receiving water body in a manner that affects the characteristics of that habitat and the potential suitability of that habitat for local fish, shellfish, and other aquatic organisms.

Aerobic organisms, such as fish, require oxygen, and the concentration of dissolved oxygen in a water body is one of the most important ecological water quality parameters. Dissolved oxygen also influences several inorganic chemical reactions. In general, dissolved oxygen concentrations of less than 3 parts per million (ppm) in warmwater habitats or less than 5 ppm in coldwater habitats can adversely affect fish (Morrow and Fischenich 2000-TN7351). Oxygen dissolves into water via diffusion, aeration, and as a product of photosynthesis. The amount of oxygen water can absorb depends on temperature; the amount of oxygen that can dissolve in a volume of water (i.e., the saturation point) is inversely proportional to the temperature of the water. Thus, when other chemical and physical conditions are equal, the warmer the water is, the less dissolved oxygen it can hold. Increased water temperatures also affect the amount of oxygen that aquatic organisms need due to increase in metabolic rates and chemical reaction rates. The rates of many chemical reactions in water approximately double for every 18°F (10°C) increase in temperature.

The thermal effluent discharges of nuclear power plants have the potential to stress aquatic organisms by simultaneously increasing these organisms' need for oxygen and decreasing oxygen availability. Aquatic organisms are more likely to experience adverse effects from thermal effluents in ecosystems where dissolved oxygen levels are already approaching suboptimal levels from other factors in the environment. This is most likely to occur in ecosystems where increased levels of detritus and nutrients (e.g., eutrophication), low flow, and high ambient temperatures already exist. These conditions can occur from drought conditions or in hot weather, especially in lakes, reservoirs, or other dammed freshwater.

Although the thermal effluents of nuclear power plants may contribute to reduced dissolved oxygen in the immediate vicinity of the discharge point, as the effluent disperses, diffusion and aeration from turbulent movement introduce additional oxygen into the water. As the water cools, the saturation point increases, and the water can absorb additional oxygen as it is released by aquatic plants and algae through photosynthesis, which is a continuously ongoing process during daylight hours. Therefore, lower dissolved oxygen is generally only a concern within the thermal mixing zone, which is typically a small area of the receiving water body. Many States address thermal mixing zones in State water quality criteria to ensure that mixing zones provide a continuous zone of passage for aquatic organisms. Additionally, the EPA, or authorized States and Tribes, often imposes conditions specifically addressing dissolved oxygen through NPDES permits to ensure that receiving water bodies maintain adequate levels of oxygen to support aquatic life. These conditions are established pursuant to CWA Section 316(a), which requires that regulated facilities operate under effluent limitations that ensure the protection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife in and on the receiving water body.

Rapid heating of cooling water can also affect the solubility and saturation point of other dissolved gases, including nitrogen. As water passes through the condenser cooling system, it can become supersaturated with gases. Once the supersaturated water is discharged in the receiving water body, dissolved gas levels equilibrate as the effluent cools and mixes with ambient water. This process is of concern if aquatic organisms remain in the supersaturated effluent for a long enough period to become equilibrated to the increased pressure associated with the effluent. If these organisms then move into water of lower pressure too quickly when, for example, swimming out of the thermal effluent or diving to depths, the dissolved gases within the affected tissues may come out of solution and cause embolism (bubbles in the circulatory system). The resulting condition is known as gas bubble disease. In fish, it is most noticeable in the eyes and fins. Affected tissues can swell or hemorrhage and result in behavioral abnormalities, increased susceptibility to predation, or death. Mortality in fish generally occurs at gas supersaturation levels above 110 or 115 percent (EPA 1986-TN7726). Aquatic insects and crustaceans appear to be more tolerant of supersaturated water (Nebeker et al. 1981-TN7725).

The ability to detect and avoid supersaturated waters varies among species. A fish can avoid supersaturated waters by either not entering the affected area or by diving to avoid the onset of supersaturated conditions near the surface. Some species, however, may not avoid supersaturated waters until symptoms of gas bubble disease occur; at that point, some fish may already be lethally exposed. Other species may be attracted to supersaturated waters because it is often warmer (Gray et al. 1983-TN7727).

The 1996 LR GEIS and 2013 LR GEIS report cases of fish mortality from gas bubble disease at hydroelectric dams and coal-fired power plants. Typically, gas bubble disease is of concern at facilities where the configuration of the discharge allows organisms to reside in the supersaturated effluent for extended periods of time (e.g., discharge canals that fish can freely enter). However, fish mortality from gas bubble disease has been observed in only one instance in the mid-1970s at a nuclear power plant that is no longer operating.

An early concern about nuclear power plant discharges was that thermal effluents would cause or speed eutrophication by stimulating biological productivity in receiving water bodies (NRC 1996-TN288). Eutrophication is the gradual increase in the concentration of phosphorus, nitrogen, and other nutrients in a slow-flowing or stagnant aquatic ecosystem, such as a lake. These nutrients enter the ecosystem primarily through runoff from agricultural land and impervious surfaces. The increase in nutrient content allows algae to proliferate on the water’s surface, which reduces light penetration and oxygen absorption necessary for underwater life. The 1996 LR GEIS reports that several nuclear power plants conducted long-term monitoring to investigate this potential effect. No evidence of eutrophication was detected.

The 1996 LR GEIS (NRC 1996-TN288) and the 2013 LR GEIS (NRC 2013-TN2654) concluded that the effects of cooling water discharge on dissolved oxygen, gas supersaturation, and eutrophication would be SMALL during the initial license renewal term. The 1996 LR GEIS evaluated these concerns as three issues; the 2013 GEIS consolidated them into one issue. In the 1999 Oconee Station LR Supplemental EIS (NRC 1999-TN8942), the NRC staff found no new and significant information concerning these issues, and the NRC staff adopted the 1996 LR GEIS’s conclusion of SMALL for Oconee Station initial license renewal. In the following discussion, the NRC staff analyzes this issue on a site-specific basis for the Oconee Station SLR term, in accordance with CLI-22-02 and CLI-22-03.

With respect to dissolved oxygen, since 1977, Duke Energy has collected physical, chemical, and biological monitoring data pursuant to NPDES permit requirements and used this data to prepare CWA Section 316(a) demonstration reports that show that the alternative thermal limits established by the SCDHEC for Oconee Station’s thermal effluents ensure the protection and propagation of a balanced, indigenous population of fish, shellfish, and wildlife in and on Lake Keowee (see Section 3.7.4.2). With each NPDES permit renewal application, Duke Energy has requested, and the SCDHEC has granted, continuation of the CWA Section 316(a) variance. The most recent CWA Section 316(a) demonstration report that covers the years 2006–2011 shows that the dissolved oxygen levels nearby the discharge location and elsewhere in Lake Keowee have been above the SCDHEC’s water quality criteria of a 5 mg/L daily average and a low of 4 mg/L (Duke Energy 2021-TN8898). Because SLR would continue current operating conditions and the site's NPDES permit would continue requiring minimum levels of and monitoring for dissolved oxygen, reduced dissolved oxygen resulting from Oconee Station's thermal effluent is not expected to be of concern during the SLR period.

With respect to gas supersaturation, Duke Energy has not reported any instances of fish kills at Oconee Station or any other information indicating that fish may have experienced symptoms of gas bubble disease (Duke Energy 2021-TN8898). As described above, gas supersaturation has only been reported at one nuclear power plant that is no longer in service. Because SLR would continue current operating conditions, gas supersaturation resulting from Oconee Station's thermal effluent is not expected to be of concern during the SLR period.

With respect to eutrophication, the main concern would be the death and decomposition of algal (phytoplankton) blooms that would reduce dissolved oxygen. As discussed above, eutrophication has not been a concern because dissolved oxygen levels have remained above SCDHEC thresholds (i.e., 5 mg/L daily average and a low of 4 mg/L) (SCDHEC 2014-TN6986). Duke Energy's most recent CWA Section 316(a) demonstration report analyzes phytoplankton abundances and trends (via chlorophyll α levels) near the thermal effluent discharge and elsewhere in Lake Keowee from 1994–2011 (Duke Energy 2022-TN8899). All chlorophyll α samples during this time period were within the State water quality standard of 40 µg/L, and chlorophyll α levels were similar near the discharge and elsewhere in the lake. Eutrophication is not expected to be a concern during the SLR period because the SLR would continue current operating conditions and eutrophication has not been a problem in the past.

The SLR would enable the continuation of current operating conditions and environmental stressors rather than introduce entirely new impacts. Therefore, the impacts of current operations and SLR on aquatic resources would be similar. For these reasons, the effects of cooling water discharge on dissolved oxygen, gas supersaturation, and eutrophication would be minor and would neither destabilize nor noticeably alter any important attribute of aquatic ecosystems during the SLR term. The NRC staff concludes that the impacts of cooling water discharge on dissolved oxygen, gas supersaturation, and eutrophication during the Oconee Station SLR term would be SMALL.

3.7.4.6 Effects of Nonradiological Contaminants on Aquatic Organisms

This issue concerns the potential effects of nonradiological contaminants on aquatic organisms that could occur as a result of nuclear power plant operations. This issue was originally of concern because some nuclear power plants used heavy metals in condenser tubing that could leach from the tubing and expose aquatic organisms to these contaminants. Because aquatic organisms can bioaccumulate heavy metals, even when exposed at low levels, this can cause toxicity in fish and other animals that consume contaminated organisms. Section 3.9.2 of the 2013 LR GEIS (NRC 2013-TN2654) describes instances in which copper contamination was an issue at operating nuclear power plants. Heavy metals have not been found to be of concern other than in these few instances. In all cases, the nuclear power plants eliminated leaching by replacing the affected piping, and these changes were implemented during the initial operating license terms. The NRC staff has not identified this issue to be of concern during any license renewal reviews to date.

The 1996 LR GEIS (NRC 1996-TN288) and the 2013 LR GEIS (NRC 2013-TN2654) concluded that the effects of nonradiological contaminants on aquatic organisms would be SMALL during the initial license renewal term. In the 1999 Oconee Station LR Supplemental EIS (NRC 1999-TN8942), the NRC staff did not identify any nonradiological contamination impacts beyond what was discussed in the 1996 LR GEIS (NRC 1996-TN288). In the following discussion, the NRC staff analyzes this issue on a site-specific basis for the Oconee Station SLR term, in accordance with CLI-22-02 and CLI-22-03.

Oconee Station's NPDES permit establishes nonradiological pollutant discharge limits, and it requires Duke Energy to monitor and report the concentrations of these contaminants that are discharged to Lake Keowee with the thermal effluent. Currently, Duke Energy uses no biocides in the cooling water system, and the NPDES permit would require Duke Energy to seek approval if Duke Energy were to do so in the future. With respect to storm water pollution, Duke maintains a SWPPP as a requirement of the NPDES permit. Duke Energy routes stormwater and any spills from operations to chemical treatment ponds in the wastewater treatment system. Duke Energy discharges effluent from this system at Outfall 002 in accordance with NPDES permit requirements (Duke Energy 2021-TN8897). Section 3.5.1.3 of this EIS describes one NOV and two self-reported wastewater events. In all instances, Duke Energy identified that it took action to remedy the issue and minimize environmental impacts of the spills and that the SCDHEC required no further action.

As explained in Section 3.7.1.2 of this EIS, the SCDHEC has issued consumption advisories for certain fish because of mercury concentrations. However, Oconee Station is not the source of this contamination. During the most recent NPDES permit renewal in 2010, SCDHEC evaluated whether it should include discharge limits for certain metals, including mercury, in the renewed permit. The SCDHEC opted not to include such limits because it determined that there was no reasonable potential for Oconee Station to contribute to water quality violation for metals (Duke Energy 2022-TN8899).

Duke Energy has complied with their NPDES permit requirements for nonradiological contamination and will be required to in the future by the SCDHEC. Any violations must be reported to the SCDHEC and are subject to investigation and potential mitigation actions.

The SLR would continue current operating conditions and environmental stressors rather than introduce entirely new impacts. Therefore, the impacts of current operations and SLR on aquatic resources would be similar. For these reasons, the effects of nonradiological contaminants on aquatic organisms would be minor and would neither destabilize nor noticeably alter any important attribute of aquatic resources during the SLR term. The NRC staff concludes that the impacts of nonradiological contaminants on aquatic organisms during the Oconee Station SLR term would be SMALL.

3.7.4.7 Exposure of Aquatic Organisms to Radionuclides

This issue concerns the potential impacts on aquatic organisms from exposure to radionuclides from routine radiological effluent releases. As explained in Sections 2.1.4 and 3.5.2, radionuclides may be released from nuclear power plants into the environment through several pathways, including via gaseous and liquid emissions. Aquatic plants can absorb radionuclides that enter shallow groundwater or surface waters through their roots. Aquatic animals can be exposed externally to ionizing radiation from radionuclides in water, sediment, and other biota and can be exposed internally through ingested food, water, and sediment and absorption through the integument and respiratory organs.

As explained in Section 3.6.4.2, the DOE has produced a standard for a graded approach to evaluating radiation doses to aquatic and terrestrial biota (DOE 2019-TN6817). The DOE standard provides methods, models, and guidance that can be used to characterize radiation doses to terrestrial and aquatic biota exposed to radioactive material (DOE 2019-TN6817). For aquatic animals, the DOE guidance dose rate is 1 rad/d (0.1 Gy/d), which represents the level below which no adverse effects on resident populations are expected. The DOE also recommends that the screening-level concentrations of most radionuclides in aquatic environments be based on internal exposure as well as external exposure to contaminated sediments, rather than external exposure to contaminated water (DOE 2019-TN6817).

Previously, in the early 1990s, the International Atomic Energy Agency (IAEA) (IAEA 1992-TN712) and the National Council on Radiation Protection and Measurements (NCRP 1991-TN729) had also concluded that a chronic dose rate of no greater than 1 rad/d (0.01 Gy/d) to the maximally exposed individual in a population of aquatic organisms would ensure protection of the population. The United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) concluded in 1996 and re-affirmed in 2008 that chronic dose rates of less than 0.4 mGy/hr (1.0 rad/day or 0.01 Gy/day) to the most highly exposed individuals would be unlikely to have significant effects on most aquatic communities (UNSCEAR 2010-TN7974).

In the 2013 LR GEIS (NRC 2013-TN2654), the NRC staff adopted the DOE's standard on a graded approach for evaluating radiation doses to terrestrial and aquatic biota (DOE 2019-TN6817). In addition, the NRC estimated the total radiological dose that aquatic biota would be expected to receive during normal nuclear power plant operations using plant-specific radionuclide concentrations in water and sediments at 15 nuclear power plants using Argonne National Laboratory's RESRAD-BIOTA dose evaluation model. The NRC found that total calculated dose rates for aquatic organisms at all 15 plants was all less than 0.2 rad/d (0.002 Gy/d), which is less than the DOE guideline value of 1 rad/d (0.01 Gy/d). As a result, the NRC anticipated in the 2013 LR GEIS that normal operations of these facilities would not result in negative effects on aquatic biota. The 2013 LR GEIS concluded that the impact of radionuclides on aquatic biota from past operations would be SMALL for all nuclear power plants and would not be expected to change appreciably during the initial license renewal period.

The NRC staff neither evaluated the exposure of aquatic organisms to radionuclides during the initial license renewal period in the 1999 Oconee Station LR Supplemental EIS (NRC 1999-TN8942) nor was it addressed in the 1996 LR GEIS. However, the 2013 LR GEIS later addressed this issue generically for initial license renewal of all nuclear power plants and concluded that impacts would be SMALL. In the following discussion, the NRC staff analyzes this issue on a site-specific basis for the Oconee Station SLR term, in accordance with CLI-22-02 and CLI-22-03.

As discussed in Section 2.1.4 of this EIS, the NRC requires nuclear power plants to maintain a radiological environmental monitoring program (REMP) through its regulations at 10 CFR Part 50, Appendix I (TN249), 10 CFR Part 20 (TN283), and 10 CFR Part 72 (TN4884), and through plant-specific technical specifications. These collectively require that licensees establish and implement a REMP to obtain data on measurable levels of radiation and radioactive material. The NRC staff provides guidance to licensees on acceptance methods for establishing and conducting REMPs in Regulatory Guide 4.1 (NRC 2009-TN3802).

Duke Energy's REMP measures the aquatic, terrestrial, and atmospheric environment for ambient radiation and radioactivity. Monitoring is conducted for the following: direct radiation, air, precipitation, well water, river water, surface water, milk, food products and vegetation (such as edible broad leaf vegetation), fish, silt, and shoreline sediment. The REMP also measures background radiation (i.e., cosmic sources, global fallout, and naturally occurring radioactive material, including radon. As part of its environmental review, the NRC staff reviewed the past five years of REMP reports (Duke Energy 2017-TN9157, TN9158, TN9159, TN9160, TN9160). A 5-year period provides a dataset that covers a broad range of activities that occur at a nuclear power plant, such as refueling outages, routine operation, and maintenance that can affect the generation and release of radioactive effluents into the environment. During this period, Duke Energy collected 12 to 15 fish per year for gamma spectroscopy testing. All tested samples were below reportable limits for radionuclides in environmental samples.

The NRC regulations require nuclear power plants to monitor radiation in the environment and to report the results of such monitoring to the NRC through a REMP. Maintaining REMP monitoring ensures that levels of radiation are below regulatory limits and that any changes in radionuclide concentrations are detected and addressed. To date, Duke Energy has not detected levels of radioactivity attributable to Oconee Station operations that would result in measurable radiological impacts on aquatic organisms.

The SLR would continue current operating conditions and environmental stressors rather than introduce entirely new impacts. Therefore, the impacts of current operations and SLR on aquatic resources would be similar. For these reasons, the effects of radionuclides on aquatic organisms would be minor and would neither destabilize nor noticeably alter any important attribute of aquatic resources during the SLR term. The NRC staff concludes that the impacts of radionuclides on aquatic organisms during the Oconee Station SLR term would be SMALL.

3.7.4.8 Effects of Dredging on Aquatic Organisms

This issue concerns the effects of dredging at nuclear power plants on aquatic resources. Small-particle sediment, such as sand and silt, that enters water bodies through erosion can subsequently deposit and accumulate along shorelines and in shallow water areas. If sediment deposition affects cooling system function or reliability, a nuclear power plant may need to periodically dredge to improve intake flow and keep the area clear of sediment. Nuclear power plants where dredging may be necessary are typically located along fast-flowing waters with sandy or silty bottoms, such as large rivers or the ocean. In some instances, dredging may be performed to maintain barge slips for transport of materials and waste to and from the site. Dredging entails excavating a layer of sediment from the affected areas and transporting that sediment to onshore or offshore areas for disposal. The three main types of dredges are mechanical dredges, hydraulic dredges, and airlift dredges. The selection of dredge type generally is related to the sediment type, the size of the area to be dredged, and the aquatic resources present. At operating nuclear power plants, dredging is performed infrequently, if at all.

In the 1999 Oconee Station LR Supplemental EIS (NRC 1999-TN8942), the NRC staff did not consider dredging because Duke Energy did not anticipate that dredging would be required during the Oconee Station initial license renewal period. The 2013 LR GEIS (NRC 2013-TN2654) analyzed the effects of dredging on aquatic organisms as a new issue and concluded that the effects of this issue would be SMALL during the initial license renewal term for all nuclear power plants. In the following discussion, the NRC staff analyzes this issue on a site-specific basis for the Oconee Station SLR term, in accordance with CLI-22-02 and CLI 22-03.

Duke Energy (TN8897) anticipates no dredging as part of Oconee Station SLR term. Therefore, there would be no impacts on aquatic resources. If Duke Energy determines at a future date that dredging is necessary, Duke Energy would be required to obtain permits from the USACE under CWA Section 404. BMPs and conditions associated with these permits would minimize impacts on the ecological environment. The granting of such permits would also require the USACE to conduct environmental reviews prior to undertaking dredging. The NRC staff expects that Duke Energy would continue to implement site environmental procedures and would obtain any necessary permits for future dredging activities, if determined necessary. Implementation of such controls would further reduce or mitigate potential effects.

The SLR would continue current operating conditions and environmental stressors rather than introduce entirely new impacts. Therefore, the impacts of current operations and SLR on aquatic resources would be similar. Dredging is not expected during the SLR, and if it were, Duke Energy would need to obtain the necessary permits and implement environmental procedures. For these reasons, the effects of dredging on aquatic resources would be minor and would neither destabilize nor noticeably alter any important attribute of aquatic resources during the SLR term. The NRC staff concludes that the effects of dredging on aquatic resources during the Oconee Station SLR term would be SMALL.

3.7.4.9 Effects on Aquatic Resources (Non-cooling System Impacts)

This issue concerns the effects of nuclear power plant operations on aquatic resources during SLR that are unrelated to operation of the cooling system. Such activities include landscape and grounds maintenance, stormwater management, and ground-disturbing activities that could directly disturb aquatic habitat or cause runoff or sedimentation. These impacts are expected to be like past and ongoing impacts that aquatic resources are already experiencing at the nuclear power plant site.

The 1996 LR GEIS (NRC 1996-TN288) and the 2013 LR GEIS (NRC 2013-TN2654) concluded that the non-cooling system impacts on aquatic resources would be SMALL during the initial license renewal term. In the 1996 LR GEIS, the NRC evaluated the impacts of refurbishment on aquatic resources. In the 2013 LR GEIS, the NRC expanded this issue to include impacts of other site activities, unrelated to cooling system operation, that may affect aquatic resources. In the 1999 Oconee Station LR Supplemental EIS (NRC 1999-TN8942), the NRC staff found no new and significant information concerning this issue, and the NRC staff adopted the 1996 LR GEIS's conclusion of SMALL for Oconee Station initial license renewal. In the following discussion, the NRC staff analyzes this issue on a site-specific basis for the Oconee Station SLR term, in accordance with CLI-22-02 and CLI-22-03.

Regarding ground disturbance, Duke Energy does not plan on any refurbishment or construction activities for the proposed SLR term (Duke Energy 2021-TN8897) that would impact aquatic habitats. If Duke Energy determines that ground disturbance is needed, Duke Energy indicates that it would acquire the necessary permits. For instance, ground disturbance of over one acre would require a stormwater permit from the SCDHEC that would specify BMPs to reduce erosion and sedimentation of onsite waters). Duke Energy's Shoreline Management Plan (Duke Energy 2014-TN9131) addresses these same issues along the Lake Keowee shoreline (Duke Energy 2021-TN8897).

With respect to stormwater management, stormwater runoff from impervious surfaces can change the frequency or duration of inundation and soil infiltration within wetlands and neighboring terrestrial habitats. The effects of stormwater runoff may include erosion, altered hydrology, sedimentation, and other changes in nuclear power plant community characteristics. Runoff may contain sediments, contaminants and oils from road or parking surfaces, or herbicides.

Duke Energy’s SWPPP identifies BMPs to prevent or reduce soil erosion (see Sections 3.4.3 and 3.5.1 of this EIS). In addition, sumps capture liquid spills and stormwater runoff from operational areas and divert it to chemical treatment ponds. Duke Energy monitors discharges from this wastewater treatment system at Outfall 002 in accordance with the NPDES permit. Duke Energy also maintains a chemical control program designed to reduce contamination risks, such as the frequency and severity of oil spills. Collectively, these measures ensure that the effects on aquatic resources from pollutants carried by stormwater would be minimized during the SLR term (Duke Energy 2021-TN8897).

The SLR would continue current operating conditions and environmental stressors rather than introduce entirely new impacts. Therefore, the impacts of current operations and SLR on aquatic resources would be similar. For these reasons, the non-cooling system impacts on aquatic resources would be minor and would neither destabilize nor noticeably alter any important attribute of aquatic resources during the SLR term. The NRC staff concludes that the non-cooling system impacts on aquatic resources during the Oconee Station SLR term would be SMALL.

3.7.4.10 Impacts of Transmission Line Right-of-Way (ROW) Management on Aquatic Resources

This issue concerns the effects of transmission line ROW management on aquatic plants and animals. Transmission line management can directly disturb aquatic habitats if ROWs traverse aquatic features and heavy machinery are used in these areas. Heavy equipment can also compact soils, which can affect soil quality and reduce infiltration to shallow groundwater, resulting in runoff and erosion in nearby aquatic habitats. Chemical herbicides applied in ROWs can be transported to nearby aquatic habitats through precipitation and runoff. For small streams, trees may grow sufficiently between cutting cycles to provide shading and support microhabitats. Tree removal to maintain appropriate transmission line clearance could alter the suitability of habitats for fish and other aquatic organisms and locally increase water temperatures.

The 1996 LR GEIS (NRC 1996-TN288) and the 2013 LR GEIS (NRC 2013-TN2654) concluded that the impacts of transmission line ROW management on aquatic resources would be SMALL during the initial license renewal term. In the 1999 Oconee Station LR Supplemental EIS (NRC 1999-TN8942), the NRC staff found no new and significant information concerning this issue, and the NRC staff adopted the 1996 LR GEIS’s conclusion of SMALL for Oconee Station initial license renewal. In the following discussion, the NRC staff analyzes this issue on a site-specific basis for the Oconee Station SLR term, in accordance with CLI-22-02 and CLI-22-03.

As described in Section 3.6.4, which discusses the impacts of transmission line ROW maintenance on terrestrial resources, the transmission lines within the scope of the Oconee Station SLR review are contained within the industrial use portion of the site. Since these lines do not cross any natural areas, vegetation management is not required. Therefore, maintenance of these lines has no discernible effect on ecological resources.

The SLR would continue current operating conditions and environmental stressors rather than introduce entirely new impacts. Therefore, the impacts of current operations and SLR would be similar for aquatic resources. For these reasons, the effects of transmission line ROW maintenance on aquatic resources would be minor and would neither destabilize nor noticeably alter any important attribute of plant or animal populations during the SLR term. The NRC staff concludes that the impacts of transmission line ROW maintenance on aquatic resources during the Oconee Station SLR term would be SMALL.

3.7.4.11 Losses from Predation, Parasitism, and Disease Among Organisms Exposed to Sublethal Stresses

This issue concerns the effects of nuclear power plant operation that can increase the susceptibility of aquatic organisms to predation, parasitism, and disease. Such sublethal effects can result from impingement, if an organism is subsequently returned to the source water body, as well as from exposure to thermal effluents. This issue does not apply to entrainment. Because entrainable organisms generally consist of fragile life stages, all entrained organisms are assumed to die (79 FR 48300-TN4488) and would, therefore, not survive entrainment to subsequently experience sublethal effects.

The 1996 LR GEIS (NRC 1996-TN288) and the 2013 LR GEIS (NRC 2013-TN2654) concluded that the losses from predation, parasitism, and disease among organisms exposed to sublethal stresses would be SMALL during the initial license renewal term. In the 1999 Oconee Station LR Supplemental EIS (NRC 1999-TN8942), the NRC staff found no new and significant information concerning this issue, and the NRC staff adopted the 1996 LR GEIS's conclusion of SMALL for Oconee Station initial license renewal. In the following discussion, the NRC staff analyzes this issue on a site-specific basis for the Oconee Station SLR term, in accordance with CLI-22-02 and CLI-22-03.

<u>Sublethal Effects of Impingement</u> The EPA's 2014 CWA Section 316(b) regulations establish BTA standards for impingement mortality. Impingement mortality considers the survival rate of impinged organisms, rather than simply the total number of organisms impinged. Survival studies typically consider latent mortality associated with stunning, disorientation, or injury. Such effects can result from the injury itself or from increased susceptibility to predation, parasitism, or disease that results from the sublethal effects of impingement.

As explained in Section 3.7.3, the Oconee Station intake system does not include a fish return system, and Duke Energy has no plans to alter the design or function of the cooling system under the proposed action. Therefore, all impingement would result in mortality, and the issue of sublethal effects from impingement does not apply to Oconee Station.

<u>Sublethal Effects of Thermal Effluents</u> Fish and shellfish that are exposed to the thermal effluent of a nuclear power plant may experience stunning, disorientation, or injury. These sublethal effects can subsequently affect an organism's susceptibility to predation, parasitism, or disease.

With respect to susceptibility to predation, laboratory studies of the secondary mortality of fish following exposure to heat or cold shock demonstrate increased susceptibility of these fish to predation; however, field evidence of such effects is often limited to anecdotal information, such as observations of increased feeding activity of seagulls and predatory fish near effluent outfalls (e.g., Cada et al. 1981-TN7733). For example, Barkley and Perrin (1971-TN7734) and Romberg et al. (1974-TN7891) reported increased concentration of predators feeding on forage fish attracted to thermal plumes. However, these studies did not quantify whether the observed behaviors resulted in population-level effects on prey species.

With respect to susceptibility to parasitism and disease, Langford (1983-TN7676) found that the tendency for fish to congregate in heated effluent plumes, the increased physiological stress that higher water temperatures exert on fish, and the ability of some diseases and parasites to proliferate at higher temperatures were all factors that could contribute to increased rates of disease or parasitism in exposed fish. Some studies have suggested that crowding of fish within the thermal plume, rather than the thermal plume itself, may lead to an increased risk of exposure to infectious diseases (Coutant 1987-TN7736).

The 1996 and 2013 LR GEISs reported that neither scientific literature reviews nor consultations with agencies or utilities yielded clear evidence of nuclear power plant operation causing sublethal effects that result in noticeable increases in the susceptibility of exposed organisms to predation, parasitism, or disease. Duke Energy (TN8897, TN8899) reports no evidence of such effects, and Duke Energy's continued adherence to its CWA Section 316(a) variance would ensure that such effects would be minimized.

The SLR would continue current operating conditions and environmental stressors rather than introduce entirely new impacts. Therefore, the impacts of current operations and SLR would be similar. For these reasons, losses from predation, parasitism, and disease among organisms exposed to sublethal stresses would be minor and would neither destabilize nor noticeably alter any important attribute of aquatic populations during the SLR term. The NRC staff concludes that the impacts of losses from predation, parasitism, and disease among organisms exposed to sublethal stresses during the Oconee Station SLR term would be SMALL.

3.7.5 No-Action Alternative

If Oconee Station were to permanently cease operating, impacts on the aquatic environment would decrease or stop following reactor shutdown. Some withdrawal of water from Lake Keowee would continue during the shutdown period to provide cooling to spent fuel in the spent fuel pool until that fuel could be transferred to dry storage. The amount of water withdrawn for this purpose would be a small fraction of water withdrawals during operations, would decrease over time, and would likely end within the first several years following shutdown. The reduced demand for cooling water would substantially decrease the effects of impingement, entrainment, and thermal effluent on aquatic organisms, and these effects would entirely cease following the transfer of spent fuel to dry storage. Effects from cold shock would be unlikely, given the small area of Lake Keowee affected by thermal effluent under normal operating conditions, combined with the phased reductions in withdrawal and discharge of lake water that would occur following shutdown.

Based on the above, the NRC staff concludes that the impacts of the no-action alternative on aquatic resources would be SMALL.

3.7.6 Replacement Power Alternatives: Common Impacts

Construction impacts for many components of the replacement power alternatives would be qualitatively and quantitatively similar. Construction could result in aquatic habitat loss, alteration, or fragmentation; disturbance and displacement of aquatic organisms; mortality of aquatic organisms; and increase in human access. For instance, construction-related chemical spills, runoff, and soil erosion could degrade water quality in Lake Keowee, its tributaries, or the Keowee River by introducing pollutants and increasing sedimentation and turbidity. Dredging and other in-water work could directly remove or alter the aquatic environment and disturb or kill aquatic organisms. Because construction effects would be short term, associated habitat degradation would be relatively localized and temporary. Effects could be minimized by the use of existing infrastructure, such as the Oconee Station intake and discharge systems for those alternatives that would make use of the existing site, as well as the use of existing transmission lines, roads, parking areas, and certain existing buildings and structures. Aquatic habitat alteration and loss could be minimized by siting components of the alternatives farther from waterbodies and away from drainages and other aquatic features.

Water quality permits required through Federal and State regulations would control, reduce, or mitigate potential effects on the aquatic environment. Through such permits, the permitting agencies could include conditions requiring Duke Energy to follow BMPs or to take certain mitigation measures if adverse impacts are anticipated. For instance, USACE oversees CWA Section 404 permitting for dredge and fill activities, and the SCDHEC oversees NPDES permitting and general stormwater permitting. Duke Energy would likely be required to obtain each of these permits to construct a new replacement power alternative on the Oconee Station site. Notably, the EPA final rule under Phase I of the CWA Section 316(b) regulations applies to new facilities and sets standards to limit intake capacity and velocity to minimize impacts on fish and other aquatic organisms in the source water (40 CFR Part 125-TN254). Any new replacement power alternative subject to this rule would be required to comply with the associated technology standards.

With respect to operation of a new replacement power alternative, operational impacts for the replacement power alternatives would be qualitatively similar but would vary in intensity, based on each alternative's water use and consumption. Each alternative would use mechanical draft cooling towers to dissipate waste heat. The NRC staff analyzed the impacts of operating cooling tower nuclear power plants on the aquatic environment in the LR GEIS (NRC 2013-TN2654) and determined that operation of nuclear facilities with cooling towers would result in SMALL impacts on the aquatic environment, including those impacts resulting from impingement, entrainment, and thermal effluents. These results are caused by the relatively low volume of make-up water withdrawal for nuclear power plants with a cooling tower system and the minimal heated effluent that would be discharged. The same would be true of nonnuclear facilities, such as the NGCC alternative, which would also use mechanical draft cooling towers but would consume significantly less water during operations.

3.7.7 New Nuclear (Advanced Light-Water Reactor and Small Modular Reactor) Alternative

The NRC staff evaluated the impacts of the ALWR portion of this alternative in its 2013 final EIS for the proposed W.S. Lee Nuclear Station, Units 1 and 2 (NRC 2013-TN6435). The NRC staff concluded that construction of the cooling water reservoir required to supply water to the cooling system would result in MODERATE impacts on the aquatic environment. To create the reservoir, London Creek and portions of its tributaries would be impounded. Impacts on streams and open water would occur because of excavation of borrow material, placement of fill and spoil material, building of new haul roads, and temporary flooding associated with the use of cofferdams. Impounding London Creek and building a make-up water supplemental reservoir would replace a lotic system with a lentic system, resulting in a clearly noticeable and permanent change in aquatic resources in London Creek and its tributaries. Some of the upper reaches of tributaries to London Creek not impounded would retain their lotic characteristics, but they would become isolated from other lotic habitats. Most of the riparian habitat of the main-stem London Creek would be lost.

Operational impacts of the ALWR portion of this alternative would be SMALL (NRC 2013-TN6435). Cooling towers would be operated with low through-screen velocity (less than 0.5 fps [0.15 m/s]), a fish return system, and would be located in deep-water areas away from primary fish spawning and rearing habitat. Effluent discharge would be controlled by an NPDES permit that would minimize adverse impacts on aquatic life.

With respect to the SMR portion of this alternative, the types of impacts that the aquatic environment would experience are characterized in the previous section discussing impacts common to all replacement power alternatives. In that section, construction impacts are sufficiently addressed as they would apply to the new nuclear alternative. Based on that discussion, the NRC staff finds that the impacts of construction on aquatic resources would be

SMALL because construction effects would be of limited duration, the new nuclear power plant would use some of the existing site infrastructure and buildings, and required Federal and State water quality permits would likely include conditions requiring BMPs and mitigation strategies to minimize environmental effects.

With respect to operation of the SMR portion of this alternative, Federal and State water quality permits would control and mitigate many of the potential effects on the aquatic environment, including water withdrawal and discharge, such that the associated effects would be unlikely to noticeably alter or destabilize any important attribute of the aquatic environment. Therefore, the NRC staff finds that the impacts of operation on aquatic resources would be SMALL.

Based on the above, the NRC staff concludes that the impacts on aquatic resources from a new nuclear alternative would be MODERATE during construction and SMALL during operation.

3.7.8 Natural Gas Combined-Cycle Alternative

The types of impacts that the aquatic environment would experience from this alternative are characterized in the previous section discussing impacts common to all replacement power alternatives. This alternative would also involve the construction of a new pipeline and associated utility corridors that would run approximately 21 mi (34 km) to connect with existing gas service to the southeast in Centerville, South Carolina. This pipeline would cross several streams and tributaries. Implementation of BMPs would minimize potential effects to waterways, drainage areas, or other isolated aquatic features that may be present. The NRC staff finds that the impacts of construction on aquatic resources would be SMALL because construction effects would be of limited duration, the natural gas combined-cycle alternative would use some of the existing site infrastructure and buildings and required Federal and State water quality permits would likely include conditions requiring BMPs and mitigation strategies to minimize environmental effects.

With respect to operation, Federal and State water quality permits would control and mitigate many of the potential effects on the aquatic environment, including water withdrawal and discharge, such that the associated effects would be unlikely to noticeably alter or destabilize any important attribute of the aquatic environment. Therefore, the NRC staff finds that the impacts of operation on aquatic resources would be SMALL.

Based on the above, the NRC staff concludes that the impacts on aquatic resources from construction and operation of a natural gas alternative would be SMALL.

3.7.9 Combination Alternative (Solar PV, Offshore Wind, Small Modular Reactor, and Demand-Side Management)

The types of impacts that the aquatic environment would experience from the SMR portion of the combination alternative are characterized in Sections 3.7.6 and 3.7.7 discussing impacts common to all alternatives and impacts of the new nuclear alternative. Construction and operation impacts of this portion of the combination alternative would be qualitatively similar. Because the nuclear portion of the combination alternative would involve construction and operation of a smaller SMR facility, less cooling water would be required, which would result in fewer impacts on the aquatic environment. Therefore, the NRC staff finds that the impacts of construction and operation of the SMR portion of the combination alternative on aquatic resources would be SMALL.

Impacts of constructing the solar PV portion of the combination alternative are also addressed in Section 3.7.6 under impacts common to all alternatives. These impacts would be SMALL to MODERATE, depending on the site(s) selected, the aquatic habitats present, and the extent to which construction would degrade, modify, or permanently alter those habitats. Operation of the solar PV portion would have no discernable effects on the aquatic environment.

The impacts of constructing the offshore wind component of this alternative would include increased turbidity, noise, vibration, and other physical disturbances to the aquatic environment from pile-driving, turbine construction, and submarine power cable installation. Cable installation could disturb large spans of aquatic habitat and would be especially detrimental to nearshore and estuarine habitats used by early life stages of finfish and shellfish. Dredging would likely be necessary in some areas to prepare for cable installation and would result in destruction of the existing benthic habitat and temporary habitat loss until the benthic community could repopulate the area. Increased vessel anchoring during survey activities, construction, installation, and maintenance would increase turbidity and disturb the benthic environment. Accidental releases of contaminants from fuel and chemical spills would also pose a hazard to the aquatic environment and would be especially detrimental to nearshore, estuarine, and unique or sensitive habitats (BOEM 2020-TN7494). As explained under the discussion of impacts common to all alternatives, water quality permits required through Federal and State regulations would control, reduce, or mitigate potential effects on the aquatic environment. Through such permits, the permitting agencies could include conditions requiring Duke Energy to follow BMPs or to take certain mitigation measures if adverse impacts are anticipated. The impacts of construction of the offshore wind component of this alternative on aquatic resources would likely be MODERATE to LARGE, depending on the sensitivity and uniqueness of the particular aquatic habitats affected.

During operation of the offshore wind component of this alternative, fuel and chemical spills would remain a potential hazard. The presence of permanent structures could lead to impacts on finfish and aquatic invertebrates through entanglement from gear loss, hydrodynamic disturbance, fish aggregation, habitat conversion, and migration disturbances. These impacts may arise from buoys, meteorological towers, foundations, scour/cable protection, and transmission cable infrastructure. However, structure-oriented or hard-bottom species could benefit from the new structures because they would have new material or substrate to anchor themselves upon and build colonies (BOEM 2020-TN7494). The impacts of operation of this component of the alternative on aquatic resources would be SMALL to MODERATE, depending on the effectiveness of the measures implemented to control accidental releases of contaminants or to clean up such releases if they occur.

The demand-side management component would have no discernable effects on the aquatic environment.

The NRC staff concludes that the impacts on aquatic resources from construction and operation of a combination alternative would be MODERATE to LARGE during construction and SMALL to MODERATE during operation. The higher magnitude of potential impacts experienced by the aquatic environment is primarily attributable to the offshore wind component of the alternative.

3.8 Special Status Species and Habitats

The NRC must consider the effects of its actions on ecological resources protected under several Federal statutes and must consult with the FWS or the National Oceanic and

Atmospheric Administration (NOAA) prior to taking action in cases where an agency action may affect those resources. These statutes include the following:

- Endangered Species Act of 1973, as amended (ESA) (16 U.S.C. § 1531 et seq.-TN1010)
- Magnuson–Stevens Fisheries Conservation and Management Act (MSA) of 1996 as amended by the Sustainable Fisheries Act of 1996 (16 U.S.C. § 1801 et seq.-TN7841)
- National Marine Sanctuaries Act (NMSA) (16 U.S.C. § 1431 et seq.-TN7197)

This section describes the species and habitats that are federally protected under these statutes and analyzes how the proposed SLR and alternatives may affect these resources.

3.8.1 Endangered Species Act

Congress enacted the ESA in 1973 to protect and recover imperiled species and the ecosystems upon which they depend. The ESA provides a program for the conservation of endangered and threatened plants and animals (collectively, "listed species") and the habitats in which they are found. The FWS and National Marine Fisheries Service (NMFS) are the lead Federal agencies for implementing the ESA, and these agencies are charged with identifying species that warrant listing. The following sections describe the Oconee Station action area and the species and habitats that may occur in the action area under each of the Services' jurisdictions.

3.8.1.1 Endangered Species Act: Action Area

The implementing regulations for Section 7(a)(2) of the ESA define "action area" as all areas affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02-TN4312). The action area effectively bounds the analysis of federally listed species and critical habitats because only species and habitats that occur within the action area may be affected by the Federal action.

For the purposes of assessing the potential impacts of Oconee Station SLR on federally listed species, the NRC staff considers the action area to consist of the following.

<u>Oconee Station Site</u>: The terrestrial region of the action area consists of the 510 ac (206 ha) Oconee Station site in Oconee County, South Carolina. Lake Keowee occupies the area immediately north and west of the site. The majority (60.8 percent) of the Oconee Station site is developed. Deciduous, evergreen, and mixed forests occupy 17.4 percent of the site, while the remaining 21.8 percent comprises of grasslands, pastures, wetlands, barren land, and open water. Section 3.2 and Section 3.6 of this EIS describe the developed and natural features of the site and the characteristic vegetation and habitats.

<u>Lake Keowee</u>: The aquatic region of the action area encompasses the impingement AOI (described in Section 3.7.4.1 of this EIS), the entrainment AOI (described in Section 3.7.4.1 of this EIS), and the area of the Lake Keowee that experiences increased temperatures from discharge of heated effluent (described in Section 3.7.4.2 of this EIS).

The NRC staff recognizes that, although the described action area is stationary, federally listed species can move in and out of the action area. For instance, a migratory bird could occur in the action area seasonally as it forages or breeds within the action area. Thus, in its analysis, the NRC staff considers not only those species known to occur directly within the action area but those species that may passively or actively move into the action area. The NRC staff then considers if the life history and habitat requirements of each species make it likely to occur in the action area where it could be affected by the proposed SLR. The following sections first discuss listed species and critical habitats under FWS jurisdiction, followed by those under NMFS jurisdiction.

3.8.1.2 Endangered Species Act: Federally Listed Species and Critical Habitats under U.S. Fish and Wildlife Service Jurisdiction

This section evaluates nine species, eight of which are listed and one of which is proposed for listing under the ESA, that may be present in the action area. The NRC staff determined these species to be relevant to this review based on desktop analysis of the Oconee Station action area, available scientific literature and studies, and the results of past ESA Section 7 consultations in connection with the Oconee Station site. Table 3-13 lists each of these species and its federal status. No designated or proposed critical habitat occurs in the action area.

Table 3-13 Federally Listed Species Under U.S. Fish and Wildlife Service Jurisdiction Evaluated for Oconee Station Subsequent License Renewal

Common Name	Species	Federal Status[(a)]
monarch butterfly	*Danaus plexippus*	FC
Indiana bat	*Myotis sodalis*	FE
northern long-eared bat	*Myotis septentrionalis*	FE
tricolored bat	*Perimyotis subflavus*	FPE
bog turtle	*Clemmys muhlenbuergii*	FT
persistent trillium	*Trillium persistens*	FE
small whorled pogonia	*Isotria medeoloides*	FT
smooth coneflower	*Echinacea laevigata*	FT
dwarf-flowered heartleaf	*Hexastylis naniflora*	FT
mountain sweet pitcher-plant	*Sarracenia rubra* ssp. *jonesii*	FE

(a) Indicates protection status under the Endangered Species Act. FC = candidate for federal listing; FE = federally endangered; FPE = proposed for Federal listing as endangered; and FT = federally threatened.

During the NRC staff's environmental review for the 1999 initial license renewal, the staff evaluated the effects of Oconee Station operation on several federally listed species that occur within Oconee County. These species were the Indiana bat (*Myotis sodalis*), persistent trillium (*Trillium persistens*), small whorled pogonia (*Isotria medeoloides*), and smooth coneflower (*Echinacea laevigata*). The staff also evaluated the bald eagle and peregrine falcon (*Falco perengrinus*), both of which the FWS has since delisted. In its biological assessment, the NRC (NRC 1999-TN8964) concluded that license renewal would have no effect on all these species, except for the smooth coneflower, for which the NRC concluded "not likely to adversely affect" because ROW vegetation management would maintain open prairie habitat, and such management would be beneficial to this species, if present. The FWS (1999-TN9002, 1999-TN9003) concurred with these determinations. Notably, this consultation also addressed several species that had the potential to inhabit approximately 330 mi (530 km) of ROWs associated with offsite transmission lines. For the current proposed action of SLR, all offsite transmission lines that distribute power to or from Oconee Station would remain energized regardless of whether Oconee Station operates for an additional 20 years. Therefore, offsite transmission lines are not within the action area for SLR.

During preparation of its SLR application, Duke Energy coordinated with the FWS pursuant to the ESA in 2019 and 2020 (Duke Energy 2021-TN8897). In a November 18, 2019 letter, the FWS (FWS 2019 in Duke Energy 2021-TN8897) stated that no federally protected threatened or endangered species or designated critical habitats occur within the action area or within 6 mi (10 km) of the Oconee Station site. In April 2020, Duke Energy (Duke Energy 2021-TN8897) met with the FWS, and the FWS confirmed that this determination remained valid.

During its environmental review for the proposed SLR, the NRC staff reviewed the previously discussed information as well as records in the FWS's Environmental Conservation Online System Information for Planning and Conservation (IPaC) database and available ecological surveys. The IPaC database identified seven federally listed species under FWS jurisdiction that may be present in the Oconee Station action area: northern long-eared bat (*Myotis septentrionalis*), bog turtle (*Clemmys muhlenbuergii*), dwarf-flowered heartleaf (*Hexastylis naniflora*), mountain sweet pitcher-plant (*Sarracenia rubra* ssp. *jonesii*), persistent trillium, small whorled pogonia, and smooth coneflower (FWS 2023-TN9004). Additionally, the FWS proposed to list the tricolored bat (*Perimyotis subflavus*) as endangered in 2022 and the monarch butterfly (*Danaus plexippus*) became a candidate species (FWS 2023-TN9004). The database identified no candidate species or critical habitats (proposed or designated) within the Oconee Station action area. As explained below, available information suggests that no federally listed species are likely to be present in the action area; however, the tricolored bat has been identified in acoustic surveys conducted on the site.

The northern long-eared bat is present but uncommon in the Blue Ridge province portions of Oconee, Pickens, and Greenville counties in western South Carolina. However, the Oconee Station action area is too low in elevation based on records of the species from western South Carolina (Webster 2013-TN8968). In a 2013 mammalian survey associated with the Federal Energy Regulatory Commission's license renewal of the Keowee-Toxaway Project, researchers determined that the northern long-eared bat was not present in the area (Webster 2013-TN8968). In a 2015 acoustic bat survey associated with the Oconee Station independent spent fuel storage expansion, researchers recorded 253 bat call sequences over 45 night hours of acoustic monitoring. These calls were identified as eastern red bat (*Lasiurus borealis*), little brown bat (*Myotis lucifugus*), tricolored bat (*Perimyotis subflavus*), big brown bat (*Eptesicus fuscus*), and hoary bat (*Lasiurus cinereus*) (Duke Energy 2018-TN8965). The northern long-eared bat was not recorded, and researchers determined that the species is unlikely to be present (Duke Energy 2018-TN8965).

Bog turtles in South Carolina are part of the southern population, which is federally listed as threatened because of similarity of appearance to bog turtles found in northern states (i.e., Connecticut, Delaware, Maryland, Massachusetts, New Jersey, New York, and Pennsylvania), which are listed as threatened. This designation bans the collection and interstate and international commercial trade of bog turtles from the southern population but has no effect on land management activities by private landowners within the southern population range. The FWS also considers the southern population of bog turtles as a Federal species of concern because of habitat loss. Bog turtles are associated with wetlands and herbaceous sedge meadows or fens with thickly vegetated or wooded borders. They are known to occur in Pickens County, South Carolina, but the species has not been observed near the Oconee Station site (FERC 2016-TN8967).

With respect to the listed plant species, researchers identified no suitable habitat for such species in a 2013 botanical field survey associated with the Federal Energy Regulatory Commission's license renewal of the Keowee-Toxaway Project (Gaddy 2013-TN8969). In its

ER, Duke Energy (TN8897) states that its shoreline management plan would ensure that Duke Energy takes the appropriate actions to protect federally listed species at its nuclear power plants if any were to be identified on the Oconee Station site in the future.

Based on the above information, the NRC staff finds that no federally listed species or designated critical habitats under FWS jurisdiction occur in the action area. The monarch butterfly, a candidate species, and the tricolored bat, a proposed species that is known to occur in the action area, are discussed in detail below.

Monarch Butterfly

The monarch butterfly is a candidate for Federal listing. In 2020, the FWS issued a 12-month finding announcing its intent to prepare a proposed rule to list the monarch as threatened (85 FR 81813-TN8590). In 2022, the FWS identified the monarch listing action as a priority because the magnitude of threats is moderate to low, however those threats are imminent for the eastern and western North American populations. Although the ESA does not require consultation for candidates, the NRC considers this species here at the recommendation of the FWS (2023-TN9004) in its IPaC report for the proposed project. Information in this section is drawn from the FWS's candidate review unless otherwise cited (87 FR 26152-TN8591).

The monarch is a large butterfly with bright orange wings and black veining and borders. During the breeding season, females lay eggs on milkweed (primarily *Asclepias* spp.). Developing larvae feed on milkweed, which allows them to sequester toxic chemicals as a defense against predators, before pupating into a chrysalis to transform into the adult butterfly form. Monarchs produce multiple generations each breeding season, and most adult butterflies live two to five weeks. Overwintering adults, however, enter reproductive diapause and live six to nine months.

Monarch butterflies occur in 90 countries, islands, or island groups. Monarch butterflies have become naturalized at most of these locations outside of North America since 1840. The populations outside of eastern and western North America (including southern Florida) do not exhibit long-distance migratory behavior. In many regions, monarchs breed year-round. In temperate climates, such as eastern and western North America, monarchs migrate long distances and live for an extended period. In the fall, in both eastern and western North America, monarchs begin migrating to their respective overwintering sites in the forests of California and Mexico. These overwintering sites provide protection from the elements and moderate temperatures, as well as nectar and clean water sources located nearby. Migrations can be of distances of over 1,900 mi (3,000 km) and span a two-month period. In early spring (February–March), surviving monarchs break diapause and mate at overwintering sites before dispersing. The same individuals that undertook the initial southward migration begin flying back through the breeding grounds and their offspring start the cycle of generational migration over again.

Factors Affecting the Species

The primary threats to the monarch's biological status include loss and degradation of habitat from conversion of grasslands to agricultural land, widespread use of herbicides, logging/thinning at overwintering sites in Mexico, senescence and incompatible management of overwintering sites in California, urban development, drought, exposure to insecticides, and effects of climate change.

Occurrence Within the Action Area

Monarchs are associated with prairie, meadow, and grassland habitats. Within Ohio, 13 native milkweed species provide habitat for the development of monarch eggs and larvae, the most prevalent of which is the common milkweed (*Asclepias syriaca*). It is unknown whether milkweed occurs on the Oconee Station site, although grasslands within the action area are undeveloped and would remain undisturbed during the proposed license renewal period. The NRC staff conservatively assumes that monarchs could occur in the action area during spring and fall migration when individuals are moving between areas of more suitable habitat. Accordingly, the staff assesses the potential impacts of the proposed action on this species in Section 3.8.4 of this EIS.

<u>Tricolored Bat (Perimyotis subflavus)</u>

The FWS issued a proposed rule to list the tricolored bat as endangered in 2022 (87 FR 56381-TN8546). The FWS proposed no critical habitat with the rule because it found that such a designation could increase the degree of threat to the species. Information in this section is drawn from the FWS's species status assessment (FWS 2021-TN8589) unless otherwise cited.

The tricolored bat is a small insectivorous bat that is distinguished by its unique tricolored fur, which often appears yellowish to nearly orange. The species occurs across 39 states in the eastern and central United States and in portions of southern Canada, Mexico, and Central America. During the winter, tricolored bats are often found in caves and abandoned mines. In the southern United States, where caves are sparse, tricolored bats also roost in road culverts where they exhibit shorter hibernation bouts and may leave hibernacula to forage during warm nights. Tricolored bats hibernate singly, but sometimes in pairs or in small clusters of both sexes away from other bats. Between mid-August and mid-October, males and females converge at cave and mine entrances to swarm and mate, and females typically give birth to two young between May and July.

Tricolored bats disperse from winter hibernacula to summer roosting habitat in the spring. Tracking studies have recorded migration paths that span from 27 mi (44 km) to 151 mi (243 km). During the spring, summer, and fall, tricolored bats occupy forested habitats. Individuals roost among leaves of live or recently dead deciduous hardwood trees, but individuals may also roost in pines (*Pinus* spp.), eastern red cedar (*Juniperus virginiana*), Spanish moss (*Tillandsia usneoides*), *Usnea trichodea* lichen, and occasionally human-made structures. Tricolored bats are opportunistic feeders and consume small insects including caddisflies (Trichoptera), flying moths (Lepidoptera), small beetles (Coleoptera), small wasps and flying ants (Hymenoptera), true bugs (Homoptera), and flies (Diptera).

Factors Affecting the Species

Tricolored bats face extinction primarily due to the rangewide impacts of whitenose syndrome, a deadly disease affecting cave-dwelling bats. The FWS estimates that white-nose syndrome has caused population declines of 90 percent or more in affected tricolored bat colonies across most of the species' range.

Occurrence Within the Action Area

As described previously in this section, the tricolored bat was identified in a 2015 acoustic bat survey to be associated with the Oconee Station independent spent fuel storage expansion

(Duke Energy 2018-TN8965). Therefore, the species is known to occur within the action area. The NRC staff assumes that deciduous forest habitat within the action area, which covers 50 ac (20 ha), could support foraging, mating, and sheltering in the spring, summer, and fall. Accordingly, the staff assesses the potential impacts of the proposed action on this species in Section 3.8.4.1 of this EIS.

Summary of Potential Species Occurrences in the Action Area

Table 3-14 below summarizes the potential for each federally listed species discussed in this section to occur in the action area. As explained in the beginning of this section, no proposed or designated critical habitat occurs in the action area.

Table 3-14 Occurrences of Federally Listed Species Under U.S. Fish and Wildlife Service Jurisdiction in the Oconee Station Subsequent License Renewal Action Area

Species	Type of and Likelihood of Occurrence in the Oconee Station Subsequent License Renewal Action Area
monarch butterfly	Occasional transitory presence possible during spring and fall migration when individuals are moving between areas of more suitable habitat.
Indiana bat	Not present.
Northern long-eared bat	Not present.
Tricolored bat	Presence possible in spring, summer, and fall in deciduous forest habitat within the action area.
Bog turtle	Not present.
Persistent trillium	Not present.
Small whorled pogonia	Not present.
Smooth coneflower	Not present.
Dwarf-flowered heartleaf	Not present.
Mountain sweet pitcher-plant	Not present.

3.8.1.3 Endangered Species Act: Federally Listed Species and Critical Habitats under National Marine Fisheries Service Jurisdiction

No federally listed species or designated critical habitats under NMFS jurisdiction occur in the action area. Therefore, this section of this EIS does not contain a discussion of any such species or habitats.

3.8.2 Magnuson–Stevens Act: Essential Fish Habitat

Congress enacted the Magnuson–Stevens Act (MSA) in 1976 to foster long-term biological and economic sustainability of the Nation’s marine fisheries (TN7841). The Magnuson–Stevens Fishery Conservation and Management Act directs the Fishery Management Councils, in conjunction with NMFS, to designate areas of essential fish habitat (EFH) and to manage marine resources within those areas. The EFH represents the coastal and marine waters and substrate necessary for fish to spawn, breed, feed, or grow to maturity (50 CFR Part 600-TN1342). For each federally managed species, the Fishery Management Councils and NMFS designate and describe the EFH by life stage (i.e., egg, larva, juvenile, and adult). No coastal or marine waters occur near Oconee Station. Therefore, this EIS does not discuss EFH.

No EFH occurs within Lake Keowee. Therefore, this section of this EIS does not discuss any species or habitats protected under the act.

3.8.3 National Marine Sanctuaries Act: Sanctuary Resources

The Congress enacted the NMSA in 1972 to protect areas of the marine environment that have special national significance. The NMSA authorizes the Secretary of Commerce to establish the National Marine Sanctuary System and designate sanctuaries within that system, which includes 15 sanctuaries and two marine national monuments, encompassing more than 600,000 square miles (m^2) of marine and Great Lakes waters from Washington State to the Florida Keys, and from Lake Huron to American Samoa. Within these areas, sanctuary resources include any living or nonliving resource of a national marine sanctuary that contributes to the conservation, recreational, ecological, historical, educational, cultural, archaeological, scientific, or aesthetic value of the sanctuary. No coastal or marine waters or Great Lakes occur near Oconee Station. Therefore, this EIS does not discuss national marine sanctuaries or their resources.

3.8.4 Proposed Action

The following sections address the site-specific environmental impacts of the Oconee Station SLR on the environmental issues related to special status species and habitats in accordance with Commission direction in CLI-22-02 and CLI-22-03.

3.8.4.1 Endangered Species Act: Federally Listed Species and Critical Habitats under U.S. Fish and Wildlife Jurisdiction

In Section 3.8.1.2, the NRC staff determines that no federally listed species or proposed or designated critical habitat occur in the action area. However, the monarch butterfly, a candidate species, and the tricolored bat, which is proposed for Federal listing as endangered, occur in the action area. Section 3.8.1.2 includes relevant information on habitat requirements, life history, and regional occurrence of these species. In the sections below, the NRC staff analyzes the potential impacts of the proposed Oconee Station SLR on the monarch butterfly and tricolored bat. Table 3-15 identifies the NRC staff's Endangered Species Act effect determination that resulted from the staff's analysis.

Table 3-15 Effect Determinations for Federally Listed Species Under U.S. Fish and Wildlife Service Jurisdiction for Oconee Station Subsequent License Renewal

Species	Federal Status[(a)]	Potentially Present in the Action Area?	Effect Determination[(b)]
monarch butterfly	FC	Yes	NLAA
Indiana bat	FE	No	NE
northern long-eared bat	FE	No	NE
tricolored bat	FPE	Yes	NLAA
bog turtle	FT	No	NE
persistent trillium	FE	No	NE
small whorled pogonia	FT	No	NE
smooth coneflower	FT	No	NE

Species	Federal Status[(a)]	Potentially Present in the Action Area?	Effect Determination[(b)]
dwarf-flowered heartleaf	FT	No	NE
mountain sweet pitcher-plant	FE	No	NE

(a) Indicates protection status under the Endangered Species Act. FC = candidate for Federal listing; FE = federally endangered; FPE = proposed for federal listing as endangered; FT = federally threatened; and FPT = proposed for federal listing as endangered.
(b) The NRC staff makes its effect determinations for federally listed species in accordance with the language and definitions specified in the FWS and NMFS Endangered Species Consultation Handbook (FWS and NMFS 1998-TN1031). NLAA = may affect but is not likely to adversely affect; NE = no effect.

In Section 3.8.1.2, the NRC staff describes several federally listed species. The staff explains that these species do not occur in the action area; therefore, the staff does not address these species any further because SLR would have no effect on them. Table 3-15 identifies these species and the NRC's staff's "no effect" findings.

Appendix C.1 of this EIS summarizes the NRC's obligations under ESA Section 7, describes the NRC's consultation with FWS for Oconee SLR, and lists relevant correspondence.

Monarch Butterfly

In Section 3.8.1.2 of this Supplemental EIS, the NRC staff concludes that monarch butterflies may occur in the action area during spring and fall migration when individuals are moving between areas of more suitable habitat. If present, monarchs would occur occasionally and for short periods of time.

The FWS (2020-TN8593) identifies the primary drivers affecting the health of the two North American migratory populations of monarch butterfly as: (1) habitat loss and degradation and (2) insecticide exposure, and (3) climate change effects.

Monarch habitat loss and degradation has resulted from conversion of grasslands to agriculture, widespread use of herbicides, logging/thinning at overwintering sites in Mexico, senescence and incompatible management of overwintering sites in California, urban development, and drought (FWS 2020-TN8593). The proposed Oconee Station SLR would not involve any habitat loss, land-disturbing activities, or any activities that would degrade existing natural areas or potential habitat for monarch butterflies. The continued preservation of existing natural areas on the site would result in positive impacts on monarch butterflies.

Most insecticides are non-specific and broad-spectrum in nature. Furthermore, the larvae of many Lepidopterans are considered major pest species, and insecticides are specifically tested on this taxon to ensure that they will effectively kill individuals at the labeled application rates (FWS 2020-TN8593). Although insecticide use is most often associated with agricultural production, any habitat where monarchs are found may be subject to insecticide use. Studies looking specifically at dose-response of monarchs to neonicotinoids, organophosphates, and pyrethroids have demonstrated monarch toxicity (e.g., Krischik et al. 2015-TN8596; James 2019-TN8595; Krishnan et al. 2020-TN8597; Bagar et al. 2020-TN8594). Moreover, the magnitude of risk posed by insecticides may be underestimated, as research usually examines the effects of the active ingredient alone, while many of the formulated products contain more than one active insecticide.

During the proposed SLR period, Duke Energy would continue applying herbicides, as needed, according to labeled uses. Application would primarily be confined to industrial-use and other developed portions of the site, such as perimeters of parking lots, roads, and walkways. Continued herbicide application could directly affect monarchs in the action area by injuring or killing individuals exposed to these chemicals. Certain herbicides, such as glyphosate (e.g., Roundup) can kill milkweed, which can affect the ability of female monarchs to lay eggs. However, milkweed is not specifically known to occur on the Oconee Station site, and Duke Energy has no plans to apply herbicides to natural areas. Additionally, monarchs are only likely to occur in the action area seasonally during spring and fall migration when individuals are moving between areas of more suitable habitat. Because of the low likelihood of monarchs to be exposed to hazardous levels of chemicals, this potential impact is insignificant because it is unlikely to reach the scale where a take might occur.

Because the current and projected monarch population numbers are low, both the eastern and western populations are more vulnerable to catastrophic events, such as extreme storms at the overwintering habitat, and other climate change related phenomena. The FWS (2020-TN8593) anticipates that the eastern population will gain habitat in the northcentral region of North America as the species expands northward in response to increasing ambient temperatures. The degree and rate of which this expansion occurs will depend on the simultaneous northward expansion of milkweed. In the southern region of the continent, the population will either experience no gain or some loss of habitat.

Impacts on climate change during normal operations at nuclear power plants can result from the release of greenhouse gases from stationary combustion sources, refrigeration systems, electrical transmission and distribution systems, and mobile sources. However, such emissions are typically very minor because nuclear power plants do not normally combust fossil fuels to generate electricity. During the proposed SLR term, the contribution of Oconee Station operations to climate change-related effects on monarch butterflies would be too small to be meaningfully measured, detected, or evaluated.

Summary of Effects

The potential stressors evaluated in this section are unlikely to result in effects on the monarch butterfly that could be meaningfully measured, detected, or evaluated, and such stressors are otherwise unlikely to occur for the following reasons:

- The proposed action would not involve any habitat loss, land-disturbing activities, or any activities that would degrade existing natural areas or potential habitat for monarch butterflies.
- Continued preservation of the existing natural areas on the site would result in positive impacts on monarch butterflies.
- Herbicides would only be applied according to labeled uses in developed and manicured areas of the site. Herbicides would not be applied in natural areas. Monarchs would only have to potential to occur in the action area seasonally and infrequently, making the likelihood of herbicide exposure low. This represents an insignificant effect because it is unlikely to reach the scale where a take might occur.
- The contribution of Oconee Station operations to climate change-related effects on monarch butterflies would be too small to be meaningfully measured, detected, or evaluate.

Conclusion for the Monarch Butterfly

All potential effects on the monarch butterfly resulting from the proposed action would be insignificant. Therefore, the NRC staff concludes that the proposed action *may affect but is not likely to adversely affect* the monarch butterfly. Because the monarch is a candidate for Federal listing, the ESA does not require the NRC to consult with or receive concurrence from the FWS regarding this species.

<u>Tricolored Bat</u>

In Section 3.8.1.2 of this EIS, the NRC staff concludes that tricolored bats may occur in the action area's deciduous forest habitat in spring, summer, and fall based on positive identification of the species during acoustic monitoring of the site in 2015.

The potential stressors that tricolored bats could experience from operation of a nuclear power plant (generically) are as follows.

- mortality or injury from collisions with nuclear power plant structures and vehicles
- habitat loss, degradation, disturbance, or fragmentation, and associated effects
- behavioral changes resulting from refurbishment or other site activities

This section addresses each of these stressors below.

Mortality or Injury from Collisions with Nuclear Power Plant Structures and Vehicles

Listed bats can be vulnerable to mortality or injury from collisions with nuclear power plant structures and vehicles. Bat collisions with human-made structures at nuclear power plants are not well documented but are likely rare based on the available information. In an assessment of the potential effects of operation of the Davis-Besse Nuclear Power Station in Ohio, the NRC (NRC 2014-TN7385) noted that four dead bats were collected at the nuclear power plant during bird mortality studies conducted from 1972 through 1979. Two red bats (*Lasiurus borealis*) were collected from the cooling tower, and one big brown bat (*Eptesicus fuscus*) and one tricolored bat (*Perimyotis subflavus*) were collected near other nuclear power plant structures. During the initial license renewal review, the NRC (NRC 2014-TN7385) found that future collisions of bats would be extremely unlikely and, therefore, discountable given the small number of bats collected during the study and the marginal suitable habitat that the nuclear power plant site provides. Notably, the tricolored bat was not yet proposed for listing when the NRC conducted this review; hence this consultation only considered the bat (*Myotis sodalis*), and northern long-eared bat (*M. septentrionalis*). The FWS (FWS 2014-TN7605) concurred with this determination. In a 2015 assessment associated with the Indian Point plant in New York, the NRC (NRC 2015-TN7382) determined that bat collisions were less likely to occur at the Indian Point plant than at the Davis-Besse Nuclear Power Station because Indian Point does not have cooling towers or similarly large obstructions. The tallest structures on the Indian Point site are 134 ft (40.8 m) tall turbine buildings and 250 ft (76.2 m) tall reactor containment structures. The NRC (NRC 2015-TN7382) concluded that the likelihood of bats colliding with these and other nuclear power plant structures on the Indian Point site during the license renewal period was extremely unlikely and, therefore, discountable. The FWS (NRC 2014-TN7385) concurred with this determination. In 2018, the NRC (NRC 2018-TN7381) determined that the likelihood of bats colliding with site buildings or structures on the Seabrook Nuclear Power Plant site in New Hampshire would be extremely unlikely. The tallest structures on that site are a 199 ft (61 m) tall containment structure and 103 ft (31 m) tall turbine and heater bay building. The FWS (FWS 2018-TN7610) concurred with the NRC's determination. In 2020, the NRC (NRC 2020-TN7324) determined that the likelihood of bats colliding with site buildings or structures on the Surry Power Station site in Virginia would be extremely unlikely. The FWS (FWS 2019-TN7609) again concurred with the NRC staff's determination on the basis that activities associated with the Surry Power Station SLR would be consistent with the activities analyzed in the FWS's January 5, 2016, programmatic biological opinion (FWS 2016-TN7400). Most recently, the NRC (NRC 2021-TN7293) determined that the likelihood of bats colliding with site buildings or structures at the Point Beach Nuclear plant in Wisconsin would be extremely unlikely based on structure height and operating experience. The FWS (NRC 2021-TN9162) also concurred with this determination on the basis of the FWS's 2016 programmatic biological opinion (FWS 2016-TN7400).

On the Oconee Station site, the tallest site structures are the reactor containment buildings, each of which is 191 ft (58 m) high (Duke Energy 2021-TN8897). The turbine buildings and transmission lines are also prominent features on the site that could pose collision hazard. To date, Duke Energy has reported no incidents of injury or mortality of any species of bat on the Oconee Station site associated with site buildings or structures. Accordingly, the NRC staff finds the likelihood of tricolored bat collisions with site buildings or structures to be extremely unlikely and, therefore, discountable.

Vehicle collision risk for bats varies depending on factors including time of year, location of roads and travel pathways in relation to roosting and foraging areas, the characteristics of individuals' flight, traffic volume, and whether young bats are dispersing. Although collision has been documented for several species of bats, the Indiana Bat Draft Recovery Plan (FWS 2007-TN934) indicates that bat species do not seem to be particularly susceptible to vehicle collisions. However, FWS also finds it difficult to determine whether roads pose a greater risk for bats colliding with vehicles or a greater likelihood of decreasing risk of collision by deterring bat activity (FWS 2016-TN7400). In most cases, FWS expects that roads of increasing size decrease the likelihood of bats crossing the roads and, therefore, reduce collision risk (FWS 2016-TN7400).

During the proposed Oconee Station SLR term, vehicular traffic from truck deliveries, site maintenance activities, and personnel commuting to and from the site would continue throughout the SLR period as they have during the current licensing period. Vehicle use would occur primarily in areas that bats would be less likely to frequent, such as along established county and State roads or within industrial-use areas of the Oconee Station site. Additionally, most vehicle activity would occur during daylight hours when bats are less active. To date, Duke Energy has reported no incidents of injury or mortality of any species of bat on the Oconee Station site associated with vehicle collisions. Accordingly, the NRC staff finds the likelihood of future northern long-eared bat collisions with vehicles to be extremely unlikely and, therefore, discountable.

Habitat Loss, Degradation, Disturbance, or Fragmentation, and Associated Effects

As previously discussed in this EIS, the Oconee Station action area includes deciduous forest habitat that tricolored bats may inhabit in spring, summer, and fall.

In its final rule listing the northern long-eared bat (80 FR 17974-TN4216), the FWS identifies forest conversion and forest modification as two of the most common causes of habitat loss, degradation, disturbance, or fragmentation affecting federally listed bats. Forest conversion is the loss of forest to another land use type, such as cropland, residential, or industrial. This can lead to loss of suitable habitat, fragmentation of remaining habitat patches, and elimination of travel corridors (80 FR 17974-TN4216). Forest management practices maintain forest habitat at the landscape level, but they involve practices that can have direct and indirect effects on bats.

Impacts from forest management are typically temporary in nature and can include positive, neutral, and negative impacts.

The proposed action would not involve forest conversion or management and would generally not disturb existing forested habitat on the site. Duke Energy states that it would continue to perform vegetation maintenance on the site over the course of the proposed SLR term. Most maintenance would be of grassy, mowed areas between buildings and along walkways within the industrial portion of the site or on adjacent hillsides. Duke Energy would continue to maintain onsite transmission line ROWs in accordance with North American Electric Reliability Corporation standards. Less-developed areas and forested areas would be largely unaffected. Duke Energy does not intend to expand the existing facilities or otherwise perform construction or maintenance activities within these areas (Duke Energy 2021-TN8897). Site personnel may occasionally remove select trees around the margins of existing forested areas if those trees are deemed hazardous to buildings, infrastructure, or other site facilities or to existing overhead clearances. Negative impacts on bats could result if such trees are potential roost trees. Bats could also be directly injured during tree clearing. However, tree removal would be infrequent, and Duke Energy personnel would follow company guidance to minimize potential impacts on bats, as discussed in more detail below.

The NRC staff finds that infrequent to rare hazardous tree removal in forested areas during the proposed SLR term would not measurably affect any potential bat habitat in the action area. Direct injury or mortality to bats during tree removal is also unlikely because Duke Energy company guidance would ensure that personnel take the appropriate measures to avoid this potential impact. For instance, Duke Energy could avoid this impact by removing hazardous trees in the winter when bats are unlikely to be present on the site. Additionally, the continued preservation of the existing forested areas on the site during the SLR term would result in positive impacts on tricolored if they are present within or near the action area.

Behavioral Changes Resulting from Refurbishment or Other Site Activities

Construction or refurbishment and other site activities, including site maintenance and infrastructure repairs, could prompt behavioral changes in bats. Noise and vibration and general human disturbance are stressors that may disrupt normal feeding, sheltering, and breeding activities in bats (FWS 2016-TN7400). At low noise levels or farther distances, bats initially may be startled but would likely habituate to the low background noise levels. At closer range and louder noise levels, particularly if accompanied by physical vibrations from heavy machinery, many bats would likely be startled to the point of fleeing from their daytime roosts. Fleeing individuals could experience increased susceptibility to predation and would expend increased levels of energy, which could result in decreased reproductive fitness (FWS 2016-TN7400, Table 4-1). Increased noise may also affect foraging success. Schaub et al. (TN8867) found that the foraging success of the greater mouse-eared bat (*Myotis myotis*) diminished in areas with noise mimicking the traffic sounds that would be experienced within 15 m (49 ft) of a highway.

Within the Oconee Station action area, noise, vibration, and other human disturbances could dissuade bats from using the action area’s forested habitat during migration, which could also reduce the fitness of migrating bats. However, bats that use the action area have likely become habituated to such disturbance because Oconee Station has been consistently operating for several decades. According to the FWS, bats that are repeatedly exposed to predictable, loud noises may habituate to such stimuli over time (FWS 2010-TN8537). For instance, Indiana bats have been documented as roosting within approximately 1,000 ft (300 m) of a busy State route adjacent to Fort Drum Military Installation and immediately adjacent to housing areas and construction activities on the installation (Army 2014-TN8512). Tricolored bats would likely respond similarly.

Continued operation of Oconee Station during the SLR term would not include major construction or refurbishment and would involve no other maintenance or infrastructure repair activities besides routine activities already performed on the site. Levels and intensity of noise, lighting, and human activity associated with continued day-to-day activities and site maintenance during the SLR term would be similar to ongoing conditions since Oconee Station began operating, and such activity would only occur on the developed, industrial-use portions of the site. While these disturbances could cause behavioral changes in migrating or summer roosting bats, such as the expenditure of additional energy to find alternative suitable roosts, the NRC staff assumes that tricolored bats, if present in the action area, have already acclimated to regular site disturbances. Thus, continued disturbances during the SLR term would not cause behavioral changes in bats to a degree that would be able to be meaningfully measured, detected, or evaluated or that would reach the scale where a take might occur.

Duke Energy Endangered Species Procedure

During the NRC staff's April 2023 environmental audit, staff reviewed Duke Energy's corporate Endangered Species Procedure. This procedure applies to all Duke Energy business units, including the Oconee Station site. The procedure summarizes the requirements of the ESA and how these requirements apply to Duke Energy's sites and activities. It includes checklists and protocols to ensure that Duke Energy employees and contractors adequately consider listed species before undertaking an activity that has the potential to affect such species. The procedure details how incidents should be logged and reported if a listed species is harmed. Duke Energy personnel must gather detailed information about the incident and report it to the Duke Energy wildlife team, the FWS, National Marine Fisheries Service, and the appropriate State natural resource agency, as appropriate. Such reporting would also trigger a report to the NRC under 10 CFR 50.72(b)(2)(xi), as described in Section 3.2.12 of NUREG-1022, Revision 3, "Event Report Guidelines 10 CFR 50.72 and 50.73" (Duke Energy 2023-TN8952).

Duke Energy requires that employees and contractors complete training if they could encounter listed species or have incidents during their everyday work activities. Such trainings must be conducted by a qualified subject matter expert and should be project- or species-specific. For instance, Duke Energy has recently conducted trainings for employees and contractors on protected bats, including current and likely-to-be-listed species, such as the tricolored bat, and how Duke Energy is addressing potential impacts of its projects and activities on these species. The trainings have addressed bat life history, seasonal distributions, habitat preferences, and how to identify suitable versus non-suitable roosting trees, among other topics (Duke Energy 2023-TN8952).

Duke Energy Habitat Conservation Plan Development

In discussions among NRC staff and Duke Energy personnel during the NRC staff's April 2023 environmental audit, Duke Energy shared that it is preparing a multi-state Habitat Conservation Plan (HCP) that would cover its entire regulated service area (e.g., Ohio, Indiana, North Carolina, South Carolina, Kentucky, Tennessee, and Florida). This will include the Oconee Station site. The HCP will address all federally protected bats, including the Indiana bat, northern long-eared bat, gray bat (*Myotis grisescens*), Florida bonneted bat (*Eumops floridanus*), and likely-to-be-listed bats, including the tricolored bat and little brown bat (*Myotis lucifugus*). The HCP will address potential impacts to include tree trimming and cutting, grounds maintenance, and other routine operational activities at facilities such as the Oconee

Station site. Duke Energy is also developing facility-based bat management plans as part of this effort, which would be implemented at Oconee Station, among other sites. Duke Energy is coordinating with the FWS in its development of the HCP. Once drafted, Duke Energy will submit the HCP, along with an Incidental Take Permit application, to the FWS for approval in accordance with ESA Section 10. Duke Energy estimates that it will receive approval by roughly 2027 (Duke Energy 2023-TN8952).

Summary of Effects

The potential stressors evaluated in this section are unlikely to result in effects on the tricolored bat that could be meaningfully measured, detected, or evaluated, and such stressors are otherwise unlikely to occur for the following reasons:

- Bat collisions with nuclear power plant structures in the United States are rare, and none have been reported at Oconee Station. Vehicle collisions attributable to the proposed action are also unlikely, and none have been reported at Oconee Station.
- The proposed action would not involve any construction, land clearing, or other ground-disturbing activities.
- Continued preservation of the existing forested areas on the site would result in positive impacts on northern long-eared bats.
- Bats, if present in the action area, have likely already acclimated to the noise, vibration, and general human disturbances associated with site maintenance, infrastructure repairs, and other site activities. During the SLR term, such disturbances and activities would continue at current rates and would be limited to the industrial-use portions of the site.
- Duke Energy maintains a corporate Endangered Species Procedure to ensure that federally listed species are appropriately considered when planning activities and projects. Duke Energy is also preparing an HCP to address listed bats that will cover its entire regulated service area. Duke will submit the FWS, along with an Incidental Take Permit application, to the FWS for approval in accordance with ESA Section 10.

Conclusion for the Tricolored Bat

All potential effects on the tricolored bat resulting from the proposed action would be insignificant or discountable. Therefore, the NRC staff concludes that the proposed action *may affect but is not likely to adversely affect* the tricolored bat. Following the issuance of this EIS, the NRC staff will seek the FWS's concurrence regarding this finding.

3.8.4.2 Endangered Species Act: Federally Listed Species and Critical Habitats under National Marine Fisheries Service Jurisdiction

No EFH occurs within the action area (see Section 3.8.1.3). Therefore, the NRC staff concludes that the proposed action would have no effect on the EFH.

3.8.4.3 Endangered Species Act: Cumulative Effects

The Endangered Species Act regulations at 50 CFR 402.12(f)(4) (TN4312) direct Federal agencies to consider cumulative effects as part of the proposed action effects analysis. Under the Endangered Species Act, cumulative effects are those effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 CFR 402.02-TN4312). Cumulative effects under the Endangered Species Act do not include past actions or other Federal actions requiring separate Endangered Species Act Section 7 consultation, which differs from the definition of "cumulative impacts" under NEPA.

When formulating biological opinions under formal Endangered Species Act Section 7 consultation, FWS and NMFS (FWS and NMFS 1998-TN1031) consider cumulative effects when determining the likelihood of jeopardy or adverse modification. Therefore, cumulative effects need only be considered under the Endangered Species Act if listed species will be adversely affected by the proposed action and formal Section 7 consultation is necessary (FWS 2017-TN5753). Because the NRC staff concluded earlier in this section that the proposed SLR is not likely to adversely affect any federally listed species and would not destroy or adversely modify designated critical habitats, the NRC staff did not separately consider cumulative effects for the listed species and designated critical habitats. Further, the NRC staff did not identify any actions within the action area that meet the definition of cumulative effects under the Endangered Species Act.

3.8.4.4 Magnuson–Stevens Act: Essential Fish Habitat

No EFH occurs within the action area (see Section 3.8.2). Therefore, the NRC staff concludes that the proposed action would have no effect on the EFH.

3.8.4.5 National Marine Sanctuaries Act: Sanctuary Resources

No National Marine Sanctuaries occur within the affected area (see Section 3.8.3). Therefore, the NRC staff concludes that the proposed action would have no effect on sanctuary resources.

3.8.5 No-Action Alternative

Under the no-action alternative, the NRC would not issue a renewed license, and Oconee Station would shut down on or before the expiration of the current renewed facility operating licenses. Upon shutdown, the nuclear power plant would require substantially less cooling water and would produce little to no discernable thermal effluent. Thus, the potential for impacts on all aquatic species related to cooling system operation would be significantly reduced. The Endangered Species Act action area under the no-action alternative would most likely be the same or similar to the area described in Section 3.8.1.1. No federally listed species or designated critical habitats currently occur in the action area (see Section 3.8.1), nor does any EFH occur in the region (see Section 3.8.2). Thus, shutdown is unlikely to result in impacts on such species and habitats. However, actual impacts would depend on the specific shutdown activities and if any listed species, critical habitats, or designated EFH are present when the no-action alternative is implemented.

3.8.6 Replacement Power Alternatives: Common Impacts

The Endangered Species Act action area and estuarine waters potentially containing designated EFH for any of the replacement alternatives would depend on factors including site selection, current land uses, planned construction activities, temporary and permanent structure locations and parameters, and the timeline of the alternative. The listed species, critical habitats, and EFH potentially affected by a replacement power alternative would depend on the boundaries of that alternative's effects and the species and habitats federally protected at the time the alternative is implemented. For instance, if Oconee Station continues to operate until the end of the current license terms and a replacement power alternative is implemented at that time, the FWS and NMFS may have listed new species, delisted currently listed species whose populations have recovered, or revised EFH designations. These listing and designation activities would change the potential for the various alternatives to impact special status species and habitats. Additionally, requirements for consultation under Section 7 of the Endangered Species Act with the FWS and NMFS as well as EFH consultation with the NMFS would depend on whether Federal permits or authorizations are required to implement each alternative.

Sections 3.6.5 and 3.8.6 describe the types of impacts that terrestrial and aquatic resources would experience under each alternative. Impacts on special status species and habitats would likely be similar in type. However, the magnitude and significance of such impacts could be greater for special status species and habitats because such species and habitats are rare and more sensitive to environmental stressors.

3.8.7 New Nuclear (Advanced Light-Water Reactor and Small Modular Reactor) Alternative

The impacts of the new nuclear alternative are largely addressed in the impacts common to all replacement power alternatives described in the previous section. Because the NRC would remain the licensing agency under this alternative, the ESA and Magnuson–Stevens Fishery Conservation and Management Act would require the NRC to consult with the FWS and NMFS, as applicable, before issuing a license for construction and operation of the new facility. During these consultations, the agencies would determine whether the new reactors would affect any federally listed species, adversely modify or destroy designated critical habitat, or result in adverse effects on EFH. If the new facility requires a CWA Section 404 permit, USACE may be a cooperating agency for required consultations, or USACE may be required to consult separately. Ultimately, the magnitude and significance of adverse impacts on special status species and habitats would depend on the site location and layout, nuclear power plant design, nuclear power plant operations, and the special status species and habitats present in the area when the alternative is implemented.

3.8.8 Natural Gas Combined-Cycle Alternative

The NRC does not license natural gas facilities; therefore, the NRC would not be responsible for ESA Section 7 or EFH consultation for this alternative. The Federal and private responsibilities for addressing impacts on special status species and habitats under this alternative would be similar to those described in Section 3.8.4 of this EIS. Ultimately, the magnitude and significance of adverse impacts on special status species and habitats resulting from the natural gas alternative would depend on the site location and layout, nuclear power plant design, nuclear power plant operations, and the special status species and habitats present in the area when the alternative is implemented.

3.8.9 Combination Alternative (Solar PV, Offshore Wind, Small Modular Reactor, and Demand-Side Management)

Section 3.8.5 above addresses the impacts of the SMR component of this alternative. The NRC does not license solar or wind facilities or play a role in energy-planning decisions; therefore, the NRC would not be responsible for ESA Section 7 or an EFH consultation for these components of the alternative. The Federal and private responsibilities for addressing impacts on special status species and habitats under these components of this alternative would be similar to those described in Section 3.8.4. Ultimately, the magnitude and significance of adverse impacts on special status species and habitats resulting from the combination alternative would depend on the site location and layout, nuclear power plant design, nuclear power plant operations, and the special status species and habitats present in the area when the alternative is implemented.

3.9 Historic and Cultural Resources

This section describes the cultural background and the historic and cultural resources found at Oconee Station and in the surrounding area. The description of the resources is followed by the staff's analysis of the potential impacts on historic and cultural resources from the proposed action (SLR) and alternatives to the proposed action.

3.9.1 Cultural Background

Human occupation in South Carolina dates back more than more than 12,000 years. Prehistoric occupation of the area is commonly divided into the following cultural periods:

- Paleoindian Period (12,000–8,000 BC)
- Archaic Period (8,000–13,000 BC)
- Woodland Period (3,000 BC–1,000 AD)
- Mississippian Period (1,000 AD–1,520 AD)

The Paleoindian Period is characterized by the presence of small mobile bands dependent on large game, and to some extent on smaller aquatic and terrestrial game and flora. Many of these bands lived in sites at the confluence of large streams and rivers. The Archaic Period is divided into early, middle, and late subperiods defined on the basis of changing projectile point types and evolving resource procurement strategies. During this period, people appear to have become increasingly less nomadic and more adept at exploiting resources found within their environment, thereby resulting in an overall increase in population. The late Archaic Period is characterized by the presence of sand-tempered pottery, which arrived at the Piedmont region by way of the coastal plain. The earliest known house in South Carolina, constructed from shell middens along the outer coastal plain, also dates from this period. The Woodland Period is similarly divided into early, middle, and late subperiods characterized by changing pottery types. During this time in the Piedmont region, bow and arrow technology and extensive use of pottery was employed, reliance on freshwater shellfish increased, and larger settlements were established along major river terraces where horticulture was practiced. The Mississippian Period is characterized by ceremonial mounds, distinctive mortuary practices, and large maize agriculture-based settlements generally considered to have been controlled by chiefdoms. Non-mound sites from this period are also common across South Carolina (Duke Energy 2021-TN8897; NRC 2013-TN6435; SCDAH 2023-TN9005).

The arrival of Europeans in 1526 began the Exploratory Period in South Carolina, during which Spanish, and later French, explorers attempted to establish early settlements. These efforts resulted in severe reductions to Native American populations in the region caused by the introduction of European and African diseases. The current Historic Period in South Carolina began with colonization by the British in 1670 and the establishment of trading posts. Tensions between colonists and several Native American Tribes led to the Yamasee War from 1715 to 1717. Ultimately, many of these Tribes were unable to resist colonial encroachment in the region and were forced to migrate west. An exception to this migration were the Catawba, who were granted a reservation in 1763 and remain in South Carolina to this day (Duke Energy 2021-TN8897; NRC 2013-TN6435; SCDAH 2023-TN9005).

During the period between the Revolutionary War and the Civil War, the region was populated by small farms focused primarily on livestock, grain, and cotton production. In the late 1800s, the development of a greater regional railroad infrastructure led to the establishment of several small towns centered around cotton and textile mills. In the 1960s, Duke Energy began a large-scale power-generating project in the area. Known as the Keowee-Toxaway complex, it included the construction of Lake Keowee and Lake Jocassee; the Keowee, Jocassee, and Bad Creek hydroelectric stations; and Oconee Station. Following the decline of the local textile industry in the late 1900s and Duke Energy's development of the Keowee-Toxaway complex, increased focus has been directed toward establishing and promoting recreation and tourism opportunities in the region (Duke Energy 2021-TN8897; NRC 1999-TN8942; SCDAH 2023-TN9005).

3.9.2 Historic and Cultural Resources at Oconee Station

Historic and cultural resources within the Oconee Station site can include prehistoric era and historic era archaeological sites, historic districts, and buildings; as well as any site, structure, or object that may be considered eligible for listing on the National Register of Historic Places (NRHP). Historic and cultural resources also include traditional cultural properties that are important to a living community of people for maintaining their culture. "Historic property" is the legal term for a historic or cultural resource that is included on, or eligible for inclusion on, the NRHP.

Cultural resource surveys were not conducted within the 510 ac (210 ha) Oconee Station site before construction. Although construction of the Oconee Station facility would have impacted any archaeological resources that may have been located within its footprint, much of the surrounding area remains largely undisturbed (Duke Energy 2021-TN8897). Nine cultural resource surveys of the offsite area within a 6 mi (9.6 km) radius of Oconee Station have subsequently identified the presence of 104 archaeological and historic resources (Duke Energy 2021-TN8897, Duke Energy 2022-TN8948).

The NRHP lists 22 historic properties in Oconee County, and 28 in Pickens County (NPS 2023-TN9230). Three of these historic properties are located within a 6 mi radius from the center of the Oconee Station site: the Old Pickens Presbyterian Church (adjacent to the southeast corner of the Oconee Station site), the Alexander-Hill House (approximately 2 mi [3.5 km] west) and the Newry Historic District, (approximately 5 mi [8 km] south) (Duke Energy 2021-TN8897, NPS 2023-TN9230). Duke Energy has also commissioned an architectural survey to evaluate the eligibility of Oconee Station for listing on the NRHP (see Section 3.9.4.2 below).

3.9.3 Procedures and Integrated Cultural Resources Management Plan

Duke Energy has multiple procedures in place to protect cultural resources, including the Corporate Cultural Resources Procedure, the nuclear Environmental Review Process and Environmental Checklist, the Nuclear Land Disturbing Activities procedure, and the cultural resources section of the corporate Environmental, Health, and Safety Handbook. These procedures help to increase awareness of the importance identifying, protecting, and minimizing disturbance to cultural resources during the planning, scoping, and implementation of all potential ground disturbing activities at Oconee Station (Duke Energy 2022-TN8948).

3.9.4 Proposed Action

The following sections address the site-specific environmental impacts of the Oconee Station SLR on the environmental issues related to historic and cultural resources in accordance with Commission direction in CLI-22-02 and CLI-22-03.

3.9.4.1 Historic and Cultural Resources

The NHPA (54 U.S.C. 300101 et seq. TN4157), requires Federal agencies to consider the effects of their undertakings on historic properties. Issuing a renewed operating license to a nuclear power plant is an undertaking that could potentially affect historic properties. Historic properties are defined as resources included on, or eligible for inclusion on, the NRHP. The criteria for eligibility are listed in 36 CFR 60.4 “Criteria for Evaluation,” [TN1682] and include: (1) association with significant events in history, (2) association with the lives of persons significant in the past, (3) embodiment of distinctive characteristics of type, period, or construction, and (4) sites or places that have yielded, or are likely to yield, important information.

The historic preservation review process (Section 106 of the NHPA is outlined in regulations issued by the Advisory Council on Historic Preservation in 36 CFR Part 800, “Protection of Historic Properties” (TN513). In accordance with NHPA provisions, the NRC is required to make a reasonable effort to identify historic properties included on, or eligible for inclusion on, the NRHP in the area of potential effect. The area of potential effect for a license renewal action includes the nuclear power plant site, the transmission lines up to the first substation, and immediate environs that may be affected by the SLR decision and land-disturbing activities associated with continued reactor operations during the SLR term. In addition, the NRC is required to notify the State Historic Preservation Officer (SHPO) if historic properties would not be affected by SLR or if no historic properties are present. In South Carolina, the State Historic Preservation Office within the South Carolina Department of Archives and History, administers the State’s historic preservation program. The NRC also notifies all consulting parties, including Indian Tribes, and makes this finding public (through the NEPA process) before issuing the renewed operating license. Similarly, if historic properties are present and could be affected by the undertaking, the NRC is required to assess and resolve any adverse effects in consultation with the SHPO and any Indian Tribe that attaches religious and cultural significance to identified historic properties.

3.9.4.2 Consultation

In accordance with 36 CFR 800.8(c), “Coordination with the National Environmental Policy Act,” (TN513) on August 23, 2021, the NRC initiated written consultations with the Advisory Council on Historic Preservation and the South Carolina State Historic Preservation Office. Also, on August 23, 2021, the NRC initiated consultation with the following federally recognized Tribes:

- Catawba Indian Nation
- Cherokee Nation
- Eastern Band of Cherokee Indians
- Muscogee (Creek) Nation
- United Keetoowah Band of Cherokee Indians in Oklahoma

In these letters, the NRC provided information about the proposed action, defined the area of potential effect, and indicated that the NHPA review would be integrated with the NEPA process, in accordance with 36 CFR 800.8(c) (TN513). The NRC invited participation in the identification of, and possible decisions concerning, historic properties, and also invited participation in the scoping process. Separate from these consultations, the NRC staff also sent a letter inviting a State-recognized Tribe, the Piedmont American Indian Association, and the Lower Eastern Cherokee Nation of South Carolina to participate in the scoping process.

On September 20, 2021, the South Carolina State Historic Preservation Office stated in correspondence to the NRC that it was their understanding that Duke Energy had commissioned a cultural resources survey of primary structures at Oconee Station and recommended that an evaluation of the eligibility of these structures for the NRHP be conducted as a part of the license renewal undertaking (SCDAH 2023-TN9005). Duke Energy's draft report concerning the architectural survey and NRHP eligibility evaluation that was submitted to the South Carolina State Historic Preservation Office identified resources within the boundary of Oconee Station and revisited the Old Pickens Presbyterian Church located outside the boundary. The survey recommended three resources as eligible for listing in the NRHP:

- The Oconee Nuclear Station, with multiple contributing resources, including the reactor buildings, turbine buildings, intake structure, discharge structure, water tower, skimmer wall, and steam generator retirement facility
- The World of Energy Visitor Center, which is individually eligible and also contributes to a proposed Oconee Nuclear Station Historic District
- The Keowee-Toxaway Hydroelectric Facility, with contributing resources including the Keowee power house, intake structure, and spillway

The South Carolina State Historic Preservation Office provided initial concurrence that these resources meet the criteria for listing in the NRHP on October 7, 2021, and final concurrence of the report and findings on January 4, 2022 (Duke Energy 2022-TN8948, SCDAH 2023-TN9005).

3.9.4.3 Findings

Section 3.9.2 discusses cultural resources on the Oconee Station property. Duke Energy does not anticipate physical changes or ground-disturbing activities at Oconee Station or any location outside the property boundary to support SLR (Duke Energy 2021-TN8897). Duke Energy has procedures in place to manage and protect cultural resources at Oconee Station. If inadvertent cultural or historic resources are encountered, work should be stopped and the SHPO should be contacted to determine the appropriate next steps (Duke Energy 2021-TN8897, Duke Energy 2022-TN8948).

Given (1) that no new ground disturbance or modifications are anticipated during the SLR period, (2) the location of historic properties within and near the area of potential effect is known, and (3) that Duke Energy has procedures in place to manage and protect cultural resources, the NRC staff concludes that SLR for Oconee Station would not adversely affect any known historic properties or historic and cultural resources.

3.9.5 No-Action Alternative

Under the no-action alternative, the NRC would not issue subsequent licenses, and Duke Energy would terminate reactor operation on or before the expiration of the current renewed licenses. As a result of facility shutdown, land-disturbing activities or dismantlement are not anticipated because these would be conducted during decommissioning. However, effects on historic properties or historic and cultural resources would depend on the specific shutdown activities when the no-action alternative is implemented.

3.9.6 Replacement Power Alternatives: Common Impacts

If construction and operation of replacement power alternatives require a Federal undertaking (e.g., license, permit), the Federal agency would need to make a reasonable effort to identify historic properties within the area of potential effects and consider the effects of their undertakings on historic properties, in accordance with Section 106 of the NHPA of 1966, as amended (54 U.S.C. 300101 et seq. TN4157). Historic and cultural resources identified would need to be recorded and evaluated for eligibility for listing on the NRHP. If historic properties are present and could be affected by the undertaking, adverse effects would be assessed, determined, and resolved in consultation with the state historic preservation officer and any Indian Tribe that attaches religious and cultural significance to identified historic properties through the NHPA Section 106 process.

Construction

Impacts to historic and cultural resources from the construction of replacement power alternatives are primarily related to ground disturbance (e.g., land clearing, excavations). For the natural gas alternative, and SMR portions of the new nuclear alternative and combination alternative, this environmental review assumes the new facilities would be built on the Oconee Station site. A portion of the new nuclear alternative would also be constructed at the W.S. Lee Nuclear Station in Cherokee County, South Carolina. For the solar PV and offshore wind portions of the combination alternative, this environmental review assumes they would be constructed at other sites (offsite from the Oconee Station site). Undisturbed land areas (onsite and offsite) would need to be surveyed to identify and record historic and cultural material. Any historic or cultural resources and archaeological sites found during these surveys would need to be evaluated for eligibility for listing on the NRHP. Areas of greatest cultural sensitivity should be avoided while maximizing the use of previously disturbed areas.

Operation

The potential for impacts on historic and cultural resources from the operation of replacement power alternatives would be related to maintenance activities at the site, as well as visual impacts that would vary with nuclear power plant heights and associated exhaust stack or cooling towers. As in the case of construction (discussed above), undisturbed land areas would need to be surveyed to identify and record historic and cultural material. Any historic and cultural resources and archaeological sites found during these surveys would need to be evaluated for eligibility for listing on the NRHP. Areas of greatest cultural sensitivity should be avoided while maximizing the use of previously disturbed areas.

3.9.7 New Nuclear (Advanced Light-Water Reactor and Small Modular Reactor) Alternative

Potential impacts on historic and cultural resources from the construction and operation of a new nuclear alternative would include those common to all replacement power alternatives discussed in Section 3.9.6. The ALWR portion of a new nuclear alternative would require more than 3,000 ac (1,200 ha) of land on the W.S. Lee Nuclear Station site; and the SMR portion would require approximately 36 ac (15 ha) on or adjacent to the Oconee Station site. The extent of potential impacts on historic properties would depend on the degree to which the lands chosen for the new nuclear facilities have been previously developed or disturbed. Avoidance of historic and cultural material may not be possible but would be minimized or mitigated.

Construction and operation of a new nuclear alternative would introduce additional buildings and structures to the W.S. Lee Nuclear Station and Oconee Station sites that, while not out of character with the current facilities, could affect the viewshed of historic properties or historic and cultural resources. A plume, particularly during winter months, could also be visible as a result of operation of the mechanical draft cooling towers. The impact determination of this alternative would depend on the specific locations chosen for the new ALWR and SMR facilities. The South Carolina SHPO would need to be consulted before commencing any ground-disturbing activities in undisturbed land areas at each location.

3.9.8 Natural Gas Combined-Cycle Alternative

Potential impacts on historic and cultural resources from the construction of a natural gas alternative would include those common to all replacement power alternatives discussed in Section 3.9.6. The natural gas alternative would require an estimated 130 ac (53 ha) of land on and adjacent to the Oconee Station site and up to an additional 191 ac (77 ha) for a natural gas pipeline. The extent of potential impacts on historic properties would depend on the degree to which the lands chosen for the natural gas facilities have been previously developed or disturbed. Avoidance of historic and cultural material may not be possible but would be minimized or mitigated.

Construction and operation of a natural gas alternative would introduce additional buildings and structures to the Oconee Station site that, while not out of character with the current facility, could affect the viewshed of historic properties or historic and cultural resources. A plume, particularly during winter months, could also be visible as a result of operation of the mechanical draft cooling towers. The impact determination of this alternative would depend on the specific location chosen for the natural gas facilities. The South Carolina SHPO would need to be consulted before commencing any ground-disturbing activities in undisturbed land areas at Oconee Station.

3.9.9 Combination Alternative (Solar PV, Offshore Wind, Small Modular Reactor, and Demand-Side Management)

Potential impacts on historic and cultural resources during construction and operation of a combination of SMR, solar PV, and offshore wind power-generating facilities would include those common to all replacement power alternatives discussed in 3.9.6. Activities associated with demand-side management would not likely have any direct impact on these resources.

Because it would be sited within the Oconee Station site and have similar nuclear power plant structures, potential impacts on historic and cultural resources from construction and operation of the SMR portion of the combination alternative would be similar to those discussed for the SMR portion of the new nuclear alternative in Section 3.9.7, although the size of the facility footprint would be larger and require approximately 110 ac (45 ha) on or adjacent to the Oconee Station site. The solar PV portion of the combination alternative would require approximately 9,600 ac (3,900 ha) of land located at multiple locations within Duke Energy’s service area offsite of Oconee Station. The offshore wind portion of the combination alternative would be sited within an approximately 66 square-nautical miles (56,000 ac, 23000 ha) area, and the onshore battery storage systems supporting these facilities would disturb an additional 60 ac

(24 ha) of land offsite of Oconee Station. The extent of potential impacts on historic properties would depend on the degree to which the areas chosen for these facilities have been previously developed or disturbed. Taller structures, such as wind turbines, would be visible for extended distances.

Avoidance of historic and cultural material may not be possible but would be minimized or mitigated. The impact determination of this alternative would depend on the specific location of new facilities. The South Carolina SHPO would need to be consulted before commencing any ground- or seabed-disturbing activities in undisturbed areas at Oconee Station and at other onshore and offshore locations within its jurisdiction.

3.10 Socioeconomics

This section describes current socioeconomic factors that have the potential to be affected by changes in nuclear power plant operations at Oconee Station. Oconee Station and the communities that support it can be described as a dynamic socioeconomic system. The communities support the people, goods, and services required to operate the nuclear power plant. Nuclear power plant operations, in turn, supply wages and benefits for people as well as dollar expenditures for goods and services. The measure of a community's ability to support Oconee Station's operations depend on the community's ability to respond to changing environmental, social, economic, and demographic conditions.

3.10.1 Nuclear Power Plant Employment

The socioeconomic ROI is defined by the areas where Oconee Station workers and their families reside, spend their income, and use their benefits, thus affecting the economic conditions of the regions. In 2023, Duke Energy employed a permanent workforce of 622 workers and 495 contingent non-outage workers (Duke Energy 2023-TN8952). Approximately, 76 percent of Oconee Station permanent workers reside in Oconee County (44 percent of the workers) and Pickens County (32 percent of the workers), South Carolina. The remaining workers are spread among counties in South Carolina, Georgia, and North Carolina (Duke Energy 2023-TN8952). Because most of Oconee Station's permanent workers are concentrated in Oconee County and Pickens County, the greatest socioeconomics effects are likely to be experienced there. The focus of the impact analysis, therefore, is on the socioeconomic impacts of continued Oconee Station operation on these two counties.

Refueling outages occur on a 58-month cycle for all three units on a staggered schedule, with one fall outage scheduled during odd years, and spring and fall outages scheduled for even years. Refueling outages last approximately 30 days and an additional 800 to 900 workers are onsite during a typical outage.

3.10.2 Regional Economic Characteristics

Goods and services are needed to operate the Oconee Station site. Although procured from a wider region, some portion of these goods and services are purchased directly from within the socioeconomic ROI. These transactions sustain existing jobs and maintain income levels in the local economy. This section presents information on employment and income in the Oconee Station socioeconomic ROI.

According to the U.S. Census Bureau's (USCB) 2017–2021 American Community Survey 5-Year Estimates, the educational services and healthcare and social assistance industry represented the largest employment section in the socioeconomic ROI, followed by manufacturing (USCB 2022-TN9034). The Oconee County and Pickens county civilian labor force was 97,121 persons and the number of individuals employed was 92,280 (USCB 2022-TN9034). Estimated income information for the socioeconomic ROI is presented in Table 3-16. As shown in Table 3-16, people living in the two-county ROI had a median household income less than the State average. Additionally, the percentage of individuals living below the poverty level in Oconee and Pickens counties was higher than the percentage of individuals living below the poverty level in the State of South Carolina.

According the USCB 2017–2021 American Community Survey 5-Year Estimates, the unemployment rate in Oconee County and Pickens County were 6.1 and 4.4 percent, respectively. Comparatively, the unemployment rate in South Carolina during the same time period was 5.3 percent (USCB 2022-TN9034).

Table 3-16 Estimated Income Information for the Oconee Station Socioeconomic Region of Influence (2017–2021, 5-Year Estimates)

Parameter	Oconee County	Pickens County	South Carolina
Median household income (dollars)[(a)]	52,842	53,188	58,234
Per capita income (dollars)[(a)]	32,986	29,218	32,823
Families living below the poverty level (percent)	10.2	8.8	10.4
People living below the poverty level (percent)	15.4	17.2	14.5

(a) In 2021 inflation-adjusted U.S. dollars.
Source: USCB 2022-TN9034.

3.10.3 Demographic Characteristics

According to the 2020 Census, an estimated 226,363 people lived within 20 mi (32 km) radius of Oconee Station, which equates to a population density of 180 persons per square mile (persons/mi^2) (Duke Energy 2023-TN8952). This amount translates to a Category 4, “Least sparse” population density using the LR GEIS (NRC 1996-TN288) measure of sparseness, which is defined as “greater than or equal to 120 persons per square mile within 20 mi [32 km].” An estimated 1,549,634 people live within a 50 mi (80 km) radius of the Oconee Station site, which equates to a population density of 197 persons/mi^2 (Duke Energy 2023-TN8952). This translates to a Category 4 proximity index. Therefore, Oconee Station is in a “high” population area based on the LR GEIS spareness and proximity matrix (NRC 1996-TN288).

Table 3-17 shows population projections and percent growth from 1990 to 2060 for Oconee and Pickens Counties. During the last several decades, both counties have experienced increasing population. Based on population projections, the population in both counties is expected to continue to increase, but at a slower rate.

Table 3-17 Population and Percent Growth in Oconee Station Socioeconomic Region of Influence Counties 1990–2020 and 2030–2060 (Projected)

Year	Oconee County Population	Oconee County Percent Change	Pickens County Population	Pickens County Percent Change
1990	57,494	-	93,894	-
2000	66,215	15.2	110,757	18.0
2010	74,273	12.2	119,224	7.6

Year	Oconee County Population	Oconee County Percent Change	Pickens County Population	Pickens County Percent Change
2020	78,607	5.8	131,404	10.2
2030	84,940	8.1	135,865	3.4
2040	88,493	4.2	143,818	5.9
2050	96,554	9.1	156,206	8.6
2060	102,711	6.4	165,838	6.2

No table entry has been denoted by "–".
Sources: 1900 data from USCB 1992-TN9035; 2000 data from USCB 2001-TN9036; 2010 data from USCB 2012-TN9037; 2020 data from USCB 2022-TN9038; 2030–2040 Projected Data from Appalachian Council of Governments ACOG 2022-TN9039; 2050–2060 projected population calculated by NRC.

The 2020 Census demographic profile of the Oconee Station ROI population is presented in Table 3-18. According to the 2020 Census, minorities (race and ethnicity combined) comprised approximately 18.1 percent of the total population for the ROI. The largest minority population in the ROI were Black or African American of any race (6.4 percent of the total population; 36 percent of the total minority population). According to the USCB's 2020 census, since 2010, minority populations in the two-county ROI were estimated to have increased approximately by 12,336 persons, and now comprise 18 percent of the population (see Table 3-18). The largest changes occurred in the population of people who identify themselves as two or more races (not Hispanic or Latino), which grew by more than 6,600 persons since 2010.

Table 3-18 Demographic Profile of the Population in the Oconee Region of Influence in 2020

Demographics	Oconee County	Pickens County	Region of Influence
Total Population	**78,607**	**131,404**	**210,011**
Percent White race	82.3	81.6	81.9
Percent Black or African American race	6.5	6.4	6.4
Percent American Indian and Alaska Native race	0.2	0.2	0.2
Percent Asian race	0.8	2.1	1.6
Percent Native Hawaiian and other Pacific Islander race	0.0	0.0	0.0
Percent some other race	0.2	0.3	0.3
Percent two or more races	4.4	4.3	4.3
Hispanic, Latino, or Spanish Ethnicity of any race (total population)	4,384	6,572	10,956
Percent Hispanic, Latino, or Spanish Ethnicity of any race of total population	5.6	5.0	5.2
Total minority	13,911	24,157	38,068
Percent of total population	17.7	18.4	18.1

Source: USCB 2020-TN9040.

3.10.3.1 Transient Population

Oconee County and Pickens County can experience seasonal transient population growth as a result of local tourism, recreational activities, or college and university attendance. For instance, there are four State parks, three County parks, multiple camping areas, the Sumter National Forest, and multiple lake and river recreational resources in Oconee County. Pickens County has a number of parks, including Table Rock State Park, Mile Creek Park, and Keowee-Toxaway State Park (Pickens County 2022-TN9041). In 2022, approximately 28,466 students were enrolled in Clemson University (Clemson University 2022-TN9042). A transient population creates a demand for temporary housing and service in the area. Based on the Census Bureau's 2017–2021 American Community Survey 5-Year Estimates (USCB 2021-TN9043), 4,844 seasonal housing units are located in the two-county socioeconomic ROI.

3.10.3.2 Migrant Farm Workers

Migrant farm workers are individuals whose employment requires travel to harvest agricultural crops. These workers may or may not have a permanent residence. Some migrant workers follow the harvesting of crops, particularly fruit, throughout rural areas of the United States. Migrant workers may be members of minority or low-income populations. Because they travel and can spend a significant amount of time in an area without being actual residents, migrant workers may be unavailable for counting by census takers. If uncounted, these minority and low-income workers would be under-represented in the decennial Census population counts.

Since 2002, the Census of Agriculture reports the numbers of farms hiring migrant workers. Migrant workers, as defined by the Census of Agriculture, are farm workers whose employment requires travel that prevents the worker from returning to their permanent place of residence the same day (USDA 2019-TN9044). The Census of Agriculture is conducted every 5 years and results in a comprehensive compilation of agricultural production data for every county in the Nation.

Information about both migrant and temporary farm labor (i.e., working fewer than 150 days) can be found in the 2017 Census of Agriculture (at the time of publication of this EIS, the 2022 Census of Agriculture data was not yet available). Table 3-19 presents information on migrant and temporary farm labor in Oconee County and Pickens County. According to the 2017 Census of Agriculture, 481 farm workers were hired to work for fewer than 150 days and were employed on 201 farms in the two-county ROI. One farm in Pickens County reported hiring migrant workers.

Table 3-19 Migrant Farm Workers and Temporary Farm Labor in Oconee County and Pickens County

County	Number of Farms with Hired Farm Labor[(a)]	Number of Farms Hiring Workers for Less Than 150 days[(a)]	Number of Farm Workers Working for Less Than 150 days[(a)]	Number of Farms Reporting Migrant Farm Labor[(a)]
Total	276	201	481	1
South Carolina County—Oconee	152	98	200	N/A
South Carolina County—Pickens	124	103	281	1

N/A = not available; ROI = region of influence.
Note: ROI counties are in bold italics.
(a) Source: Table 7. Hired farm Labor—Workers and Payroll: 2017 (USDA 2019-TN9044).

3.10.4 Housing and Community Services

This section presents information on housing and local public services, including education and water supply.

3.10.4.1 Housing

Table 3-20 lists the total number of occupied and vacant housing units, vacancy rates, and median values in the two-county ROI. Based on the USCB’s 2017–2021 American Community Survey 5-year estimates, there were 96,462 housing units in the ROI, of which 81,851 were occupied. The median values of owner-occupied housing units in the ROI range from $169,900 in Oconee County to $166,800 in Pickens county. The homeowner vacancy rate was approximately 1.1 percent in Oconee county and 0.9 percent in Pickens county (USCB 2021-TN9045).

Table 3-20 Housing in the Oconee Station Region of Influence (2017–2021, 5-Year Estimate)

Parameter	Oconee County	Pickens County	Region of Influence
Total housing units	**40,531**	**55,931**	**96,462**
Occupied housing units	32,413	49,438	81,851
Total vacant housing units	8,118	6,493	14,611
Percent total vacant	20.0	11.6	17.9
Owner-occupied units	24,131	34,040	58,171
Median value (dollars)	169,900	166,800	168,086[(a)]
Owner vacancy rate (percent)	1.1	0.9	1.0[(b)]
Renter-occupied units	8,282	15,398	23,680
Median rent (U.S. dollars/month)	801	842	828[(c)]
Rental vacancy rate (percent)	7.6	6.3	6.8[(b)]

(a) Weighted average by owner-occupied units in Oconee County and Pickens County.
(b) Weighted average by total housing units in Oconee County and Pickens County.
(c) Weighted average by occupied units paying rent in Oconee County and Pickens County.
Source: USCB 2021-TN9045.

3.10.4.2 Education

The Oconee County School District comprises 16 public schools, with a total of 10,232 students as of October 2022 (School District of Oconee County 2022-TN9046). These 16 public schools include 10 elementary schools, three middle schools, and three high schools. The Oconee County School District budget was approximately $84 million dollars for the 2019–2020 school year (Oconee County 2019-TN9047). The Pickens County School District comprises 23 public schools, with approximately 16,400 students for the 2020–2021 school year (School District of Pickens County [SDPC]; SDPC 2020-TN9048). These 23 public schools include 14 elementary schools, 5 middle schools, and 4 high schools. The Pickens County School District budget for the 2022–2023 school year was approximately $146 million dollars (SDPC 2022-TN9049).

3.10.4.3 Public Water Supply

Water service is provided to residents of Oconee County by 22 community water systems, of which seven are public water systems (Oconee County 2020-TN9067). Major water sources for Oconee County include Lake Keowee, Chauga Creek, Coneross Creek, and Lake Hartwell. In Oconee County, water treatment is primarily provided by four plants: the City of Seneca Water Treatment Plant, the City of Walhalla Coneross Creek Water Treatment Plant, the City of Westminster Water Treatment Plant, and the Robert J. Stevenson Water Treatment Plant. Table 3-21 presents the capacity, average daily demand, and water source for each of these water treatment plants. At the Oconee Station site, water from the City of Seneca Water Treatment Plant is used for potable water (Duke Energy 2021-TN8897).

Wastewater treatment in Oconee County is provided by the Oconee Joint Regional Sewer Authority's Coneross Creek Wastewater Treatment Plant. The Coneross Creek Wastewater Treatment Plant has a capacity of 7.8 million gallons per day (mgd) (0.3 cubic meters/second [m^3/sec]) and an average daily flow of 3 mgd (0.1 m^3/sec) (Oconee County 2020-TN9067). Additionally, the Oconee Joint Regional Sewer Authority owns and operates a wastewater conveyance system that consists of 60 mi (97 km) of gravity sewer,18 pump stations, 20 mi (32 km) of force mains, and three permanent flow-monitoring stations. Public wastewater is managed by five providers.

Table 3-21 Oconee County Water Treatment Plant Characteristics

Water Treatment Plant	Capacity (mgd)[(a)]	Average Daily Demand (mgd)	Water Sources
City of Seneca Water Treatment Plant	20	6.5	Lake Keowee
City of Walhalla Coneross Creek Water Treatment Plant	3	1.9	Coneross Creek
City of Westminster Water Treatment Plant	4	2	Chauga River
Robert J Stevenson Water Treatment Plant	2.5	-	Lake Hartwell

(a) million gallons per day (mgd)
Source: Oconee County 2020-TN9067.

The Pickens County Water and Sewer Authority operates all water distribution systems in Pickens County. There are 14 municipal water districts in Pickens County that supply water to customers, three water sellers that wholesale water to the districts, and five water treatment facilities (Pickens County 2022-TN9041; Clemson Strom Thurmond Institute 2012-TN9050). The primary sources source of water for Pickens County include Lake Keowee, Lake Hartwell, Twelve Mile Creek, the City Lake, and Lake Saluda. Wastewater treatment in Pickens County is provided by the Pickens County Public Service Commission, the City of Pickens, the Easley Combined Utilities, and the City of Clemson. The Pickens County Public Service Commission operates six wastewater facilities which have a total capacity of 2.9 mgd (0.1 m^3/sec) (Pickens County-TN9051). The City of Pickens operates the Twelve Mile River wastewater treatment plant with a capacity of 0.95 mgd (0.04 m^3/sec) (City of Pickens-TN9052). The Easley Combined Utilities operates three wastewater treatment plants with a total capacity of 4.9 mgd (0.2 m^3/sec) (ECU-TN9053). The City of Clemson jointly operates with the City of Pendleton one wastewater treatment plant with a total capacity of 2.0 mgd (Pendleton South Carolina-TN9054).

3.10.5 Tax Revenue

The State of South Carolina does not have a State-level property tax. Counties, cities, and school districts are authorized to impose ad valorem taxes on real and personal property. Oconee County bills and collects its own property taxes. Oconee County also collects taxes and their disbursement for the Keowee Key Fire District and the Oconee County School District. Property taxes are levied on the assessed value of real and personal property. As discussed below, Duke Energy pays property taxes on behalf of the Oconee Station site to Oconee County.

The Oconee County budget is comprised of appropriations from various sources. The total Oconee County revenues for fiscal years 2018–2022 are presented in Table 3-22. Property taxes are a significant source of Oconee County funding. For instance, property tax revenues have ranged from 60 to 67 percent of the total Oconee County revenues between 2018–2022. Oconee County revenues fund various programs, including public safety, public works, transportation, general government, culture and recreation, education, health and welfare, and economic development (Oconee County 2021-TN9055). Oconee Station property tax payments for 2018–2022 are also presented in Table 3-22.

Table 3-22 Duke Energy Tax Payments, 2018–2022

Parameter	2018	2019	2020	2021	2022
Oconee county revenues[(a)]	64,559,875	68,100,110	72,021,067	77,975,524	86,661,419
Fiscal year Oconee county property tax revenue[(a)]	43,219,013	44,172,858	46,988,932	49,241,399	52,080,875
Oconee power station annual property tax paid[(b)]	19,892,944[(b)]	18,235,040[(b)]	20,365,583[(b)]	24,398,227	23,892,267
Oconee proportion of total county revenue	31%	27%	28%	31%	28%

(a) Source: Oconee County 2022-TN9058, Oconee County 2021-TN9059, Oconee County 2020-TN9060, Oconee County 2019-TN9057; Oconee County 2018-TN9061.
(b) Tax property paid include accounts for manufacturer tax exemption and tax adjustments.
Source: Duke Energy 2023-TN8952.

In 2017, the State of Carolina provided partial exemption from property taxes for the value of manufacturing property assessed for property tax purposes (SDCR 2018-TN9056). The partial exemption is phased in over six equal and cumulative percentage installments starting with the 2018 property tax year. However, the State of South Carolina concluded that a power company does not qualify as a manufacturer under the statute (Duke Energy 2021-TN8897). In 2019, Duke Energy contested the State of South Carolina's decision that a power company does not qualify as a manufacturer. On December 21, 2020, the South Carolina Administrative Law Court issued a decision and held that Duke Energy is a manufacturer for South Carolina property tax purposes; and therefore, the property qualifies for a partial manufacturing property tax exemption in South Carolina. Furthermore, the Court ruled that Duke Energy is entitled to the exemption for all the property used in manufacturing; but property not used in manufacturing is not eligible for the exemption. However, a determination was not made as to what portion of the property is eligible for the property tax exemption; and on October 7, 2021, the Court issued a decision concluding that more evidence is needed to determine what portion of the property qualifies for the exemption and parties are conducting discovery (Duke Energy 2022-TN8948). Subsequently, Duke Energy resolved the exemption determination for tax years 2018 through 2020 and received a tax reduction for those years (reflected in Table 3-22). However, there will be no tax reduction going forward because the State of South Carolina has changed the law to exclude electric companies from the property tax exemption. (Duke Energy 2021-TN8897, Duke Energy 2022-TN8948, Duke Energy 2023-TN8952).

In addition to property taxes, Duke Energy makes payments to Oconee County for the Duke Energy Fixed Nuclear Facility Fund for preparation and evaluation of radiological response and preparedness (Oconee County 2019-TN9057). Furthermore, Duke Energy employees annually participate in charitable fundraising. In 2018, Duke Energy employees, along with the Duke Energy Foundation community grants, contributed $109,000 to United Way of Oconee, Baby Read, Youth Link, and the Education Foundation of Oconee County (Duke Energy 2021-TN8897; Duke Energy 2022-TN8948).

3.10.6 Local Transportation

The transportation network surrounding the Oconee Station site is comprised of interstate, State highways, and local roads. Interstate 85 (I-85) is a major interstate highway that runs southwest-northeast through South Carolina. Interstate I-85 is south of Oconee Station and intersects U.S. highways and State highways that link to State highways that provide access to the Oconee Station site. Access to the Oconee Station site is by way of SC 183 (E. Pickens Highway) and SC 130 (Rochester Highway) (Duke Energy 2021-TN8897). The SC 183 is a 53 mi (85 km) State highway that travels from Westminster to Greenville in a southeast-northeast direction. Near Oconee, SC 183 is a two-lane highway. The SC 130 is a 30 mi (48 km) State highway that generally travels in a south-north direction. Near Oconee, SC 130 is a two-lane highway. Table 3-23 lists the South Carolina Department of Transportation (SCDoT) ADDT volumes for these State highways for the 2020–2022 time period. As part of a 10 year Statewide plan, the SCDoT plans to improve the road safety of SC 183 (SCDoT 2021-TN9062). A start date for these improvements has not been established.

Table 3-23 South Carolina State Routes in the Vicinity of Oconee Station: Annual Average Daily Traffic Volume Estimates

Roadway and Location	Annual Average Daily Traffic Volume Estimates for 2022	Annual Average Daily Traffic Volume Estimates for 2021	Annual Average Daily Traffic Volume Estimates for 2020
Keowee River Road	1,700	1,750	1,500
SC 130 (Rochester Hwy) to County Line –Pickens (east of Oconee Station Entrance and West of Keowee River) (Station ID: 37-0245)	7,100	7,000	6,300
County Line – Oconee Station to S-157 (Gap Hill RD), L-157 (West of the Keowee River) (Station ID: 39-0368)	6,600	6,500	6,200
SC 183 (Rochester Hwy), S-15 to SC 183 (Pickens Hwy) (Station ID: 37-0211)	9,200	9,000	8,500
S 38 (Katelynn Lane) to SC 183 (Rochester Hwy), S-15 (Station ID: 370209)	7,400	7,200	6,900

Within a 10 mi (16 km) radius of Oconee Station, there are eight aviation airfields (Duke Energy 2021-TN8897). The nearest airport to Oconee Station is the Greenville-Spartanburg International Airport located east of Greenville, South Carolina. Amtrak rail also provides service to the region with the closest station to Oconee Station being located in Clemson, South Carolina.

3.10.7 Proposed Action

The following sections address the site-specific environmental impacts of the Oconee Station SLR on the environmental issues related to socioeconomics in accordance with Commission direction in CLI-22-02 and CLI-22-03.

3.10.7.1 Employment and Income, Recreation, and Tourism

Oconee Station and the communities that support it can be described as a dynamic socioeconomic system. The communities supply the people, goods, and services required to operate the nuclear power plant. Power plant operations, in turn, supply wages and benefits for people and dollar expenditures for goods and services. The measure of a community's ability to support Oconee Station operations depends on the community's ability to respond to changing environmental, social, economic, and demographic conditions. The following sections address the site-specific environmental impacts of Oconee Station SLR on five environmental issues related to socioeconomics. As discussed in Section 3.10.13.10.1 the majority of permanent workers (76 percent) reside in Oconee and Pickens County, and the most significant socioeconomic effects of plant operations are likely to occur in these counties. The focus of the impact analysis and ROI, therefore, is on the socioeconomic impacts of continued Oconee Station operations during the SLR period on Oconee and Pickens County.

Nuclear power plants generate employment and income in the local economy. Therefore, continued operations and refurbishment associated with SLR can impact employment, income, recreation, and tourism. Nuclear power plant operations provide employment and income and pays for goods and services from communities. Wages, salaries, and expenditures generated by nuclear plant operation create demand for goods and services in the local economy, while wage and salary spending by workers creates additional demand for services and housing. Additional employment and expenditures occur during refueling and maintenance outages and refurbishment activities at nuclear power plants. Payments for these goods and services create additional employment and income opportunities in the community. Communities located near nuclear power plants in coastal regions experience summer, weekend, and retirement population increases due to the recreational and tourism related activities that attract visitors. Some communities attract visitors interested in outdoor recreational activities. The aesthetic impacts of nuclear plant operations and refurbishment activities could potentially affect tourism and recreational businesses.

Duke Energy indicated in its environmental report that there are no SLR related refurbishment activities, and that Duke Energy has no plans to add additional employees to support nuclear power plant operations during the SLR term (Duke Energy 2021-TN8897, Duke Energy 2022-TN8948). In 2021, the Oconee and Pickens County combined civilian labor force was 97,121 persons and the number of employed persons was 92,280 (USCB 2022-TN9034). Oconee Station's permanent workforce (475 workers) residing in Oconee and Pickens County represents a small fraction of Oconee and Pickens County's combined employed civilian labor force (Duke Energy 2023-TN8952). In Section 3.3.1 of this EIS, the NRC considered the aesthetic impacts of Oconee Station continued operations and concluded that the impacts would be SMALL.

The effects of Oconee Station operations on employment, income, recreation, and tourism are ongoing and have become well established. The impacts from power plant operations during the license renewal term on employment and income in communities near nuclear power plants are not expected to noticeably change from those currently being experienced. Aesthetic impacts are SMALL and therefore are not expected to affect tourism and recreational businesses. As discussed above, the number of nuclear plant operation workers is not expected to change Therefore, SLR would not constitute new employment and new indirect jobs would not be created. Furthermore, Oconee Station's permanent workforce represent a small portion of Oconee and Pickens County's combined employed civilian workforce. Based on these considerations, the NRC staff concludes that impacts from continued nuclear plant operations during the SLR term on employment, income, recreation, and tourism would be SMALL.

3.10.7.2 Tax Revenues

Nuclear plants provide tax revenue to local jurisdictions in the form of property tax payments, payments in lieu of tax payments, or tax payments related to energy production. Changes in the workforce and property taxes or property tax payments, payments in lieu of taxes paid to local governments and public schools can directly affect socioeconomic conditions in the counties and communities near the nuclear power plant. Property tax assessments, settlements, and agreements, and State tax laws are continually changing the amount of taxes paid to tax jurisdictions by nuclear plant owners, independent of license renewal or refurbishment activities. Tax revenues may be used by local, regional, and State governmental entities to fund education, public safety, local government services, and transportation. In smaller rural communities, power plant tax revenues can affect the level and quality of public services available to local residents. Even in semiurban regions, revenues from power plants provide support for public services at the local level. The primary impact of SLR would be the continuation of the receipt of tax revenue to local governments and public-school districts.

As discussed in Section 3.10.5 of this EIS, the State of South Carolina does not have a State-level property tax. Oconee County bills and collects its own property taxes. The Oconee County budget is comprised of appropriations from various sources. Duke Energy pays property taxes on behalf of the Oconee Station site to Oconee County. The total Oconee County revenues and annual property tax payments made on behalf of Oconee Station for fiscal years 2018–2022 are presented in Table 3-22 of this EIS. Oconee property tax payments represent 27–31 percent of the total Oconee County tax revenues. In the initial license renewal Supplemental EIS for Oconee Station (NUREG-1437, Supplement 2), the NRC staff noted that Duke Energy paid $22.3 million in property taxes to Oconee County for fiscal year 1999. The NRC concluded that the tax revenue impacts from operation of Oconee Station are positive, but SMALL (NRC 1999-TN8942). Property tax payments have not substantially changed between 1999 and those for years 2018–2022, as compared and presented in Table 3-22.

Duke Energy does not expect there to be a noticeable or significant change in future property tax payments during the SLR period (Duke Energy 2021-TN8897 and Duke Energy 2022-TN8948). Given that Duke Energy does not plan to conduct refurbishment activities during the SLR term, changes to the assessed value of Oconee Station are not anticipated from these activities. Tax payments during the SLR term would be similar to those already being paid and impacts would be the same as previously experienced. Based on these considerations, the NRC staff concludes that the impacts from continued nuclear plant operations during the SLR term on tax revenue would be SMALL.

3.10.7.3 Community Services and Education

Nuclear plant operations and refurbishment activities as a result of workforce changes can affect the availability and quality of community (i.e., public safety and public utilities) and educational services. An increase in operations and refurbishment activity and related populations can increase the demand and cause disruption of community services and education. The impact on community and educational services will depend on the projected number of in-migrating workers and their families during the renewal term and the ability to respond to the level of demand for services. Tax payments from nuclear power plants can support a range of community services and have a beneficial impact on the quality and availability of these services to local residents.

Section 3.10.4.2 of this EIS discusses the Oconee and Pickens County Public School Districts. In South Carolina, the average student-teacher ratio in any school should not exceed 28 to 1 ratio based on the average daily enrollment (SBE Regulation 43-205). Oconee and Pickens County Public School Districts both meet this requirement with a student ratio of 23.3 to 1 and 26 to 1, respectively (SDoE 2023-TN9064). Section 3.10.4.3 of this EIS discusses the public water services for Oconee and Pickens Counties. As can be seen in Table 3-21, the capacity of Oconee County water treatment plants exceeds demand. Capacity and demand data was not readily available for water treatment plants in Pickens County.

Duke Energy indicated in its supplemental environmental report that there are no subsequent license renewal related refurbishment activities, and that Duke Energy has no plans to add additional employees to support plant operations during the subsequent license renewal term (Duke Energy 2022-TN8948). Therefore, continued operations of Oconee Station will not result in an increase in or additional demand for services as a result of an influx of permanent workers during the SLR term. Any potential increase in demand for community and educational services would be from the increase in number of workers at Duke Energy during regular scheduled plant refueling and maintenance outages. However, impacts to community and education services during the subsequent license renewal period would be the same as those that have occurred during past operations of Oconee Station.

Given that workforce changes would are not expected to occur at Oconee Station during the SLR term, the plant’s demand and effects on community service and education in the vicinity of the plant are not expected to change from what is currently being experienced. As discussed above, existing services in Oconee and Pickens Counties are adequate and impacts on community services and education during the SLR term would be the same to those that have occurred during past operations. Therefore, the NRC staff concludes that community services and education impacts due to continued nuclear power plant operations at Oconee Station would be SMALL.

3.10.7.4 Population and Housing

Population and housing demand and availability can be affected by changes in the numbers of workers at a nuclear power plant related to continued operations and refurbishment activities. Population growth from employment at a nuclear power plant is one of the main drivers of socioeconomic impacts. Population growth can occur as a result of an increase in the number of permanent onsite employees during the SLR term, as well as increase in the number of workers at a nuclear power during regularly scheduled plant refueling and maintenance outages and during refurbishment activities. Plant refueling and maintenance outages and refurbishment activities, however, are of temporary and short duration and therefore create a short-term increase in employment. Housing in the vicinity of nuclear power plants ranges in the number of housing units and the type and quality of available housing. Long-term housing demand can be affected by changes in the number of permanent onsite employees. Short-term increase in the demand for temporary (rental) housing occurs during periodic outages or refurbishment activities, when refueling and maintenance workers require rental accommodations.

Table 3-17 shows the population percent growth and projections from 1990 to 2060 in Oconee and Pickens County. During the last several decades, both counties have experienced increasing population. Based on population projections, the populations in both counties are expected to continue to increase, but at a slower rate. Duke Energy employs a permanent workforce of 622 (Duke Energy 2023-TN8952). Approximately 72 percent of this workforce resides in Oconee and Pickens County. Oconee Station has no plans to add additional employees to support plant operations during the SLR period and there are no SLR related refurbishment activities (Duke Energy 2021-TN8897, Duke Energy 2022-TN8948). Therefore, SLR would not constitute new employment. Any population increase would be from the increased number of workers at Oconee Station during regularly scheduled plant refueling and maintenance outages. Refueling outages occur on a 58-month cycle for all three units on a staggered schedule, with one fall outage scheduled during the odd years, and spring and fall outages scheduled for even years. Refueling outages last approximately 30 days and additional 800 to 900 workers are onsite during a typical outage. Outage workers represent less than 1 percent of the 2020 and the 2030–2060 projected population in Oconee and Pickens Counties. Furthermore, plant refueling and maintenance outages and refurbishment activities are of temporary and short duration and therefore create a short-term increase in employment and population changes.

Because Duke Energy has no plans to add additional employees to support plant operations during the SLR period and there are no SLR-related refurbishment activities, increases in housing demand would occur as a result of the short-term increase in the number of workers (800 to 900 workers for 30 days) during regularly scheduled plant refueling and maintenance outages. Table 3-20 presents the total number of occupied and vacant housing units in Oconee and Pickens Counties. Based on the United Stated Census Bureau’s 2021 American Community Survey 5-year estimates, there were 96,462 housing units in Oconee and Pickens counties, of which 14,611 were vacant, and 4,844 housing units are vacant for seasonal, recreational, or occasional use. Therefore, Oconee and Pickens Counties have available vacant housing units to support the outage workforce.

The operational effects on population and housing values and availability in the vicinity of nuclear power plants are not expected to change from what is currently being experienced. The NRC staff concludes that little or no population growth or increased demand for permanent housing would occur during the SLR term. Therefore, the NRC staff concludes that population and housing impacts due to continued power plant operations at Oconee Station during the SLR term would be SMALL.

3.10.7.5 Transportation

Continued operations and refurbishment associated with the SLR term can affect traffic volumes and local transportation systems. Local and regional transportation networks in the vicinity of nuclear power plant sites may vary considerably depending on the regional population density, location, and size of local communities, nature of economic development patterns, location of the region relative to interregional transportation corridors, and land surface features, such as mountains, rivers, and lakes. Transportation impacts depend on the size of the workforce, the capacity of the local road network, traffic patterns, and the availability of alternate commuting routes to and from the nuclear plant.

The transportation network surrounding the Oconee Station site is described in Section 3.10.6 of this EIS. Table 3-23 presents annual average daily traffic (AADT) volume estimates in the vicinity of Oconee Station. Traffic flow has stayed consistent over the years. The SC 183 and SC 130, provide access to the Oconee Station site, have a reported AADT of 7,100 (296 vehicles/hour [vehicles/h]) and 9,200 (383 vehicles/h), respectively. Near the Oconee Station site, SC 183 and SC 130 are two-lane highways. According to the Highway Capacity Manual, the capacity of a two-lane highway is 3,200 passenger vehicles/h (TRB 2000-TN9065). Therefore, there is sufficient capacity available on SC 183 and SC 130.

Duke Energy indicated in its supplemental ER that there are no SLR-related refurbishment activities, and that Duke Energy has no plans to add additional employees to support plant operations during the SLR term (Duke Energy 2022-TN8948). Increases in the number of workers would occur during regularly scheduled plant refueling and maintenance outages. During refueling outages, onsite employment typically increases by an additional 800–900. However, because of the short duration of the outages (30 days), outages result in short-term increases in traffic volumes and, as noted above, roads in the vicinity of Oconee Station have sufficient capacity to accommodate additional traffic.

Transportation impacts are ongoing and have become well established in the vicinity of Oconee Station. Given that the size of the workforce is not expected to increase during the SLR term and the capacity availability of roads in the vicinity of Oconee Station, traffic on the roads surrounding the Oconee Station site would not noticeably increase relative to the current traffic volumes as a result of SLR. No transportation impacts during the license renewal would occur beyond those already being experienced. Therefore, the NRC staff concludes that the transportation impacts from continued operation of Oconee Station during the SLR term would be SMALL.

3.10.8 No-Action Alternative

3.10.8.1 Socioeconomics

Under the no-action alternative, the NRC would not issue subsequent renewed operating licenses, and the Oconee Station site would permanently shut down on or before the expiration of the current renewed operating licenses. This would have a noticeable impact on socioeconomic conditions in the counties and communities near the Oconee Station site. Socioeconomic impacts from the termination of reactor operations would be concentrated in Oconee County and Pickens County. As jobs are eliminated, some, but not all, of the approximately 622 permanent workers could begin to leave the region. If Oconee Station workers and their families move out of the region, increasing housing vacancies and decreased demand could cause housing prices to fall.

The loss of tax revenue would result in the reduction or elimination of some public and educational services. As discussed in Section 3.10.5, Oconee Station property tax payments represent 27–31 percent of Oconee County's total tax revenue (Duke Energy 2023-TN8952). As noted in Oconee County's annual budget, any change in the assessment of the Oconee Station site property value could significantly impact the County's tax revenue (Oconee County 2021-TN9055). Therefore, a reduction in property value as a result of nuclear power plant shutdown can have a noticeable and significant loss to Oconee County's tax revenue. Therefore, the NRC staff concludes that the socioeconomic impacts from the no-action alternative would be MODERATE to LARGE.

3.10.8.2 Transportation

Traffic volume as a result of commuting workers and truck deliveries on roads in the vicinity of Oconee Station Units 1, 2, and 3 would be reduced after a nuclear power plant shutdown. The reduction in traffic would be associated with the loss of jobs. Similarly, truck deliveries to Oconee Station would be reduced. Therefore, the NRC staff concludes that traffic-related transportation impacts would be SMALL.

3.10.9 Replacement Power Alternatives: Common Impacts

The following provides a discussion of the common socioeconomic and transportation impacts during construction and operations of replacement power-generating facilities.

3.10.9.1 Socioeconomics

Socioeconomic impacts are defined in terms of changes in the social and economic conditions of a region. For example, the creation of jobs and the purchase of goods and services during the construction and operation of a replacement nuclear power plant could affect regional employment, income, and tax revenue. The socioeconomic ROI would depend on where workers and their families reside, spend their income, and use their benefits, thus affecting the economic conditions of the region. For each alternative, two types of jobs would be created: (1) construction jobs, which are transient, short in duration, and less likely to have a long-term socioeconomic impact, and (2) operations jobs, which have the greater potential for permanent, long-term socioeconomic impacts. The following provides a discussion of the common socioeconomic and transportation impacts during construction and operations of replacement power alternatives.

<u>Construction</u>

The relative economic effect of an influx of workers on the local economy and tax revenue would vary and depend on the size of the workforce and construction completion time. The greatest impact would occur in the communities where the majority of construction workers would reside and spend their incomes. While some construction workers would be local, additional workers may be required from outside the immediate area depending on the local availability of appropriate trades and occupational groups. The construction workforce would stimulate spending on goods and services resulting in the creation of indirect jobs. The ROI could experience a short-term economic boom during construction from increased tax revenue, income generated by expenditures for goods and services, and the increased demand for temporary (rental) housing. After construction, the ROI would likely experience a return to preconstruction economic conditions. The economic effect from construction would include increased tax revenue, additional wages and benefits, and increased income generated by operational expenditures. Overall, the relative socioeconomic impact from job creation, labor wages and salaries, and additional tax revenue as a result of construction, while beneficial, would depend on the tax structure of the local economy, availability of local workforce and worker migration, and location of major equipment suppliers.

<u>Operation</u>

Before the commencement of startup and operations, local communities could see an influx of operations workers and their families resulting in an increased demand for permanent housing and public services. These communities would also experience the economic benefits from increased income and tax revenue generated by the purchase of goods and services needed to operate a new replacement nuclear power plant. Consequently, operations would have a greater potential for effecting permanent, long-term socioeconomic impacts on the region. As would be the case for construction, the impacts from operations on employment and income in the local area and region around a facility would vary depending on the location of major equipment suppliers and the availability of local labor. The economic effects from operating a new facility could include increased tax revenue from property and sales tax, additional wages, increased income generated by operational expenditures, and increased demand for housing. The relative socioeconomic impact would depend on the tax structure of the local economy, availability of local workforce and worker migration, and available housing.

3.10.9.2 Transportation

Transportation impacts are defined in terms of changes in level-of-service conditions on local roads in the region. Additional vehicles on local roadways during construction and operations could lead to traffic congestion, level-of-service impacts, and delays at intersections. Transportation impacts depend on the size of the workforce and additional vehicles, the capacity of the local road network and infrastructure, and baseline traffic conditions and patterns.

Construction

Transportation impacts during the construction of a replacement nuclear power plant would consist of commuting workers and truck deliveries of equipment and material to the construction site. Workers would arrive by way of site access roads, and the volume of traffic would increase during shift changes. In addition, trucks would transport equipment and material to the construction site, thus increasing the amount of traffic on local roads. The increase in traffic volumes could result in levels of service impacts and delays at intersections during certain hours of the day. In some instances, construction material could also be delivered by rail or barge.

Operation

Traffic-related transportation impacts would be greatly reduced after construction has been completed. Transportation impacts would include daily commuting by the operations workforce and deliveries of material, and the removal of commercial waste material by truck. Increased commuter traffic would occur during shift changes and deliveries of materials and equipment to the nuclear power plant.

3.10.10 New Nuclear (Advanced Light-Water Reactor and Small Modular Reactor) Alternative

3.10.10.1 Socioeconomics

Construction

Socioeconomic impacts from construction for the new nuclear alternative would include those discussed for all replacement power alternatives in Section 3.10.9.1. Construction of the SMR portion of the new nuclear alternative at the Oconee Station site would require 550 peak workers; which would represent approximately 0.6 percent of civilian labor force in Oconee County and Pickens County. As presented in Section 3.10.4, Oconee County and Pickens County have a combined total of 14,611 vacant units to adequately support 550 peak workers.

Tax revenue increases in the form of sales taxes in the region would occur. However, increases in property tax revenue would not be anticipated until construction is completed. Therefore, the NRC staff concludes that the impacts from construction of the SMR portion at the Oconee Station site of the new nuclear alternative would be SMALL.

The ALWR portion of this alternative would be comprised of two ALWR units providing 2,234 MWe of generating capacity. The NRC evaluated the economic impacts from construction of two ALWR units with a total net electrical output capacity of 2,234 MWe at the W.S. Lee Nuclear Station site in Section 4.4.3 of NUREG-2111 (NRC 2013-TN6435: pp. 4-87 through 4-90). The staff considered the impacts from construction workers, wages, sales tax, and payments in-lieu of taxes on the regional economy and taxes. The staff concluded in NUREG-2111 that the economic impacts from construction of two ALWR units would be SMALL and beneficial. The NRC staff incorporates the analysis in Section 4.8.2 of NUREG-2111 (pp. 4-87 through 4-90) herein by reference. In Sections 4.4.4.2, 4.4.4.3, 4.4.4.4, 4.4.4.5 and 4.4.4.6 of NUREG-2111 (pp. 4-92 through 4-98), the NRC staff considered the impacts of constructing two ALWR units at the W.S. Lee Nuclear Station site with a total net electrical output capacity of 2,234 MWe on public services, recreation, housing, and education. The staff concluded in NUREG-2111 that the impacts on public services, recreation, housing, and education would be minimal. The NRC staff incorporates the analysis in Sections 4.4.4.2, 4.4.4.3, 4.4.4.4, 4.4.4.5, and 4.4.4.6 of NUREG-2111 (pp. 4-92 through 4-98) here by reference. Therefore, the NRC staff concludes that the socioeconomic impacts from constructing the ALWR portion of the new nuclear alternative (two ALWR units at the W.S. Lee Nuclear Station site) would be SMALL.

Overall, the NRC staff concludes that the socioeconomic impacts associated with construction of the new nuclear alternative would be SMALL.

<u>Operations</u>

Socioeconomic impacts from operations for the new nuclear alternative would include those discussed for all replacement power alternatives in Section 3.10.9.1. Operation of the SMR portion of the new nuclear alternative would require 250 workers. This amount would represent approximately 0.26 percent of the civilian labor force in Oconee County and Pickens County. As presented in Section 3.10.4, Oconee County and Pickens County have a combined total of 14,611 vacant units to adequately support 250 workers. Tax revenues would increase from sales taxes and property taxes. However, the SMR would be a single 400 Mwe unit with a relative small land requirement (36 ac [15 ha]). Therefore, the NRC staff concludes that the socioeconomic impacts operations of the SMR portion of the new nuclear alternative would be SMALL.

The ALWR of this alternative would be comprised of two ALWR units providing 2,234 Mwe of generating capacity. The NRC evaluated the economic impacts from operations of two ALWR units with a total net electrical output capacity of 2,234 Mwe at the W.S. Lee Nuclear Station site in Section 5.4.3 of NUREG-2111 (NRC 2013-TN6435: pp. 5-46 through 5-49). The staff considered the impacts from the operations workforce, indirect jobs, wages, sales tax, and payments in-lieu of taxes (rather than property taxes) on the regional economy. Because of the significant fee-in-lieu payments, the NRC staff concluded that the economic impacts would be LARGE and beneficial. In Sections 5.4.4.2, 5.4.4.3, 5.4.4.4, 5.4.4.5 and 5.4.4.6 of NUREG-2111 (pp. 5-50 through 5-53), the NRC staff considered the impacts from operations of two ALWR units at the W.S. Lee Nuclear Station site on public services, recreation, housing, and education. The staff concluded in NUREG-2111 that the impacts on public services, recreation, housing, and education would be SMALL because of the small relative workforce. The NRC staff incorporates the analysis in Sections 5.4.4.2, 5.4.4.3, 5.4.4.4, 5.4.4.5 and 5.4.4.6 of NUREG-2111 (pp. 5-50 through 5-53), herein by reference. Therefore, the NRC staff concludes that the socioeconomic impacts from operations of the ALWR portion (two ALWR units at the W.S. Lee Nuclear Station site) of the new nuclear alternative would be LARGE and beneficial.

Overall, the NRC staff concludes that the socioeconomic impacts associated with operations of the new nuclear alternative would be LARGE.

3.10.10.2 Transportation

Construction

Construction of the SMR portion of the new nuclear alternative would consist of an additional 550 worker vehicles during peak construction as well as truck deliveries. As discussed in Section 3.10.6, access to the Oconee Station site is by way of the two-lane State Highway SC 183 and SC 130. According to the Highway Capacity Manual, the capacity of a two-lane highway is 3,200 passenger vehicles/hour (TRB 2000-TN9065). The SC 183 and SC 130 have a reported AADT of 7,100 (296 vehicles/h) and 9,200 (383 vehicles/h), respectively (see Table 3-23 of this EIS). Conservatively assuming that all 550 vehicles would be on State Highway SC 183 or SC 130 at the same time (not accounting for shift changes), there would be sufficient capacity available on SC 183 (74 percent) and SC 130 (71 percent). Therefore, the NRC staff concludes that the transportation impacts from construction of the SMR portion of the new nuclear alternative would be SMALL.

The advanced light-water reactor portion of this alternative would be comprised of two ALWR units providing 2,234 MWe of generating capacity. The NRC evaluated the transportation impacts from construction of two ALWR units with a total net electrical output capacity of 2,234 MWe at the W.S. Lee Nuclear Station site in Section 4.4.4.1 of NUREG-2111 (pp. 4-90 through 4-92). The NRC staff considered the number of workers, number of shift changes throughout the day, number of truck deliveries, and capacity and use of the roads. The NRC staff concluded that during peak site employment, traffic from the W.S. Lee Nuclear Station site activities would have locally noticeable impacts in the immediate vicinity of the site, but not destabilizing. The NRC staff incorporates the analysis in Section 4.4.4.1 of NUREG-2111 (pp. 4-90 through 4-92). Therefore, the NRC staff concludes that the transportation impacts from construction of the ALWR portion would have the new nuclear alternative would be MODERATE.

Overall, the NRC staff concludes that the transportation impacts associated with construction of the new nuclear alternative would be MODERATE.

Operations

Operations of the SMR portion of the new nuclear alternative would consist of an additional 250 worker vehicles. According to the Highway Capacity Manual, the capacity of a two-lane high is 3,200 passenger vehicles/hour (TRB 2000-TN9065). SC 183 and SC 130 have a reported AADT of 7,100 (296 vehicles/hour) and 9,200 (383 vehicles/hr), respectively. (see Table 3-24 of this EIS). Conservatively assuming that all 250 vehicles would be on State Highway SC 183 or SC 130 at the same time (not accounting for shift changes), there would be sufficient capacity available on SC 183 (83 percent) and SC 130 (80 percent). Therefore, the NRC staff concludes that the transportation impacts from operations of the SMR portion would be SMALL.

The ALWR portion of this alternative would be comprised of two ALWR units providing 2,234 MWe of generating capacity. The NRC evaluated the transportation impacts from operations of two ALWR units with a total net electrical output capacity of 2,234 MWe at the W.S. Lee Nuclear Station site in Section 5.4.4.1 of NUREG-2111 (p. 5-50). The NRC staff considered the number of workers (950), number of shift changes throughout the day, and capacity and use of the roads. The NRC staff concluded that there is enough capacity on the nearby roads to support for the additional vehicles from operations. The NRC staff incorporates the analysis in Section 5.4.4.1 of NUREG-2111 (p. 5-50) in this EIS. Therefore, the NRC staff concludes that the transportation impacts from operation of the ALWR portion (two ALWR units at the W.S. Lee Nuclear Station site) would be MODERATE.

Overall, the NRC staff concludes that the transportation impacts associated with operations of the new nuclear alternative would be MODERATE.

3.10.11 Natural Gas Combined-Cycle Alternative

3.10.11.1 Socioeconomics

Construction

Socioeconomic impacts from construction of the natural gas alternative would include those discussed for all replacement power alternatives in Section 3.10.9.1. Construction of the natural gas alternative would require 1,000 peak workers; which would represent approximately 1.0 percent of civilian labor force in Oconee County and Pickens County. As presented in Section 3.10.4, Oconee County and Pickens County have a combined total of 14,611 vacant units to adequately support 1,000 peak workers. Tax revenue increases in the form of sales taxes and personal income tax in the region would occur. However, increases in property tax revenue would not be anticipated until construction is completed. Therefore, the NRC staff concludes that construction of the natural gas alternative would be beneficial, but SMALL.

Operations

Socioeconomic impacts from operations for the natural gas alternative would include those discussed for all replacement power alternatives in Section 3.10.9.1. Operations of the natural gas alternative would require 190 workers. Tax revenues would increase from sales taxes and property taxes. Given the number of units (i.e., six) and land requirement for natural gas alternative, property taxes could be noticeable given Oconee County’s small property tax base (see Section 3.10.5). Therefore, the NRC staff concludes that socioeconomic impacts from operations of a natural gas alternatives would be beneficial and SMALL to MODERATE.

3.10.11.2 Transportation

Construction

Construction of the natural gas alternative would consist of 1,000 worker vehicles during peak construction as well as truck deliveries. As discussed in Section 3.10.6, access to the Oconee Station site is by way of the two-lane State Highway SC 183 or SC 130. According to the Highway Capacity Manual, the capacity of a two-lane high is 3,200 passenger vehicles/h (TRB 2000-TN9065). The SC 183 and SC 130 have a reported AADT of 7,100 (296 vehicles/h) and 9,200 (383 vehicles/h), respectively (see Table 3-23 of this EIS). Conservatively assuming that all 1,000 vehicles would be on State Highway SC 183 at the same time (not accounting for shift changes), there would be sufficient capacity available on SC 183 (60 percent) or SC 130 (57 percent). However, the increase in traffic from an additional 1,000 vehicles would be noticeable. Therefore, the NRC staff concludes that the transportation impacts from construction of the natural gas alternative would be SMALL to MODERATE.

Operations

Operations of the natural gas alternative would consist of an additional 190 worker vehicles. Conservatively assuming that all 190 vehicles would be on State Highway SC 183 or SC 130 at the same time (not accounting for shift changes), there would be sufficient capacity (85 percent) available on SC 183 (85 percent) or SC 130 (82 percent). Therefore, the NRC staff concludes that the transportation impacts from operations of the natural gas alternative would be SMALL.

3.10.12 Combination Alternative (Solar PV, Offshore Wind, Small Modular Reactor, and Demand-Side Management)

3.10.12.1 Socioeconomics

Construction

The socioeconomic impacts from construction of the new nuclear portion of the combination alternative would include those discussed for all replacement power alternatives in Section 3.10.9.1. Impacts from construction of three 400-MWe small modular reactor units would be similar but greater than the impacts discussed under the single-unit 400-MWe SMR portion of the new nuclear alternative in Section 3.10.10.1. Construction of the new nuclear portion of the combination alternative would require 1,650 workers during peak construction. This amount would represent approximately 1.7 percent of the civilian labor force in Oconee County and Pickens County. The local communities would experience a short-term economic “boom” from increased tax revenue and income generated by construction expenditures and the increased demand for temporary housing. Given the relatively large construction workforce and Oconee County’s small tax base, the socioeconomic impacts could be noticeable. Therefore, the NRC staff concludes that the socioeconomic impacts from construction the new nuclear portion of the combination alternative would be SMALL to MODERATE.

The solar component of the combination alternative would consist of 12 utility-scale solar plants and require 1,100 workers during peak construction. The solar plants could be located at multiple sites across the ROI. A construction workforce of 1,100 could result in noticeable increase in housing demand, wages, or tax revenue depending on the location and the number of sites. Therefore, the NRC staff concludes that the socioeconomic impacts from constructing the solar portion would be SMALL to MODERATE.

Construction of offshore wind energy facility would provide temporary jobs for 300 workers during peak construction. Construction of offshore wind energy facilities would have beneficial impacts on tax revenues, employment, and economic activity. However, studies have found that the additional workforce during assessment activities and construction of offshore wind facilities have minor demographic and employment impacts around ports in North Carolina and South Carolina given the current population there (BOEM 2015-TN9066, BOEM 2021-TN7704). Any necessary modifications to ports during construction, such as for staging or cable landing installation, and increased vessel traffic could disrupt port activity and therefore tourism and recreation. Assessments have found that vessel traffic associated with construction of offshore wind energy facilities along the coasts of North Carolina and South Carolina would be relatively small relative to existing vessel traffic. Furthermore, impacts on recreation, tourism, and commercial fisheries were found to be minor (BOEM 2015-TN9066, BOEM 2021-TN7704).

Similarly, seafloor and acoustic disturbances are expected to have minor impacts on commercial and recreational fisheries (BOEM 2015-TN9066, BOEM 2021-TN7704). Therefore, the NRC staff concludes that the impacts from construction of the offshore wind portion of the combination alternative would be SMALL.

Overall, the NRC concludes that the socioeconomic impacts from construction of the combination alternative would be SMALL to MODERATE.

Operations

The socioeconomic impacts from operations of the new nuclear portion of the combination alternative would include those discussed for all replacement power alternatives in Section 3.10.9.1. Impacts from operations of three 400 MWe small modular reactor units would be similar but greater than the impacts discussed under the single 400 MWe small modular reactor unit portion of the new nuclear alternative in Section 3.10.10.1. Operations of the new nuclear portion of the combination alternative would require 750 workers. This amount would represent approximately 0.8 percent of the combined civilian labor force in Oconee County and Pickens County, respectively. As presented in Section 3.10.4, Oconee County and Pickens County have a combined total of 14,611 vacant units to adequately support 750 peak workers. Tax revenues would increase from sales taxes and property taxes. Given Oconee Station's small tax base, the property tax revenue from three 400 MWe SMR units would be noticeable. Therefore, the NRC staff concludes that the socioeconomic impacts of the new nuclear component of the combination alternative would be MODERATE.

A small number of workers would be needed to maintain and operate the solar portion of the combination alternative (50 workers). This amount would not result in a noticeable or substantial increase in housing demand, jobs, or wages. Operation of solar plants would generate tax revenue from operation expenditures and the large amount of land required to support this alternative (total 9,600 ac [3,900 ha]). The tax base and tax revenue could be substantial and noticeable depending on the location and number of sites. Therefore, the NRC staff concludes that the socioeconomic impacts from operations of the solar component would be SMALL to MODERATE.

Operations of the offshore wind portion would require 150 workers. Operations of offshore wind energy facilities would have beneficial impacts on tax revenues, employment, and economic activity. However, given the relatively small workforce, while beneficial, the additional workforce during operation would have minor demographic and economic impacts. Studies have found that offshore wind energy facilities have no effect on property values (BOEM 2018-TN8428). Given the distance to shore (10 to 24 nautical miles), meteorological towers and wind turbines would be minimally visible and property values due to visual effects would therefore be negligible. Increased vessel traffic would be relatively small and therefore, impacts on recreation, tourism, and commercial fisheries are expected to be minor. Therefore, the NRC staff concludes that the socioeconomic impacts from operations of the offshore wind portion of the combination alternative would be SMALL.

The demand-side management component could generate additional employment, depending on the nature of the conservation and energy efficiency programs and the need for direct measure installations in homes and office buildings. Jobs would likely be few and scattered throughout the region and would not have a noticeable effect on the local economy. Therefore, the NRC concludes that the socioeconomic impacts from the demand-side component would be SMALL.

Overall, the NRC concludes that the socioeconomic impacts from operations of the combination alternative would be MODERATE.

3.10.12.2 Transportation

Construction

Construction of the new nuclear portion of the combination alternative would consist of an additional 1,650 worker vehicles during peak construction as well as truck deliveries. Access to the Oconee Station site is by way of the two-lane State Highway SC 183 or SC 130. According to the Highway Capacity Manual, the capacity of a two-lane highway is 3,200 passenger vehicles/h (TRB 2000-TN9065). The SC 183 and SC 130 have a reported AADT of 7,100 (296 vehicles/h) and 9,200 (383 vehicles/h), respectively. Conservatively assuming that all 1,650 vehicles would be on State Highway SC 183 or SC 130 at the same time (not accounting for shift changes), there would be a significant reduction in capacity on SC 183 (39 percent) or SC 130 (36 percent). Therefore, the NRC staff concludes that the transportation impacts from construction of the advanced light-water reactor portion would be MODERATE.

Construction of solar component of the combination alternative would require 1,100 workers during peak construction. The solar plants could be located at multiple sites across the ROI. An additional 1,100 vehicles could result in noticeable changes in level of service conditions on local roads in the region depending on the location and the number of sites of the solar plants. Therefore, the NRC staff concludes that the transportation impacts from constructing the solar portion would be SMALL to MODERATE.

Construction of the offshore wind portion of the combination alternative would require 300 worker on-road vehicles during peak construction. Given the relatively small number of workers, the NRC does not anticipate a noticeable reduction in capacity of roads or level of service. Construction will also result in increased vessel activity to and from shore. Studies have found that the additional vessel activity from construction relative to existing vessel traffic along the coasts of North Carolina and South Carolina would be minor (BOEM 2015-TN9066, BOEM 2021-TN7704). Therefore, the NRC staff concludes that the transportation impacts from constructing the offshore wind portion of the combination alternative would be SMALL.

Overall, the NRC staff concludes that the transportation impacts from constructing the combination alternative would be MODERATE.

Operations

Operations of the new nuclear portion of the combination alternative would consist of an additional 750 worker vehicles. Conservatively assuming that all 750 vehicles would be on State Highway SC 183 or SC 130 at the same time (not accounting for shift changes), there would be sufficient capacity (67 percent) available on SC 183 (67 percent) or SC 130 (65 percent). Therefore, the NRC staff concludes that the transportation impacts from operations of the new nuclear portion would be SMALL.

Operation of the solar component of the combination alternative would require 50 workers. Given the relatively small workforce, an additional 50 vehicles are not anticipated to have noticeable changes in traffic; the transportation impacts from operation of the solar portion of the combination alternative would be SMALL.

Construction of the offshore wind portion of the combination alternative would require 150 worker on-road vehicles during peak construction. Given the relatively small number of workers, the NRC does not anticipate a noticeable reduction in capacity of roads or level of service. Operations will also result in increased vessel activity to and from shore. Studies have found that the additional vessel activity from operations of offshore facilities relative to existing vessel traffic along the coasts of North Carolina and South Carolina would be minor (BOEM 2015-TN9066, BOEM 2021-TN7704). Therefore, the NRC staff concludes that the transportation impacts from constructing the offshore wind portion of the combination alternative would be SMALL.

The demand-side management component could generate additional employment. However, jobs would likely be few and scattered throughout the region and would not cause an increase in traffic volumes on local roads. Therefore, the demand-side management component has no transportation impacts.

Overall, the NRC staff concludes that the transportation impacts from operations of the combination alternative would be SMALL.

3.11 Human Health

Oconee Station is both an industrial facility and a nuclear power plant. Similar to any industrial facility or nuclear power plant, the operation of Oconee Station during the SLR period will produce various human health risks for workers and members of the public. This section describes the human health risks resulting from the operation of Oconee Station, including from radiological exposure, chemical hazards, microbiological hazards, electromagnetic fields, and other hazards. The description of these risks is followed by the NRC staff's analysis of the potential impacts on human health from the proposed action (SLR) and alternatives to the proposed action.

3.11.1 Radiological Exposure and Risk

Operation of a nuclear power plant involves the use of nuclear fuel to generate electricity. Through the fission process, the nuclear reactor splits uranium atoms, resulting very generally in: (1) the production of heat, which is then used to produce steam to drive the nuclear power plant's turbines and generate electricity; and (2) the creation of radioactive byproducts. As required by NRC regulations at 10 CFR 20.1101, "Radiation protection programs," (TN283) Duke Energy designed a radiation protection program to protect onsite personnel (including employees and contractor employees), visitors, and offsite members of the public from radiation and radioactive material at Oconee Station. The Oconee Station radiation protection program is extensive and includes, but is not limited to, the following:

- organization and administration (e.g., a radiation protection manager who is responsible for the program and ensures trained and qualified workers for the program)
- implementing procedures
- an ALARA Program to minimize dose to workers and members of the public
- dosimetry program (i.e., measure radiation dose to nuclear power plant workers)
- radiological controls (e.g., protective clothing, shielding, filters, respiratory equipment, and individual work permits with specific radiological requirements)

- radiation area entry and exit controls (e.g., locked or barricaded doors, interlocks, local and remote alarms, personnel contamination monitoring stations)
- posting of radiation hazards (i.e., signs and notices alerting nuclear power plant personnel of potential hazards)
- recordkeeping and reporting (e.g., documentation of worker dose and radiation survey data)
- radiation safety training (e.g., classroom training and use of mockups to simulate complex work assignments)
- radioactive effluent monitoring management (i.e., controlling and monitoring radioactive liquid and gaseous effluents released into the environment)
- radioactive environmental monitoring (e.g., sampling and analysis of environmental media, such as direct radiation, air, water, groundwater, milk, food products [corn, soybeans, and peanuts], fish, oysters, clams, crabs, silt, and shoreline sediment to measure the levels of radioactive material in the environment that may impact human health)
- radiological waste management (i.e., controlling, monitoring, processing, and disposing of radioactive solid waste)

For radiation exposure to Oconee Station personnel, the NRC staff reviewed the data contained in NUREG-0713, Volume 42, *Occupational Radiation Exposure at Commercial Nuclear Power Reactors and other Facilities 2020: Fifty-Third Annual Report* (NRC 2022-TN8530). The Fifty-Third Annual Report was the most recent annual report available at the time of this environmental review. It summarizes the occupational exposure data in the NRC's Radiation Exposure Information and Reporting System database through 2020. Nuclear power plants are required by 10 CFR 20.2206, "Reports of individual monitoring," to report their occupational exposure data to the NRC annually (TN283).

NUREG-0713 calculates a 3-year average collective dose per reactor for workers at all nuclear power reactors licensed by the NRC. The 3-year average collective dose is one of the metrics that the NRC uses in the reactor oversight process to evaluate the applicant's ALARA program. Collective dose is the sum of the individual doses received by workers at a facility licensed to use radioactive material during a 1-year period. There are no NRC or EPA standards for collective dose. Based on the data for operating pressurized-water reactors like the units at Oconee Station, the average annual collective dose per reactor year was 31 person-roentgen equivalent man (rem) (NRC 2022-TN8530). In comparison, Oconee Station had a reported annual collective dose per reactor year of 16.6 person-rem.

Section 2.1.4, "Radioactive Waste Management Systems," of this EIS discusses offsite dose to members of the public and provides a detailed description of the radiological exposure and risk to the public.

3.11.2 Chemical Hazards

State and Federal environmental agencies regulate the use, storage, and discharge of chemicals, biocides, and sanitary wastes. Such environmental agencies also regulate how facilities like Oconee Station manage minor chemical spills. Chemical and hazardous wastes can potentially affect workers, members of the public, and the environment.

At Oconee Station, chemical effects could result from discharge of waste, heavy metal leaching, the use and disposal of chemicals, and chemical spills. Workers may encounter chemicals when adjusting coolant systems, applying biocides, during maintenance activities on equipment containing hazardous chemicals, and when solvents are used for cleaning (Duke Energy 2021-TN8897).

Duke Energy currently controls the use, storage, and discharge of chemicals, biocides, and sanitary wastes at Oconee Station in accordance with its chemical control procedures, waste management procedures, and Oconee Station site-specific chemical accident spill prevention provisions (Duke Energy 2021-TN8897). Duke Energy monitors and controls discharges of chemicals, biocides, and sanitary wastes through Oconee Station's NPDES permit process, discussed in Section 3.5.1.3. These nuclear power plant procedures, plans, and processes are designed to prevent and minimize the potential for a chemical or hazardous waste release and, in the event of such a release, minimize the impact on workers, members of the public, and the environment.

At Oconee Station, no reportable spills occurred due to Oconee Station operations from 2014 through October 2021. Two sewage spills occurred during the period from October 2021 to November 2022. Duke Energy followed reporting requirements and reported the spills to the South Carolina Department of Health and Environmental Control (Duke Energy 2022-TN8899). During the June 2023 audit, Duke Energy confirmed the corrective actions taken in response to the spills (Duke Energy 2023-TN8952). From the period of November 2022 until June 2023, Duke Energy confirmed that no reportable inadvertent releases or spills of nonradioactive contaminants occurred (Duke Energy 2023-TN8952).

3.11.3 Microbiological Hazards

Microbiological hazards occur when workers or members of the public come into contact with disease-causing microorganisms, also known as etiological agents. Thermal effluents associated with nuclear power plants that discharge to a cooling pond or lake, such as Oconee Station, have the potential to promote the growth of certain thermophilic microorganisms linked to adverse human health effects. Microorganisms of particular concern include several types of bacteria (*Legionella* species, *Salmonella* species, *Shigella* species, and *Pseudomonas aeruginosa*) and the free-living amoeba (*Naegleria fowleri*).

The public can be exposed to the thermophilic micro-organisms *Salmonella*, *Shigella*, *P*. *aeruginosa*, and *N*. *fowleri* during swimming, boating, or other recreational uses of freshwater. If these organisms are naturally occurring and a nuclear power plant's thermal effluent enhances their growth, the public could experience an elevated risk of infection when recreating in the affected waters. Public exposure to *Legionella* from nuclear power plant operation is generally not a concern because exposure risk is confined to cooling towers and related components and equipment, which are typically within the protected area of the site and, therefore, not accessible to the public.

Nuclear power plant workers can be exposed to *Legionella* when performing cooling system maintenance through inhalation of cooling tower vapors because these vapors are often within the optimum temperature range for *Legionella* growth. Nuclear power plant personnel at Oconee Station most likely to come in contact with aerosolized *Legionella* are workers who clean and maintain the condenser tubes. Nuclear power plant workers can be exposed to *N. fowleri* during cooling water discharges (Duke Energy 2022-TN8899).

Thermophilic Microorganisms of Concern

Salmonella typhimurium and *S. enteritidis* are two species of enteric bacteria that cause salmonellosis, a disease more common in summer than winter. Salmonellosis is transmitted through contact with contaminated human or animal feces and may be spread through water transmission, contact with infected animals or food, or contamination in laboratory settings (CDC 2022-TN8513). These bacteria grow at temperatures ranging from 77°F to 113°F (25°C to 45°C), have an optimal growth temperature around human body temperature (98.6°F [37°C]), and can survive extreme temperatures as low as 41°F (5°C) and as high as 122°F (50°C) (Oscar 2009-TN8514). Research studies examining the persistence of *Salmonella* species outside of a host found that the bacteria can survive for several months in water and in aquatic sediments (Moore et al. 2003-TN8515).

Shigella species causes the infection shigellosis, which can be contracted through contact with contaminated food, water, or feces. When ingested, the bacteria release toxins that irritate the intestines. Like salmonellosis, shigellosis infections are more common in summer than in winter because the bacteria optimally grow at temperatures between 77°F and 99°F (25°C and 37°C) (PHAC 2010-TN8868). Shigellosis outbreaks related to recreational uses of water are rare; almost all cases are related to food contamination.

Pseudomonas aeruginosa can be found in soil, hospital respirators, water, and sewage, and on the skin of healthy individuals. It is most commonly linked to infections transmitted in healthcare settings. Infections from exposure to *P. aeruginosa* in water can lead to the development of mild respiratory illnesses in healthy people. These bacteria optimally grow at 98.6°F (37°C) and can survive in high-temperature environments up to 107.6°F (42°C) (Todar 2004-TN7723).

The free-living amoeba *N. fowleri* prefers warm freshwater habitats and is the causative agent of human primary amebic meningoencephalitis (PAM). Infections occur when *N. fowleri* penetrate the nasal tissue through direct contact with water in warm lakes, rivers, or hot springs; and migrate to the brain tissues. This free-swimming amoeba species grows best at higher temperatures of up to 115°F (46°C) (CDC 2021-TN7271). It is typically not present in waters below 95°F (35°C) (Tyndall et al. 1989-TN8598). The *N. fowleri* caused disease PAM is rare in the United States. From 1962 through 2020, the U.S. Centers for Disease Control and Prevention reports an average of 2.5 cases of PAM annually nationwide.

Legionella is a genus of common warm water bacteria that occurs in lakes, ponds, and other surface waters, as well as some groundwater sources and soils. The bacteria thrive in aquatic environments as intracellular parasites of protozoa and are only pathogenic to humans when aerosolized and inhaled into the lungs. Approximately 2 to 5 percent of those exposed in this way develop an acute bacterial infection of the lungs known as Legionnaires' disease (AWT 2019-TN8518). *Legionella* optimally grow in stagnant surface waters containing biofilms or slimes that range in temperature from 95°F to 113°F (35°C to 45°C), although the bacteria can persist in waters from 68°F to 122°F (20°C to 50°C) (AWT 2019-TN8518). As such, human infection is often associated with complex water systems within buildings or structures, such as cooling towers (CDC 2016-TN8519). Potential adverse health effects related to *Legionella* would generally not be of concern at Oconee Station because the nuclear power plant does not use cooling towers. The U.S. Centers for Disease Control and Prevention issues biannual surveillance summary reports concerning Legionnaires' disease.

Baseline Conditions in Lake Keowee

As described in Section 2.1.3 of this EIS, Oconee Station uses a once-through cooling system for all three units drawing water from the Little River arm of Lake Keowee with discharge to the Keowee River arm of the lake just above the Lake Keowee dam. The surface water temperature of Lake Keowee can range from an average of 52.3°F to 90.7°F (11.3°C to 32.6°C) depending on the year and season. The average heated water discharge temperature can vary between 57.4°F to 94.8°F (14.1°C to 34.9°C) (Duke Energy 2021-TN8897). The current NPDES permit for Oconee Station limits the maximum discharge temperature to 100°F (37.8°C) as a daily average. The maximum temperature rise above intake is limited to 22°F (5.6°C) when the intake temperature is greater than 68°F (20°C). Under critical hydrological, meteorological, and electrical demand conditions, the discharge temperature cannot exceed 103°F (39.4°C) (Duke Energy 2021-TN8897). A distinct but variable-size thermal plume occurs in the vicinity of the Oconee Station discharge, primarily in the Keowee River watershed where the plume is largest in the winter and smallest in the summer (Duke Energy 2021-TN8897).

3.11.4 Electromagnetic Fields

Electromagnetic fields (EMFs) are generated by any electrical equipment. All nuclear power plants have electrical equipment and power transmission systems associated with them. Power transmission systems consist of switching stations (or substations) located on the nuclear power plant site and the transmission lines needed to connect the plant to the regional electrical distribution grid. Transmission lines operate at a frequency of 60 Hz (60 cycles per second), which is low compared with the frequencies of 55 to 890 MHz for television transmitters and 1,000 MHz and greater for microwaves.

The scope of the evaluation of transmission lines includes only those transmission lines that connect the plant to the switchyard where electricity is fed into the regional power distribution system (encompassing those lines that connect the plant to the first substation of the regional electric power grid) and power lines that feed the plant from the grid are considered within the regulatory scope of the license renewal environmental review. In-scope transmission lines are confined to the Oconee Station site, spanning the short distance between the generating units and the switchyards, as depicted in Figure 2.2-4 of Duke Energy’s environmental report (Duke Energy 2021-TN8897).

Electric fields are produced by voltage and their strength increases with increases in voltage. A magnetic field is produced from the flow of current through wires or electrical devices, and its strength increases as the current increases. Electric and magnetic fields, collectively referred to as EMF, are produced by operating transmission lines.

Occupational workers or members of the public near transmission lines may be exposed to the EMFs produced by the transmission lines. The EMF strength varies in time as the current and voltage change, so that the frequency of the EMF is the same (e.g., 60 Hz for standard alternating current, or AC). Electrical fields can be shielded by objects such as trees, buildings, and vehicles. Magnetic fields, however, penetrate most materials, but their strength decreases with increasing distance from the source.

The EMFs resulting from 60 Hz power transmission lines fall under the category of non-ionizing radiation. The LR license renewal GEIS (NRC 2013-TN2654) summarizes NRC accepted studies on the health effects of electromagnetic fields. There are no U.S. Federal standards limiting residential or occupational exposure to EMFs from power lines, but some States have set electric field and magnetic field standards for transmission lines (NIEHS 2002-TN6560). A voluntary occupational standard has been set for EMFs by the International Commission on Non-Ionizing Radiation Protection (ICNIRP 1998-TN6591). The National Institute of Occupational Safety and Health does not consider EMFs to be a proven health hazard (NIOSH 1996-TN6766).

3.11.5 Other Hazards

This section addresses two additional human health hazards: (1) physical occupational hazards and (2) occupational electric shock hazards.

Nuclear power plants are industrial facilities that have many of the typical occupational hazards found at any other electric power generation utility. Nuclear power plant workers may perform electrical work, electric powerline maintenance, repair work, and maintenance activities and may be exposed to potentially hazardous physical conditions. A physical hazard is an action, agent or condition that can cause harm upon contact. Physical actions could include slips, trips, and falls from height. Physical agents could include noise, vibration, and ionizing radiation. Physical conditions could include high heat, cold, pressure, confined space, or psychosocial issues, such as work-related stress.

The Occupational Safety and Health Administration (OSHA) is responsible for developing and enforcing workplace safety regulations. Congress created OSHA by enacting the Occupational Safety and Health Act of 1970, as amended (29 U.S.C. 651 et seq.-TN4453) to safeguard the health of workers. With respect to nuclear power plants, nuclear power plant conditions that result in an occupational risk, but do not affect the safety of licensed radioactive materials, are under the statutory authority of OSHA rather than the NRC as set forth in a Memorandum of Understanding (NRC and OSHA 2013-TN8542) between the NRC and OSHA. Occupational hazards are reduced when workers adhere to safety standards and use appropriate protective equipment; however, fatalities and injuries caused by accidents may still occur. Duke Energy maintains at Oconee Station an occupational safety program for its workers in accordance with OSHA regulations (Duke Energy 2021-TN8897, Duke Energy 2022-TN8899).

Based on its evaluation in the LR GEIS (NRC 2013-TN2654), the NRC has not found electric shock resulting from direct access to energized conductors or from induced charges in metallic structures to be a problem at most operating nuclear power plants. Generally, the NRC staff also does not expect electric shock from such sources to be a human health hazard during the SLR period. However, a site-specific review is required to determine the significance of the electric shock potential along the portions of the transmission lines that are within the scope of this EIS. Transmission lines that are within the scope of the NRC's SLR environmental review are limited to: (1) those transmission lines that connect the nuclear power plant to the substation where electricity is fed into the regional distribution system, and (2) those transmission lines that supply power to the nuclear power plant from the grid (NRC 2013-TN2654).

As discussed in Section 2.1.6.5, "Power Transmission Systems," of this EIS, the only transmission lines that are in-scope for Oconee Station SLR are onsite. Specifically, there are six in-scope transmission lines (Duke Energy 2021-TN8897). The three units have incoming lines from the 230 kilovolt (kV) switchyard. Units 1 and 2 have outgoing lines to the 230 kV switchyard, and Unit 3 has an outgoing line to the 525 kV switchyard. These in-scope lines are in compliance with National Electrical Safety Code clearances (Duke Energy 2021-TN8897, Duke Energy 2022-TN8899). Therefore, there is no potential shock hazard to offsite members of the public from these onsite transmission lines.

3.11.6 Proposed Action

The following sections address the site-specific environmental impacts of the Oconee Station SLR on the environmental issues related to human health in accordance with Commission direction in CLI-22-02 and CLI-22-03.

3.11.6.1 Radiation Exposures to The Public

Nuclear power plants, under controlled conditions, release small amounts of radioactive materials to the environment during normal operation. The NRC regulations in 10 CFR Part 20 (TN283) identify maximum allowable concentrations of radionuclides that can be released from a licensed nuclear power plant, such as Oconee Station, into the air and water above background at the boundary of unrestricted areas to control radiation exposures of the public and releases of radioactivity. These concentrations are derived based on an annual total effective dose equivalent of 0.1 roentgen equivalent man (rem) to individual members of the public. In addition, pursuant to 10 CFR 50.36a, “Technical specifications on effluents from nuclear power reactors,” (TN249), nuclear power plants have special license conditions called technical specifications for radioactive gaseous and liquid releases from the nuclear power plant that are required to minimize the radiological impacts associated with nuclear power plant operations to levels that are ALARA.

Radioactive waste management systems are incorporated into the design of each nuclear power plant. They are designed to remove most of the fission product radioactivity that leaks from the fuel, as well as most of the activation- and corrosion-product radioactivity produced by neutrons in the vicinity of the reactor core. The amounts of radioactivity released through vents and discharge points to areas outside the nuclear power plant boundary are recorded and published annually in the radioactive effluent release reports. These environmental monitoring programs are in place at all nuclear power plants. Because there is no reason to expect effluents to increase at Oconee Station during the SLR term, while doses from continued operation are expected to be well within regulatory limits established in 10 CFR Part 20, (TN283), and 40 CFR Part 190, “Environmental Radiation Protection Standards for Nuclear Power Operations” (TN739). No mitigation measures beyond those already implemented under the current-term license would be warranted because current mitigation practices have kept public radiation doses well below regulatory standards and are expected to continue to do so.

The NRC staff reviewed Oconee Station effluent reports from years 2018–2022 (Duke Energy 2019-TN8943, Duke Energy 2020-TN8944, Duke Energy 2021-TN8945, Duke Energy 2022-TN8946, Duke Energy 2023-TN8947) and determined that the annual public dose recorded is a fraction of the regulatory limits and was in accordance with radiation protection standards identified in 10 CFR Part 50 (TN249; Appendix I), 10 CFR Part 20 (TN283), and 40 CFR Part 190 (TN739). This 5-year review period provided a dataset that covers a broad range of activities that occur at a nuclear power plant, such as refueling outages, routine operation, and maintenance that can affect the generation and release of radioactive effluents into the environment. The NRC staff looked for indications of adverse trends (e.g., increasing radioactivity levels) over the period of 2018 through 2022. Based on its review of this information, the NRC staff found no apparent increasing trend in concentration or pattern indicating either a new inadvertent release or persistently high tritium concentrations that might indicate an ongoing inadvertent release from Oconee Station. The groundwater monitoring program at Oconee Station is robust, and any future leaks that might occur during the SLR period should be readily detected. All spills are well monitored, characterized, and actively remediated. Taken together, the data show that there were no significant radiological impacts on the environment from operations at Oconee Station.

Radiation doses to the public from continued operation are expected to continue at current levels and would remain below regulatory limits during the SLR term. The NRC staff identified no information at Oconee Station that would result in different impacts than those of current operations. The NRC staff concludes that the health impacts from public radiation exposure due to continued nuclear plant operations at Oconee Station during the SLR term would be SMALL based on public doses being maintained within regulatory limits.

3.11.6.2 Radiation Exposures to Plant Workers

Nuclear power plant workers conducting activities involving radioactively contaminated systems or working in radiation areas can be exposed to radiation. Individual occupational doses are measured by nuclear power plant licensees as required by the NRC radiation protection standard, at 10 CFR Part 20 (TN283). Most of the occupational radiation dose to nuclear power plant workers results from external radiation exposure rather than from internal exposure from inhaled or ingested radioactive materials. Workers also receive radiation exposure during the storage and handling of radioactive waste. Occupational doses from any refurbishment activities associated with SLR, and occupational doses from continued operations during the SLR term, are expected to be similar to the doses during current operations. The occupational doses are estimated to be much less than the regulatory dose limits.

Under 10 CFR 20.2206, “Reports of individual monitoring,” (TN283), the NRC requires nuclear plant licensees to submit an annual report of the results of individual monitoring carried out by the licensee for each individual for whom monitoring was required by 10 CFR 20.1502, “Conditions requiring individual monitoring of external and internal occupational dose,” during that year. The NRC staff has reviewed the Oconee Station occupational dose reports and summary reports through 2022 (NRC 2022-TN8530) and identified no information for Oconee Station that would result in different impacts than those of current operations. The NRC staff concludes that the health impacts from occupational radiation exposure due to continued nuclear plant operations at Oconee Station during the SLR term would be SMALL based on individual worker doses being maintained within 10 CFR Part 20 (TN283) limits. No mitigation measures beyond those implemented during the current license term would be warranted, because the ALARA process continues to be effective in reducing radiation doses.

3.11.6.3 Human Health Impact from Chemicals

Impacts of chemical discharges on human health are considered to be SMALL if the discharges of chemicals to water bodies are within effluent limitations designed to protect water quality and if ongoing discharges have not resulted in adverse effects on aquatic biota. During the SLR term, human health impacts from chemical hazards are expected to be the same as those experienced during operations under the prior license term.

Small quantities of biocides are readily dissipated and/or chemically altered in the water body receiving them, so significant cumulative impacts on water quality would not be expected. Major changes in the operation of the cooling system are not expected during the SLR term (Duke Energy 2022-TN8899), so no change in the effects of biocide discharges on the quality of the receiving water is anticipated.

The effects of minor chemical discharges and spills at nuclear power plants on water quality have been of SMALL significance and mitigated as needed. Significant cumulative impacts on water quality would not be expected because the small amounts of chemicals released by these minor discharges or spills are readily dissipated in Lake Keowee, the receiving water body. Although there is risk of human health impacts from chemicals due to accumulation within Lake Keowee, annual biological studies of Lake Keowee have demonstrated that operation of Oconee Station has not resulted in significant harm to the biological community (Duke Energy 2022-TN8899).

Heavy metals (e.g., copper, zinc, and chromium) may be leached as small-volume waste streams or corrosion products. However, heavy metals, including mercury, are not required to be reported by the Oconee Station NPDES permit as analysis indicated no reasonable potential for parameters to cause or contribute to a water quality violation for heavy metals (Duke Energy 2022-TN8899).

Overall, based on the existing procedures, plans and processes, the NRC staff concludes that the human health impacts from chemicals due to continued nuclear power plant operations at Oconee Station during the SLR term would be SMALL.

3.11.6.4 Microbiological Hazards to the Public (Plants with Cooling Ponds or Canals or Cooling Towers That Discharge to a River)

In the LR GEIS (NRC 2013-TN2654), the NRC staff determined that effects of thermophilic micro-organisms on the public for nuclear power plants using cooling ponds, lakes, or canals or cooling towers that discharge to a river is a Category 2 issue that requires site-specific evaluation during each license renewal review.

The thermophilic micro-organisms *N. fowleri* can pose public health concerns in recreational-use waters when these organisms are present in high enough concentrations to cause infection. Based on the information presented in Section 3.11.3, the thermophilic organisms most likely to be of potential concern in Lake Keowee are *N. fowleri*, a free-living amoeba that causes the infection PAM. The public could be exposed to these microorganisms during swimming, boating, fishing, and other recreational uses of Lake Keowee.

As previously discussed, Oconee Station's thermal effluent discharge is below *N. fowleri's* optimal growth temperature of 115°F (46°C). Thus, the Oconee Station thermal discharges are not high enough in temperature to facilitate proliferation of this microorganism or to cause a public health concern. There have been no known occurrences of PAM from Lake Keowee, and the proposed action would not result in any operational changes that would affect thermal effluent temperature or otherwise create favorable conditions for *N. fowleri* growth (Duke Energy 2022-TN8899). During the proposed SLR term, the public health risk from *N. fowleri* exposure in Lake Keowee remains extremely low.

The NRC staff concludes that the impacts of thermophilic micro-organisms on the public due to continued nuclear power plant operations at Oconee Station during the SLR term would be SMALL because thermal effluent discharges from Oconee Station during the proposed SLR term would not contribute to the proliferation in Lake Keowee of *N. fowleri*.

3.11.6.5 Microbiological Hazards to Plant Workers

Impacts from microbiological hazards to nuclear power plant workers due to continued nuclear power plant operations at Oconee Station during the SLR term are considered SMALL. Nuclear power plant workers can be exposed to *Legionella* during maintenance activities of the condenser tubes and *N. fowleri* during cooling water discharges. No change in existing microbiological hazards is expected due to SLR as Duke Energy is not proposing changes in the cooling water system or sanitary wastewater treatment and disposal. Duke Energy implements a health and safety program to minimize the potential for nuclear power plant worker exposure (Duke Energy 2022-TN8899).

3.11.6.6 Effects of Electromagnetic Fields (EMFs)

The LR GEIS (10 CFR 51 [TN250]), Subpart A, Appendix B; NRC 2013-TN2654) does not designate the chronic effects of 60 Hz EMFs from powerlines as either a Category 1 or 2 issue. Until a scientific consensus is reached on the health implications of EMFs, the NRC will not include them as Category 1 or 2 issues.

Scientific consensus on the health implications of EMFs has not been established. The potential for chronic effects from these fields continues to be studied and is not known at this time. The National Institute of Environmental Health Sciences (NIEHS) directs related research through the DOE. The NIEHS report (NIEHS 1999-TN78) contains the following conclusion:

> The NIEHS concludes that ELF-EMF (extremely low frequency electromagnetic field) exposure cannot be recognized as entirely safe because of weak scientific evidence that exposure may pose a leukemia hazard. In our opinion, this finding is insufficient to warrant aggressive regulatory concern. However, because virtually everyone in the United States uses electricity and therefore is routinely exposed to ELF-EMF, passive regulatory action is warranted such as continued emphasis on educating both the public and the regulated community on means aimed at reducing exposures. The NIEHS does not believe that other cancers or noncancer health outcomes provide sufficient evidence of a risk to currently warrant concern.

This statement did not cause the NRC to change its position with respect to the chronic effects of EMFs. The NRC staff considers the impacts to be “UNCERTAIN.”

3.11.6.7 Physical Occupational Hazards

As nuclear power plants have many of the typical occupational hazards found at other electric power generation utilities, the issue of occupational hazards can be evaluated by comparing the rate of fatal injuries and nonfatal occupational injuries and illnesses in the utility sector with the rate in all industries combined. Based on the 2021 Bureau of Labor Statistics for incidence rate of fatal and nonfatal occupational injuries, utility sector rates are lower than those of many other sectors (BLS 2021-TN7691). Occupational hazards can be minimized when workers adhere to safety standards and use appropriate personal protective equipment; however, fatalities and injuries caused by accidents may still occur.

Work at Oconee Station is under the statutory authority of OSHA and managed onsite by an industrial safety program. The NRC staff expects that workers will continue to adhere to safety standards and use protective equipment. The NRC staff expects that Duke Energy will continue to employ an occupational safety program so that physical occupational hazards due to continued nuclear power plant power operations at Oconee Station during the SLR term are minimized. As a result, the NRC staff concludes that physical occupational hazards at Oconee Station would be of SMALL significance (Duke Energy 2022-TN8899).

3.11.6.8 Electric Shock Hazards

Based on the LR GEIS (NRC 2013-TN2654), the Commission found that electric shock resulting from direct access to energized conductors or from induced charges in metallic structures has not been identified as a problem at most operating nuclear power plants and generally is not expected to be a problem during the license renewal term. However, a site-specific review is required to determine the significance of the electric shock potential along the portions of the transmission lines that are within the scope of Oconee Station SLR review.

As discussed in Section 3.11.5, "Other Hazards," there are no offsite transmission lines that are in scope for this EIS. Therefore, there are no potential impacts on members of the public. There are six onsite overhead transmission lines with the potential for electric shock to workers through induced currents. To address this occupational hazard, Duke Energy adheres to the National Electrical Safety Code for clearances and OSHA compliance requirements for shock hazard avoidance (Duke Energy 2021-TN8897, Duke Energy 2022-TN8899). As discussed in Section 3.11.5, Oconee Station maintains an occupational safety program in accordance with OSHA regulations for its workers, which includes protection from acute electric shock. Therefore, the NRC staff concludes that the potential impacts from acute electric shock during the LR term would be SMALL.

3.11.6.9 Postulated Accidents

The LR GEIS (NRC 2013-TN2654) evaluates the following two classes of postulated accidents as they relate to license renewal:

- Design-Basis Accidents: Postulated accidents that a nuclear facility must be designed and built to withstand without loss to the systems, structures, and components necessary to ensure public health and safety.
- Severe Accidents: Postulated accidents that are more severe than design-basis accidents because they could result in substantial damage to the reactor core.

As shown in Table 3-1 of this report, the LR GEIS (NRC 2013-TN2654) addresses design-basis accidents as a Category 1 issue and concludes that the environmental impacts of design-basis accidents are of SMALL significance for all nuclear power plants. For Severe Accidents, Table 3-1 refers to EIS Appendix F of this report.

Based on information in the 2013 LR GEIS, the NRC determined in 10 CFR Part 51 (TN250), Subpart A, Appendix B that for all nuclear power plants, the environmental impacts of severe accidents associated with license renewal is SMALL, with a caveat as follows:

> The probability-weighted consequences of atmospheric releases, fallout onto open bodies of water, releases to groundwater, and societal and economic impacts from severe accidents are SMALL for all plants. However, alternatives to mitigate severe accidents must be considered for all plants that have not considered such alternatives. (NRC 2013-TN2654)

The NRC Staff evaluates Postulated Accidents and SAMA for Oconee Station during the SLR term in Appendix F of this report, in accordance with Commission direction in CLI-22-02 and CLI-22-03. The results are summarized below.

Duke Energy's 1999 environmental report submitted as part of its initial license renewal application included an assessment of SAMAs for Oconee (Duke Energy 2021-TN8897). The NRC staff at that time reviewed Duke Energy's 1999 analysis of SAMAs and documented this review in its EIS for the initial license renewal, which the NRC published in 1999, as Supplement 2, "Regarding Oconee Nuclear Station" to NUREG-1437, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (NRC 1999-TN8942). Since the NRC staff had previously considered SAMAs for Oconee Station, Duke Energy is not required to perform another SAMA analysis for its SLR application (see 10 CFR 51.53(c)(3)(ii)(L) [TN250]).

However, the NRC's regulations at 10 CFR Part 51 (TN250), which implement Section 102(2) of the NEPA, require that all applicants for license renewal submit an environmental report to the NRC and in that report identify any "new and significant information regarding the environmental impacts of license renewal of which the applicant is aware" (10 CFR 51.53(c)(3)(iv)). Accordingly, in its SLR application environmental report (Duke Energy 2021-TN8897), Duke Energy evaluated areas of new and potentially significant information that could affect the environmental impact of postulated accidents during the SLR period. The NRC staff provides a discussion of new information pertaining to Postulated Accidents and SAMAs in Appendix F, "Environmental Impacts of Postulated Accidents," in this EIS.

Based on the NRC staff's review and evaluation of Duke Energy's analysis of new and potentially significant information regarding SAMAs and the staff's independent analyses as documented in Appendix F, "Environmental Impacts of Postulated Accidents," to this EIS, the staff finds that there is no new and significant information for Oconee Station related to Postulated Accidents or SAMAs.

3.11.7 No-Action Alternative

Under the no-action alternative, the NRC would not issue subsequent renewed licenses, and Oconee Station would shut down on or before the expiration of the current renewed licenses. Human health risks would be smaller following nuclear power plant shutdown. The reactor units, which currently operate within regulatory limits, would emit less radioactive gaseous, liquid, and solid material to the environment. In addition, following shutdown, the variety of potential accidents at the nuclear power plant (radiological or industrial) would be reduced to a limited set associated with shutdown events and fuel handling and storage. In Section 3.11.6, "Proposed Action," the NRC staff concluded that the impacts of continued nuclear power plant operation on human health would be SMALL, except for "Chronic effects of electromagnetic fields (EMFs)," for which the impacts are UNCERTAIN. In Section 3.11.6.9, "Postulated Accidents," the NRC staff concluded that the impacts of accidents during operation are SMALL. Therefore, as radioactive emissions to the environment decrease, and as the likelihood and types of accidents decrease following shutdown, the NRC staff concludes that the risk to human health following nuclear power plant shutdown would be SMALL.

3.11.8 Replacement Power Alternatives: Common Impacts

Impacts on human health from construction of a replacement power station would be similar to impacts associated with the construction of any major industrial facility. Compliance with worker protection rules, the use of personal protective equipment, training, and placement of engineered barriers would limit those impacts on workers to acceptable levels.

The human health impacts from the operation of a power station include public risk from inhalation of gaseous emissions. Regulatory agencies, including EPA and State of South

Carolina agencies, base air emission standards and requirements on human health impacts. These agencies also impose site-specific emission limits to protect human health.

3.11.9 New Nuclear (Advanced Light-Water Reactor and Small Modular Reactor) Alternative

The construction impacts of the new nuclear alternative would include those identified in Section 3.11.8 above. Because the NRC staff expects that the licensee would limit access to active construction areas to only authorized individuals, the impacts on human health from the construction of a two-unit advanced light-water reactor and a single-unit small modular reactor would be SMALL.

The human health effects from the operation of the new nuclear alternative would be similar to those of operating the existing Oconee Station Units 1, 2, and 3. The ALWRs and small modular reactor designs would use the same type of fuel (i.e., form of the fuel, enrichment, burnup, and fuel cladding) as those nuclear power plants considered in the NRC staff's evaluation in the LR GEIS (NRC 2013-TN2654). As such, their impacts would be similar to Oconee Station. As presented in Section 3.11.6, impacts on human health from the operation of Oconee Station would be SMALL, except for "Chronic effects of electromagnetic fields (EMFs)," for which the impacts are UNCERTAIN. Therefore, the NRC staff concludes that the impacts on human health from the operation of the new nuclear alternative would be SMALL.

3.11.10 Natural Gas Combined-Cycle Alternative

The construction impacts of the NGCC alternative would include those identified in Section 3.11.8, "Replacement Power Alternatives: Common Impacts". Because the NRC staff expects that the licensee would limit access to active construction areas to only authorized individuals, the impacts on human health from the construction of an NGCC facility would be SMALL.

The human health effects from the operation of the NGCC alternative would include those identified in Section 3.11.8 as common to the operation of all replacement power alternatives. Health risk may be attributable to nitrogen oxide emissions that contribute to ozone formation (NRC 2013-TN2654). Given the regulatory oversight exercised by the EPA and State agencies, the NRC staff concludes that the human health impacts from the NGCC alternative would be SMALL, except for "Chronic effects of electromagnetic fields (EMFs)," for which the impacts are UNCERTAIN. Therefore, the NRC staff concludes that the impacts on human health from the operation of the NGCC alternative would be SMALL.

3.11.11 Combination Alternative (Solar PV, Offshore Wind, Small Modular Reactor, and Demand-Side Management)

Impacts on human health from construction of the combination alternative would include those identified in Section 3.11.8 as common to the construction of all replacement power alternatives. Because the NRC staff expects that the builder will limit access to the active construction area to only authorized individuals, the impacts on human health from the construction of the combination SMR, solar PV, offshore wind and demand-side management (DSM) alternative would be SMALL.

The human health effects from the operation of the SMR would be similar to those of operating the existing Oconee Station Units 1, 2, and 3. Small modular reactor designs would use the same type of fuel (i.e., form of the fuel, enrichment, burnup, and fuel cladding) as those nuclear power plants considered in the NRC staff's evaluation in the LR GEIS (NRC 2013-TN2654). As such, their impacts would be similar to Oconee Station. As presented in Section 3.11.9, the "Chronic effects of electromagnetic fields (EMFs)," impacts for the SMR are UNCERTAIN. Therefore, the NRC staff concludes that the impacts on human health from the operation of the SMR component would be SMALL.

Solar PV panels are encased in heavy-duty glass or plastic. Therefore, there is little risk that the small amounts of hazardous semiconductor material that they contain would be released into the environment. In the event of a fire, hazardous PM could be released into the atmosphere. Given the short duration of fires and the high melting points of the materials found in the solar PV panels, the impacts from inhalation are minimal. Also, the risk of fire at ground-mounted solar installations is minimal because of precautions taken during site preparation, which include removal of fuels and the lack of burnable materials contained in the solar PV panels. Another potential risk associated with PV systems and fire is the potential for shock or electrocution from contact with a high-voltage conductor. Proper procedures and clear marking of system components should be used to provide emergency responders with appropriate warnings to diminish the risk of shock or electrocution (Good Company 2011-TN8599). Solar PV panels do not produce EMFs at levels considered harmful to human health, as established by the International Commission on Non-Ionizing Radiation Protection. These small EMFs diminish significantly with distance and are indistinguishable from normal background levels within several yards (Good Company 2011-TN8599). Based on this information, the NRC staff concludes that the human health impacts from the operation of the solar PV component for the combination alternative would be SMALL.

Operational hazards at an offshore wind facility for the workforce include working at heights, working near rotating mechanical or electrically energized equipment, and operating in extreme weather. Adherence to safety standards and the use of appropriate protective equipment through implementation of an OSHA-approved worker safety program would minimize occupational hazards. Potential impacts on workers include ice thrown from rotor blades and broken blades thrown as a result of mechanical failure. Adherence to proper worker safety procedures and limiting public access to wind turbine sites would minimize the impacts from ice throws and broken rotor blades. Potential impacts also include EMF exposure, aviation safety hazards, and exposure to noise and vibration from the rotating blades. Impacts from EMF exposure would be minimized by adherence to proper worker safety procedures and limiting access to any components that could create an EMF. Aviation safety hazards would be minimized by proper siting of the offshore wind turbine facilities and maintaining all proper safety warning devices, such as indicator lights, for pilot visibility. Offshore installation of wind facilities would preclude any potential human health effects from noise and vibration. Furthermore, the NRC staff has identified no epidemiologic studies on noise and vibration from wind turbines that would suggest any direct human health impact. Based on this information, the NRC staff concludes that the human health impacts from the operation of the wind component for the combination alternative would be SMALL.

The DSM programs use existing infrastructure and energy efficiency programs to provide reduction in the use of electricity. Currently, Duke Energy states DSM accounts for only 50 MWe (Duke Energy 2021-TN8897). These programs are already in place, so there are no additional human health effects from DSM programs.

Therefore, given the expected compliance with worker and environmental protection rules and the use of personal protective equipment, training, and engineered barriers, the NRC staff concludes that the potential human health impacts for the combination alternative would be SMALL.

3.12 Environmental Justice

3.12.1 Background

Under EO 12898 (59 FR 7629-TN1450), Federal agencies are responsible for identifying and addressing, as appropriate, disproportionately high and adverse human health and environmental effects of agency actions on minority and low-income populations. Independent agencies, such as the NRC, are not bound by the terms of EO 12898 but are "requested to comply with the provisions of [the] order." In 2004, the Commission issued the agency's "Policy Statement on the Treatment of Environmental Justice Matters in NRC Regulatory and Licensing Actions" (69 FR 52040-TN1009), which states: "The Commission is committed to the general goals set forth in EO 12898 and strives to meet those goals as part of its NEPA review process."

The CEQ provides the following information in "Environmental Justice: Guidance Under the National Environmental Policy Act" (CEQ 1997-TN452):

> **Disproportionately High and Adverse Human Health Effects.**
>
> Adverse health effects are measured in risks and rates that could result in latent cancer fatalities, as well as other fatal or nonfatal adverse impacts on human health. Adverse health effects may include bodily impairment, infirmity, illness, or death. Disproportionately high and adverse human health effects occur when the risk or rate of exposure to an environmental hazard for a minority or low-income population is significant (as employed by NEPA) and appreciably exceeds the risk or exposure rate for the general population or for another appropriate comparison group (CEQ 1997-TN452).
>
> **Disproportionately High and Adverse Environmental Effects.**
>
> A disproportionately high environmental impact that is significant (as employed by NEPA) refers to an impact or risk of an impact on the natural or physical environment in a low-income or minority community that appreciably exceeds the environmental impact on the larger community. Such effects may include ecological, cultural, human health, economic, or social impacts. An adverse environmental impact is an impact that is determined to be both harmful and significant (as employed by NEPA). In assessing cultural and aesthetic environmental impacts, impacts that uniquely affect geographically dislocated or dispersed minority or low-income populations or American Indian Tribes are considered (CEQ 1997-TN452).

This environmental justice analysis assesses the potential for disproportionately high and adverse human health or environmental effects on minority and low-income populations that could result from the continued operation of Oconee Station associated with the proposed action (SLR) and alternatives to the proposed action. In assessing the impacts, the following definitions of minority individuals, minority populations, and low-income population were used (CEQ 1997-TN452):

> **Minority Individuals**
>
> Individuals who identify themselves as members of the following population groups: Hispanic or Latino, American Indian or Alaska Native, Asian, Black or African American, Native Hawaiian or Other Pacific Islander, or two or more races, meaning individuals who identified themselves on a Census form as being a member of two or more races, for example, White and Asian.

Minority Populations

Minority populations are identified when (1) the minority population of an affected area exceeds 50 percent or (2) the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis.

Low-income Population

Low-income populations in an affected area are identified with the annual statistical poverty thresholds from the Census Bureau's Current Population Reports, Series P60, on Income and Poverty.

In determining the location of minority and/or low-income populations, the NRC staff uses a 50 mi (80 km) radius from the facility as the geographic area to perform a comparative analysis. The 50 mi (80 km) radius is consistent with the impact analysis conducted for human health impacts. The NRC staff compares the percentage of minority and/or low-income populations in the 50 mi (80 km) geographic area to the percentage of minority and/or low-income populations in each census block group to determine which block groups exceeds the percentage, thereby identifying the location of these populations (NRC 2020-TN6399).

Minority Population

According to the USCB's 2020 Census data, there are a total of 1,106 block groups within a 50-mile (80 km) radius of the Oconee Station site and approximately 26 percent of the population residing within a 50 mi (80 km) radius of Oconee Station identified themselves as minority individuals. The largest minority populations were Black or African American (approximately 11 percent) and Hispanic, Latino, or Spanish origin of any race (approximately 8 percent).

According to the CEQ definition, a minority population exists if the percentage of the minority population of an area (e.g., census block group) exceeds 50 percent or is meaningfully greater than the minority population percentage in the general population. The NRC staff's environmental justice analysis applied the meaningfully greater threshold in identifying higher concentrations of minority populations; with the meaningfully greater threshold being any percentage greater than the minority population within 50 mi (80 km) radius of the site. Therefore, for the purposes of identifying higher concentrations of minority populations, census block groups within the 50 mi (80 km) radius of Oconee Station were identified as minority population block groups if the percentage of the minority population in the block group exceeded 26 percent, the percent of the minority population within the 50 mi (80 km) radius of Oconee Station.

Based on this analysis, there are 403 minority population blocks groups within a 50 mi (80 km) radius of Oconee Station. Therefore, approximately 36 percent of block groups within a 50 mi (80-km) radius of Oconee Station are minority population block groups. As shown in Figure 3-8, high population minority block groups (race and ethnicity) are predominantly clustered east and south of the Oconee Station site. Based on this analysis, Oconee Station is not located in a minority population block group.

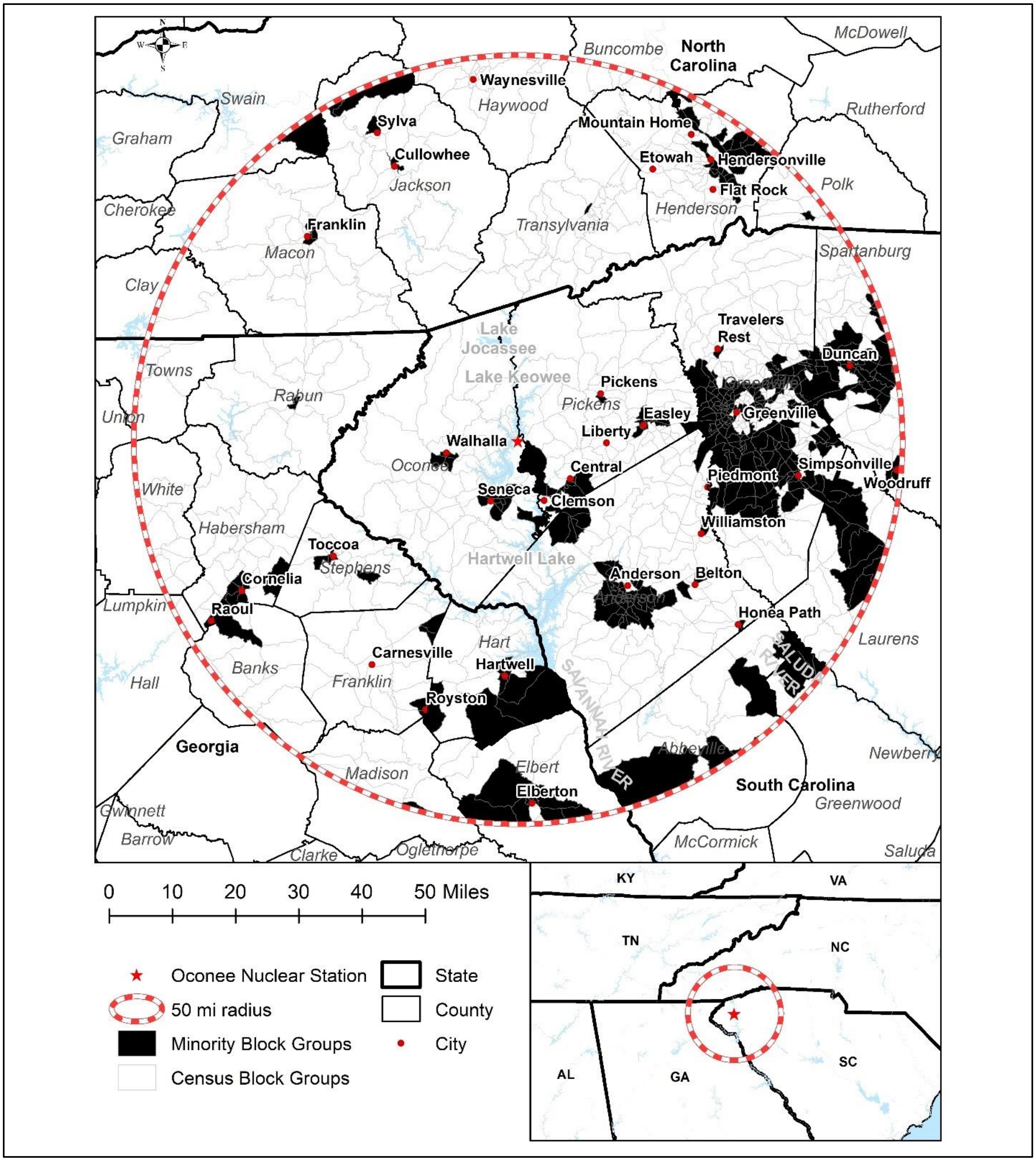

Figure 3-8 Minority Block Groups within a 50 mi (80 km) Radius of Oconee Station, South Carolina. Adapted from: USCB 2022-TN9013.

Low-Income Population

The U.S. Census Bureau's 2017–2021 American Community Survey data identifies approximately 13 percent of individuals residing within a 50 mi (80 km) radius of the Oconee Station site as living below the Federal poverty threshold (USCB 2022-TN9013). The 2021 Federal poverty threshold was $26,500 for a family of four (86 FR 7732-TN9014).

Figure 3-9 shows the location of predominantly low-income population block groups within a 50 mi (80 km) radius of Oconee Station. In accordance with NRC guidance (NRC 2020-TN6399), census block groups were considered low-income population block groups if the percentage of individuals living below the Federal poverty threshold within the block groups exceeded the percent of the individuals living below the Federal poverty threshold within 50 mi (80 km) radius of the Oconee Station site.

Based on this analysis, there are 464 low-income population blocks groups within a 50 mi (80 km) radius of the Oconee Station site. Therefore, approximately 42 percent of the block groups within a 50 mi (80 km) radius of Oconee Station are low-income population block groups. As shown in Figure 3-9, the low-income population block groups are distributed throughout within the 50 mi (80 km) radius of the Oconee Station site. Oconee Station is not located in a low-income population block group.

As discussed in Section 3.10.2 of this EIS, according to the USCB's 2017–2021 American Community Survey 5-Year Estimates, people living in the two-county ROI had a median household income less than the State average. Additionally, the percentage of individuals living below the poverty level in Oconee and Pickens counties was higher than the percentage of individuals living below the poverty level in the State of South Carolina. Adapted from USCB (2022-TN9013).

3.12.2 Proposed Action

The following sections address the site-specific environmental impacts of the Oconee Station SLR on the environmental issues related to environmental justice in accordance with Commission direction in CLI-22-02 and CLI-22-03. Minority and Low-Income Populations

The NRC addresses environmental justice matters for license renewal by: (1) identifying the location of minority and low-income populations that may be affected by the continued operation of the nuclear power plant during the license renewal term; (2) determining whether there would be any potential human health or environmental effects on these populations and special pathway receptors (groups or individuals with unique consumption practices and interactions with the environment; and (3) determining whether any of the effects may be disproportionately high and adverse.

Adverse health effects are measured in terms of the risk and rate of fatal or nonfatal adverse impacts on human health. Disproportionately high and adverse human health effects occur when the risk or rate of exposure to an environmental hazard for a minority or low-income population is significant and exceeds the risk or exposure rate for the general population or for another appropriate comparison group. Disproportionately high environmental effects refer to impacts or risks of impacts on the natural or physical environment in a minority or low-income community that are significant and appreciably exceed the environmental impact on the larger community. Such effects may include biological, cultural, economic, or social impacts.

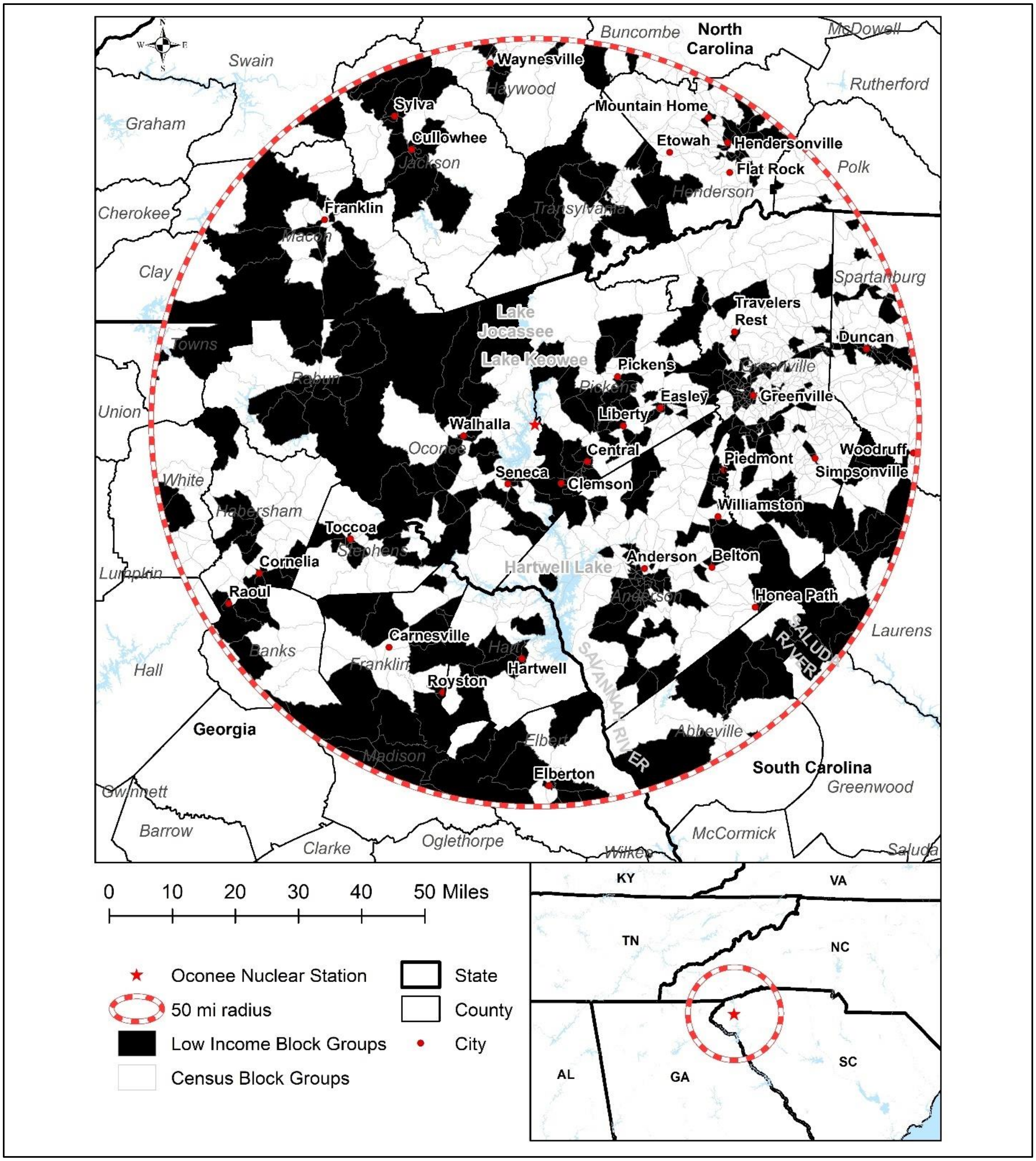

Figure 3-9 Low-Income Block Groups within a 50 mi (80 km) Radius of Oconee Station, South Carolina

Figure 3-8 and Figure 3-9 show the location of predominantly minority or population block groups residing within a 50 mi (80 km) radius of the Oconee Station site. This area of impact is consistent with the 50 mi (80 km) impact analysis for public and occupational health and safety. This chapter of this EIS presents the assessment of environmental and human health impacts for each resource area. The analyses of impacts for all environmental resource areas indicated that the impact from SLR would be SMALL.

Potential impacts on minority and low-income populations (including migrant workers or Native Americans) would mostly consist of socioeconomic and radiological effects; however, radiation doses from continued operations during the SLR term are expected to continue at current levels, and they would remain within regulatory limits. Section 3.11.6.4 discusses the environmental impacts from postulated accidents that might occur during the SLR term, which include both design-basis and severe accidents. In both cases, the Commission has generically determined that impacts associated with design-basis accidents are small because nuclear power plants are designed and operated to withstand such accidents, and the probability-weighted consequences of severe accidents are SMALL.

Therefore, based on this information and the analysis of human health and environmental impacts presented in this chapter, the NRC staff concludes that there would be no disproportionately high and adverse human health and environmental effects on minority and low-income populations from the continued operation of Oconee Station during the renewal term.

Subsistence Consumption of Fish and Wildlife

Because part of addressing environmental justice concerns associated with SLR, the NRC also assessed the potential radiological risk to special population groups (such as migrant workers or Native Americans) from exposure to radioactive material received through their unique consumption practices and interactions with the environment. Such exposure could occur through subsistence consumption of fish, wildlife, and native vegetation; contact with surface waters, sediments, and local produce; absorption of contaminants in sediments through the skin; and inhalation of airborne radioactive material released from the nuclear power plant during routine operation. The special pathway receptors analysis is an important part of the environmental justice analysis because consumption patterns may reflect the traditional or cultural practices of minority and low-income populations in the area.

Section 4-4 of EO 12898, “Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations,” (59 FR 7629-TN1450) directs Federal agencies, whenever practical and appropriate, to collect and analyze information about the consumption patterns of populations that rely principally on fish and wildlife for subsistence and to communicate the risks of these consumption patterns to the public. In this EIS, the NRC considered whether there were any means for minority or low-income populations to be disproportionately affected by examining impacts on American Indians, Hispanics, migrant workers, and other traditional lifestyle special pathway receptors. Duke Energy conducted desktop level reviews for articles or reports of subsistence populations in the vicinity of the Oconee Station site and interviewed staff that lived in the proximity to Oconee Station that could have knowledge of local subsistence populations (Duke Energy 2021-TN8897). Duke Energy did not identify subsistence activity in the vicinity of Oconee Station (Duke Energy 2021-TN8897).

The assessment of special pathways considered the levels of radiological contaminants in fish, sediments, water, milk, and food products on or near Oconee Station. Radionuclides released into the atmosphere may deposit on soil and vegetation and may therefore eventually be incorporated into the human food chain. To assess the impact of Oconee Station operations to humans from the ingestion pathway, Duke Energy collects and analyzes samples of air, water, sediment, fish, vegetation, and milk, if available, for radioactivity as part of its ongoing, comprehensive Radiological Environmental Monitoring Program.

To assess the impact of nuclear power plant operations on the environment, Duke Energy collects samples annually from the environment and analyzes them for radioactivity. A plant-specific effect would be indicated if the radioactive material detected in a sample was larger or higher than background levels. Two types of samples are collected. The first type, a control sample, is collected from areas that are beyond the influence of the nuclear power plant or any other nuclear facility. These control samples are used as reference data to determine normal background levels of radiation in the environment. The second type of samples, indicator samples, are collected near the nuclear power plant from areas where any radioactivity contribution from the nuclear power plant will be at its highest concentration. These indicator samples are then compared to the control samples to evaluate the contribution of nuclear power plant operations to radiation or radioactivity levels in the environment. An effect would be indicated if the radioactivity levels detected in an indicator sample were larger or higher than the control sample or background.

Duke Energy collected samples from the aquatic and terrestrial environmental in the vicinity of Oconee Station in 2022 (Duke Energy 2023-TN9016). The aquatic pathway specific samples include surface water samples, drinking water samples, fish, and sediment samples. The terrestrial environment was evaluated by performing radiological analyses on milk and green leaf vegetation samples. Terrestrial monitoring results for 2022 of broad lead vegetation and fish were consistent with previous levels. Tritium was reported in surface water samples; however, concentrations (range 1,830 to 15,400 pCi/L) were below the EPA's public drinking water standard for tritium (20,000 pCi/L) (Duke Energy 2023-TN9016; 40 CFR 141.66-TN4456). A 5-year period provides a dataset that covers a broad range of activities that occur at a nuclear power plant, such as refueling outages, routine operation, and maintenance that can affect the generation and release of radioactive effluents into the environment. The NRC staff looked for indications of adverse trends (i.e., increasing radioactivity levels) during that period. The data show that there were no significant radiological impacts to the environment from operations at Oconee Station.

Based on the radiological environmental monitoring data from Oconee Station, the NRC staff concludes that the special pathway receptor populations in the region are not expected to experience disproportionately high and adverse human health impacts as a result of subsistence consumption of water, local food, fish, and wildlife.

3.12.3 No-Action Alternative

Under the no-action alternative, the NRC would not renew the operating licenses, and Oconee Station Units 1, 2, and 3 would permanently shut down on or before the expiration of the current renewed facility operating licenses. Impacts on minority and low-income populations would depend on the number of jobs and the amount of tax revenues lost by communities in the immediate vicinity of the nuclear power plant after it ceases operations. Not renewing the operating licenses and terminating reactor operations could have a noticeable impact on socioeconomic conditions in the communities located near the Oconee Station site. The loss of jobs and income could have an immediate socioeconomic impact. Some, but not all, of the approximately 700 permanent workers could leave the area. In addition, the plant would generate less tax revenue, which could reduce the availability of public services. This reduction could disproportionately affect minority and low-income populations that may have become dependent on these services.

3.12.4 Replacement Power Alternatives: Common Impacts

The following discussions identify common impacts from the construction and operation of replacement power facilities that could disproportionately affect minority and low-income populations. The NRC staff cannot determine if any of the replacement power alternatives would result in disproportionately high and adverse human health and environmental effects on minority and low-income populations. This determination would depend on site location, plant design, operational characteristics of the new facility, unique consumption practices and interactions with the environment of nearby populations, and the location of predominantly minority and low-income populations.

Construction

Potential impacts to minority and low-income populations from the constructions of a new replacement power plant would mostly consist of environmental (e.g., noise, dust, and traffic) and socioeconomics effects (employment and housing impacts). Minority and low-income migrant agricultural workers could be particularly vulnerable to noise impacts if working near the construction site. However, noise impacts from construction would be short term and primarily limited to onsite activities. Air emissions would result from increased vehicle traffic, construction equipment, and fugitive dust from construction activities. These emissions would be temporary and minor. Minority and low-income populations residing alongside access roads could be affected by increased truck traffic and increased commuter vehicle traffic, especially during shift changes. Increased demand for rental housing during construction could affect low-income populations, which depends on the available housing stock.

Operation

Minority and low-income populations living near the replacement power site that rely on subsistence consumption of fish and wildlife could be disproportionately affected by replacement power alternatives. Emissions during power plant operations could disproportionately affect nearby minority and low-income populations, depending on the fuel-type used to generate replacement power.

3.12.5 New Nuclear (Advanced Light-Water Reactor and Small Modular Reactor) Alternative

Construction

Potential impacts to minority and low-income populations from the construction of a new nuclear alternative would include those common to all replacement power alternatives discussed in Section 3.12.3. The small modular reactor portion of the new nuclear alternative would be located at the Oconee Station site. The natural gas alternative would be located at the Oconee Station site. Figure 3-8 and Figure 3-9 show the location of predominantly minority and low-income population block groups residing within a 50 mi (80 km) radius of the Oconee Station site. Minority and low-income populations residing along site access roads could be affected by increased truck traffic and increased commuter vehicle traffic, especially during shift changes. However, a 2020 land use survey within a 5 mi (8 km) radius from Oconee Station identified few residents in the vicinity of the Oconee Station site, with the nearest resident located more than 1 mi (1.6 km) away from the site, and nearby residences are not near site access roads (Duke Energy 2021-TN8897). Noise would result from construction equipment, site activities, and additional traffic. Migrant agricultural workers could be particularly vulnerable to noise impacts because of their outdoor presence. However, the NRC staff has determined that noise would be temporary and not significant, and that noise levels would be lessened by distance. Air emissions would result from increased vehicle traffic, construction equipment, and fugitive dust from construction activities. These emissions would be temporary and minor (see Section 3.3.7.1 of this EIS). Increased demand for rental housing during construction could disproportionately affect low-income populations. However, as discussed in Section 3.10.4, there are more than 14,000 housing units available in Oconee County and Pickens County.

The ALWR portion of this alternative would be comprised of two ALWR units providing 2,234 MWe of generating capacity. The NRC evaluated the economic impacts from construction of two ALWR units with a total net electrical output capacity of 2,234 MWe at the W.S. Lee Nuclear Station site in Section 4.5 of NUREG-2111 (NRC 2013-TN6435: pp. 4-98 through 4-102). In that analysis, the staff considered all potentially significant pathways for human health and welfare effects and determined the impact of each pathway for individuals within the identified census block groups. The staff concluded in NUREG-2111 that there would be no disproportionately high and adverse impact on any minority or low-income populations as a result from construction of two 2,234 MWe ALWRs. The NRC staff incorporates the analysis in Section 4.5 of NUREG-2111 (NRC 2013-TN6435: pp. 4-98 through 4-99) herein by reference.

The NRC staff concludes that the construction of the new nuclear alternative would not likely have disproportionately high and adverse human health and environmental effects on minority and low-income populations.

Operations

Potential impacts to minority and low-income populations from operations of a new nuclear alternative would include those common to all replacement power alternatives discussed in Section 3.12.4. Potential impacts on minority and low-income populations from operations of the small modular reactor portion would mostly consist of environmental and radiological effects. However, radiation doses would be required to meet regulatory limits and the plant operator would maintain a radiological environmental monitoring program similar to current operation of the Oconee Station site.

The ALWR portion of this alternative would be comprised of two ALWR units providing 2,234 MWe of generating capacity. The NRC evaluated the economic impacts from operations of two ALWR units with a total net electrical output capacity of 2,234 MWe at the W.S. Lee Nuclear Station site in Section 5.5 of NUREG-2111 (NRC 2013-TN6435: pp. 5-53 through 5-57). The staff concluded in NUREG-2111 that there would be no disproportionately high and adverse impact on any minority or low-income populations as a result of operation of two ALWR units. The NRC staff incorporates the analysis in Section 5.5 of NUREG-2111 (NRC 2013-TN6435: pp. 5-53 through 5-57) herein by reference.

The NRC staff concludes that the operation of the new nuclear alternative would not likely have disproportionately high and adverse human health and environmental effects on minority and low-income populations.

3.12.6 Natural Gas Combined-Cycle Alternative

Construction

Potential impacts to minority and low-income populations from the construction of a natural gas alternative would include those common to all replacement power alternatives discussed in Section 3.12.4. The natural gas alternative would be located at the Oconee Station site. Figure 3-8 and Figure 3-9 show the location of predominantly minority and low-income population block groups residing within a 50 mi (80 km) radius of the Oconee Station site. Minority and low-income populations residing along site access roads could be affected by increased truck traffic and increased commuter vehicle traffic, especially during shift changes. However, a 2020 land use survey within a 5 mi (8- km) radius from Oconee Station identified few residents in the vicinity of the Oconee Station site, with the nearest resident located more than 1 mi (1.6 km) away from the site, and nearby residences situated away from site access roads (Duke Energy 2021-TN8897). Noise would result from construction equipment, site activities, and additional traffic. Migrant agricultural workers could be particularly vulnerable to noise impacts because of their outdoor presence. However, the NRC staff has determined that noise would be temporary and not significant, and that noise levels would be lessened by distance. Air emissions would result from increased vehicle traffic, construction equipment, and fugitive dust from construction activities. These emissions would be temporary and minor (see Section 3.3.8.1 of this EIS). Increased demand for rental housing during construction could disproportionately affect low-income populations. However, as discussed in Section 3.10.4, there are more than 14,000 housing units available in Oconee County and Pickens County.

The NRC staff concludes that the construction of the natural gas alternative would not likely have disproportionately high and adverse human health and environmental effects on minority and low-income populations.

Operations

Potential impacts to minority and low-income populations from the construction and operation of the natural gas alternative would include those discussed above in Section 3.12.4. As discussed in Section 3.3.8.1, operation of the natural gas alternative can emit substantial amounts of air emissions. However, the emissions would be noticeable but not destabilizing. The Oconee Station site is not located in a low-income population block group (see Section 3.12). Therefore, these effects are not likely to be high and adverse during plant operation.

The NRC staff concludes that the operation of the natural gas alternative would not likely have disproportionately high and adverse human health and environmental effects on minority and low-income populations.

3.12.7 Combination Alternative (Solar PV, Offshore Wind, Small Modular Reactor, and Demand-Side Management)

Construction

The new nuclear portion of the combination alternative would consist of three 400 MWe small modular reactor units. Potential impacts to minority and low-income populations from the construction of the new nuclear portion of the combination alternative would be similar to those discussed under the SMR portion (single 400 MWe small modular reactor unit) of the new nuclear alternative in Section 3.12.5. Therefore, the NRC staff concludes that the construction of the new nuclear alternative would not likely have disproportionately high and adverse human health and environmental effects on minority and low-income populations.

Potential impacts to minority and low-income populations from the construction of solar facilities would mostly consist of environmental and socioeconomic effects (e.g., noise, air emissions, traffic, employment, and housing impacts). However, the NRC staff has determined that air quality and noise impacts associated with construction of the solar PV portion of the combination alternative would be SMALL. Depending on the location of the solar facilities, socioeconomic and transportation impacts could be noticeable, but not destabilizing. Construction of the solar PV portion of the combination alternative would not likely have disproportionately high and adverse human health and environmental effects on minority and low-income populations, but this would depend on the exact location of the solar facilities.

Potential impacts to minority and low-income populations from the construction of offshore wind facilities would mostly consist of environmental and socioeconomic effects (e.g., noise, air emissions, traffic, employment, and housing impacts). However, the NRC staff has determined that air quality, noise, socioeconomic, and transportation impacts associated with construction of the offshore wind portion of the combination alternative would be SMALL. Therefore, the NRC staff concludes that the construction of the offshore wind portion of the combination alternative would not likely have disproportionately high and adverse human health and environmental effects on minority and low-income populations.

Overall, the NRC staff concludes that the construction of the combination alternative would not likely have disproportionately high and adverse human health and environmental effects on minority and low-income populations.

Operations

The new nuclear portion of the combination alternative would consist of three 400 MWe small modular reactor units. Potential impacts to minority and low-income populations from the operation of the new nuclear portion of the combination alternative would be similar to those discussed under the SMR portion (single 400 MWe small modular reactor unit) of the new nuclear alternative in Section 3.12.5. Therefore, the NRC staff concludes that the operation of the new nuclear alternative would not likely have disproportionately high and adverse human health and environmental effects on minority and low-income populations.

Potential impacts to minority and low-income populations from the operation of solar facilities would mostly consist of environmental and socioeconomic effects (e.g., noise, air emissions, traffic, employment, and housing impacts). However, the NRC staff has determined that air quality, noise, and socioeconomic impacts associated with construction of the solar PV portion of the combination alternative would be SMALL. However, depending on the location of the solar facilities, transportation impacts could be noticeable, but not destabilizing. Therefore, operations of the solar PV portion of the combination alternative would not likely have disproportionately high and adverse human health and environmental effects on minority and low-income populations, but this would depend on the exact location of the solar facilities.

Potential impacts to minority and low-income populations from the construction of offshore wind facilities would mostly consist of environmental and socioeconomic effects (e.g., noise, air emissions, traffic, employment, and housing impacts). However, the NRC staff has determined that air quality, noise, socioeconomic, and transportation impacts associated with operation of the offshore wind portion of the combination alternative would be SMALL. Therefore, operations of the offshore wind facility portion of the combination alternative would not likely have disproportionately high and adverse human health and environmental effects on minority and low-income populations.

Low-income populations could benefit from weatherization and insulation programs in a DSM energy conservation program. This program could have a greater effect on low-income populations than the general population, because low-income households generally experience greater home energy burdens than the average household.

Overall, the NRC staff concludes that the operations of the combination alternative would not likely have disproportionately high and adverse human health and environmental effects on minority and low-income populations.

3.13 Waste Management

Like any operating nuclear power plant, Oconee Station will produce both radioactive and nonradioactive waste during the SLR period. This section describes waste management and pollution prevention at Oconee Station. The description of these waste management activities is followed by the NRC staff's analysis of the potential impacts of waste management activities from the proposed action (SLR) and alternatives to the proposed action.

3.13.1 Radioactive Waste

As discussed in Section 2.1.4, "Radioactive Waste Management Systems," of this EIS, Oconee Station uses liquid, gaseous, and solid waste processing systems to collect and treat, as needed, radioactive materials produced as a byproduct of nuclear power plant operations. Radioactive materials in liquid, gaseous, and solid effluents are reduced before being released into the environment so that the resultant dose to members of the public from these effluents is well within the NRC and EPA dose standards. Radionuclides that can be efficiently removed from the liquid and gaseous effluents before release are converted to a solid waste form for disposal in a licensed disposal facility.

3.13.2 Nonradioactive Waste

Waste minimization and pollution prevention are important elements of operations at all nuclear power plants. Licensees are required to consider pollution prevention measures as dictated by the Pollution Prevention Act (Public Law 101 5084 TN6607) and the Resource Conservation and Recovery Act of 1976, as amended (Public Law 94 580) (NRC 2013-TN2654).

The Resource Conservation and Recovery Act (RCRA) governs the disposal of solid waste. The SCDHEC is authorized by the EPA to implement the RCRA and regulate solid and hazardous waste in South Carolina (Duke Energy 2021-TN8897). As described in Section 2.1.5, "Nonradioactive Waste Management System," of this EIS, Oconee Station has a nonradioactive waste management program to handle nonradioactive waste in accordance with Federal, State, and corporate regulations and procedures. Oconee Station maintains a waste minimization program that uses material control, process control, waste management, recycling, and feedback to reduce waste.

The Oconee Station SWPPP identifies potential sources of pollution that may affect the quality of stormwater discharges from permitted outfalls. The SWPPP also describes BMPs for reducing pollutants in stormwater discharges and assuring compliance with the site's NPDES permit (Duke Energy 2021-TN8897). Oconee Station also has an environmental management system (Duke Energy 2021-TN8897). Procedures are in place to monitor areas within the site that have the potential to discharge oil into or on navigable waters, in accordance with the regulations in 40 CFR Part 112, “Oil Pollution Prevention” (TN1041). The Pollution Incident/Hazardous Substance Spill Procedure identifies and describes the procedures, materials, equipment, and facilities that Duke Energy uses to minimize the frequency and severity of oil spills at Oconee Station.

Oconee Station is subject to the EPA reporting requirements in 40 CFR Part 110, “Discharge of Oil,” under CWA Section 311(b)(4) (TN8485). Under these regulations, Oconee Station must report to the U.S. Coast Guard National Response Center any discharges of oil if the quantity may be harmful to the public health or welfare or to the environment. Based on the NRC staff’s review of Section 9.5.3.6 of the ER (Duke Energy 2022-TN8899, Appendix E) and a review of records from 2014–2022, two spills were reported to the National Response Center. The spills were attributed to Keowee Hydro operations not Oconee Station operations. In addition, the applicant confirmed that no reportable spills have triggered this notification requirement since the ER was written (Duke Energy 2023-TN8952).

Oconee Station is also subject to the reporting provisions of the SCDHEC 2017-TN9028 for reporting the release of a regulated substance from an underground storage tank containing a petroleum product or hazardous substance. Based on the NRC staff’s review of Section 9.5.13.6 of the ER (Duke Energy 2022-TN8899, Appendix E) and a review of records from 2014-2020, no reportable spills under the reporting provisions of the SC R. 61-92.280.60 occurred. In addition, the applicant confirmed that there have been no reportable spills that would trigger this notification requirement since the ER was written (Duke Energy 2023-TN8952).

Oconee Station is also registered as an infectious waste generator and complies with the South Carolina Infectious Waste Management Regulations, R 61-105 for management of the waste. The infectious waste is generated at the onsite medical facility and onsite procedures comply with the bloodborne pathogens requirements in 29 CFR 1910.1030 (TN654).

3.13.3 Proposed Action

The following sections address the site-specific environmental impacts of the Oconee Station SLR on the environmental issues related to waste management in accordance with Commission direction in CLI-22-02 and CLI-22-03.

3.13.3.1 Low-Level Waste Storage and Disposal

At Oconee Station, low-level radioactive waste is stored temporarily onsite before being shipped offsite for treatment or disposal facilities (Duke Energy 2021-TN8897). Annual quantities of low-level radioactive waste generated at Oconee Station vary from year to year depending on the number of maintenance activities undertaken. Due to the comprehensive regulatory controls in place for the management of radioactive waste, Duke Energy’s compliance with these regulations, and Duke Energy’s use of licensed treatment and disposal facilities, the impacts of radioactive waste are expected to be SMALL during the SLR term. Also, there are no other operating nuclear power plants, fuel-cycle facilities, or radiological waste treatment and disposal facilities with a 50 mi (80 km) radius of Oconee Station. Therefore, the NRC staff concludes that the environmental impacts from low-level waste storage and disposal due to continued nuclear power plant operations at Oconee Station during the SLR term would be SMALL.

3.13.3.2 Onsite Storage of Spent Nuclear Fuel

As discussed in Section 2.1.4.5, Oconee Station's spent fuel is stored in a spent fuel pool at each nuclear power plant and in an onsite ISFSI. The Oconee Station ISFSI is licensed under the general license provided to nuclear power plant licensees under 10 CFR 72.210, "General license issued," (TN4884). The NRC's regulation and its oversight of onsite spent fuel storage ensure that the increased volume in onsite storage from operation during the SLR term can be safely accommodated with little environmental effect. The ISFSI safely stores spent fuel onsite in licensed and approved dry cask storage containers.

This issue was also considered for the NRC staff's environmental review of Oconee Station's initial license renewal, and no new and significant information was found at that time (NRC 1999-TN8942). The NRC staff identified no information or situations that would result in different impacts for this issue for the SLR term at Oconee Station. Therefore, the NRC staff concludes that the environmental impacts from onsite storage of spent nuclear fuel due to continued nuclear power plant operations at Oconee Station during the SLR term would be SMALL.

3.13.3.3 Offsite Radiological Impacts of Spent Nuclear Fuel and High-Level Waste Disposal

As related to the issue of offsite radiological impacts of spent nuclear fuel and high-level waste disposal, a history of the NRC's Waste Confidence activities is provided in NUREG-2157, "Generic Environmental Impact Statement for Continued Storage of Spent Nuclear Fuel (NRC 2014-TN4117), Section 1.1, History of Waste Confidence. The management and ultimate disposition of spent nuclear fuel is limited to the findings codified in the September 19, 2014, Continued Storage of Spent Nuclear Fuel, Final Rule (79 FR 56238-TN4104) and associated NUREG-2157 (NRC 2014-TN4117). The ultimate disposal of spent nuclear fuel in a potential future geologic repository is a separate and independent licensing action that is outside the regulatory scope of this site-specific review. Per 10 CFR Part 51 (TN250) Subpart A, the Commission concludes that the impacts presented in NUREG-2157 (NRC 2014-TN4117) would not be sufficiently large to require the conclusion, for any nuclear power plant, that the option of extended operation under 10 CFR Part 54 (TN4878) should be eliminated. Accordingly, while the Commission has not assigned a single level of significance for the offsite radiological impacts of spent nuclear fuel and high-level waste disposal, this issue is considered generic to all nuclear power plants pursuant to 10 CFR 51.23 (TN250) and does not warrant a site-specific analysis for the continued nuclear power plant operations at Oconee Station during the SLR term.

3.13.3.4 Mixed-Waste Storage and Disposal

Mixed waste, regulated under RCRA (TN1281) and the AEA of 1954, as amended (42 U.S.C. § 2011 et seq.-TN663), is waste that is both radioactive and hazardous. Mixed waste is subject to dual regulation: by the EPA or an authorized State for its hazardous component and by the NRC or an agreement state for its radioactive component. Similar to hazardous waste, mixed waste is generally accumulated onsite in designated areas as authorized under RCRA then shipped offsite for treatment as appropriate and for disposal. Occupational exposures and any releases from onsite treatment of these and any other types of wastes are considered when evaluating compliance with the applicable Federal standards and regulations: for example, 10 CFR Part 20 (TN283), 40 CFR Part 190 (TN739), and 10 CFR Part 50, Appendix I (TN249). Due to the comprehensive regulatory controls in place for the management of mixed waste, Duke Energy's compliance with these regulations, and Duke Energy's use of licensed treatment and disposal facilities, the impacts of mixed waste are expected to be SMALL during the SLR term. The NRC staff identified no information or situations that would result in different impacts for this issue during the SLR term at Oconee Station. Therefore, the NRC staff concludes that, the radiological and nonradiological environmental impacts from the mixed waste storage and disposal due to continued nuclear plant operations at Oconee Station during the SLR term would be SMALL.

3.13.3.5 Nonradioactive Waste Storage and Disposal

Like any other industrial facility, nuclear power plants generate wastes that are not contaminated with either radionuclides or hazardous chemicals. Oconee Station has a nonradioactive waste management system to handle its nonradioactive hazardous and nonhazardous wastes. The waste is managed in accordance with Duke Energy's procedures. Waste minimization and pollution prevention are important elements of operations at all nuclear power plants. Licensees are required to consider pollution prevention measures as dictated by the Pollution Prevention Act (Public Law 101-508; TN6607) and RCRA (Public Law 94-580; TN1281). In addition, as discussed in Section 2.1.5, Oconee Station has a nonradioactive waste management program to handle nonradioactive waste in accordance with Federal, State, and corporate regulations and procedures. Oconee Station will continue to store and dispose of nonradioactive hazardous and nonhazardous waste in accordance with EPA, State, and local regulations in permitted disposal facilities. With respect to unplanned, nonradiological releases, Duke Energy reported two sewage spills between 2021 and 2022 (Duke Energy 2022-TN8899). Duke Energy followed reporting requirements and reported the spills to SCDHEC. No other accidental spills or releases of nonradioactive substances, including petroleum products, occurred at Oconee Station over the past 5 years, or were any associated notices of violation issued to Duke Energy for such releases (Duke Energy 2022-TN8899; Response to Requests for Additional Information/Request for Confirmation of Information (Duke Energy 2023-TN8952). The NRC staff's review of available information and regulatory databases found no documented instances of accidental spills of chemical or petroleum products to groundwater due to Oconee Station operations that resulted in a regulatory action over the last 5 years. Due to the comprehensive regulatory controls in place for the management of nonradioactive waste and Duke Energy's compliance with these regulations, the impacts of nonradioactive waste are expected to be SMALL during the SLR term. The NRC staff identified no information or situations that would result in different impacts for this issue for the SLR term at Oconee Station. Therefore, the NRC staff concludes that the environmental impacts from nonradioactive waste storage and disposal due to continued nuclear plant operations at Oconee Station during the SLR term would be SMALL.

3.13.4 No-Action Alternative

Under the no-action alternative, Oconee Station would cease operation at the end of the term of the renewed facility operating licenses or sooner and enter decommissioning. After entering decommissioning, the nuclear power plant would generate less spent nuclear fuel, emit less gaseous and liquid radioactive effluents into the environment, and generate less low-level radioactive and nonradioactive wastes. In addition, following shutdown, the variety of potential accidents at the nuclear power plant (radiological and industrial) would be reduced to a limited set associated with shutdown events and fuel handling and storage. Therefore, as radioactive emissions to the environment decrease, and the likelihood and variety of accidents decrease following shutdown and decommissioning, the NRC staff concludes that impacts resulting from waste management from implementation of the no-action alternative would be SMALL.

3.13.5 Replacement Power Alternatives: Common Impacts

Impacts from waste management common to all analyzed replacement power alternatives would be from construction-related nonradiological debris generated during construction activities. This waste would be recycled or disposed of in approved landfills.

3.13.6 New Nuclear (Advanced Light-Water Reactor and Small Modular Reactor) Alternative

Impacts from the waste generated during the construction of the new nuclear alternative would include those identified in Section 3.13.5 above, as common to all replacement power alternatives.

During normal nuclear power plant operations, routine nuclear power plant maintenance and cleaning activities would generate radioactive low-level waste, spent nuclear fuel, high-level waste, and nonradioactive waste. Sections 2.1.4 and 2.1.5 of this EIS discuss radioactive and nonradioactive waste management at Oconee Station. ALWRs and small modular reactor designs would use the same type of fuel (i.e., form of the fuel, enrichment, burnup, and fuel cladding) as those nuclear power plants considered in the NRC staff's evaluation in the LR GEIS (NRC 2013-TN2654). As such, all wastes generated would be similar to those generated at Oconee Station. According to the LR GEIS, the NRC does not expect the generation and management of solid radioactive and nonradioactive waste to result in significant environmental impacts. The NRC staff identified no information or situations that would result in different impacts for this issue during the SLR term. Therefore, the NRC staff concludes that the impacts on waste from the operation of the new nuclear alternative would be SMALL.

3.13.7 Natural Gas Combined-Cycle Alternative

Impacts from the waste generated during the construction of the natural gas combined-cycle alternative would include those identified in Section 3.13.5 of this EIS as common to all replacement power alternatives.

Waste generation from natural gas technology would be minimal. The only significant waste generated at a natural gas combined-cycle power plant would be spent selective catalytic reduction catalyst (plants use selective catalytic reduction catalyst to control nitrogen oxide emissions).

The spent catalyst would be regenerated or disposed of offsite. Other than the spent selective catalytic reduction catalyst, waste generation at an operating natural gas fired plant would be limited largely to typical operations and maintenance of nonhazardous waste. Based on this information, the NRC staff concludes that the waste impacts for the natural gas combined-cycle alternative would be SMALL.

3.13.8 Combination Alternative (Solar PV, Offshore Wind, Small Modular Reactor, and Demand-Side Management)

Impacts from the waste generated during the construction of the combination alternative would include those identified in Section 3.13.5 of this EIS as common to all replacement power alternatives.

During normal nuclear power plant operations, routine nuclear power plant maintenance and cleaning activities would generate radioactive low-level waste, spent nuclear fuel, high-level waste, and nonradioactive waste. Sections 2.1.4 and 2.1.5 of this EIS discuss radioactive and nonradioactive waste management, respectively, at Oconee Station. Small modular reactor designs would use the same type of fuel (i.e., form of the fuel, enrichment, burnup, and fuel cladding) as those nuclear power plants considered in the NRC staff's evaluation in the LR GEIS (NRC 2013-TN2654), and as such, all wastes generated would be similar to those generated at Oconee Station. According to the LR GEIS, the NRC does not expect the generation and management of solid radioactive and nonradioactive waste to result in significant environmental impacts. The NRC staff identified no information or situations that would result in different impacts for this issue during the SLR term. Therefore, the NRC staff concludes that the waste impacts for the new nuclear alternative would be SMALL.

The construction of the solar PV facilities would create sanitary and industrial waste, although it would be of smaller quantity compared to the SMR. This waste could be recycled or shipped to an offsite waste disposal facility. All the waste would be handled in accordance with appropriate South Carolina Department of Natural Resources (SCDNR) regulations. Impacts on waste management resulting from the construction and operation of the solar PV facilities of the combination alternative would be minimal, and of a smaller quantity, compared to the SMR. In summary, the NRC staff concludes that the waste management impacts resulting from the construction and operation of the PV facilities would be SMALL.

During construction of offshore wind facilities as part of the combination alternative, waste materials or the accidental release of fuels are expected to be negligible because of the very limited amount of vessel traffic and construction activity that might occur with construction, installation, operation, and decommissioning of offshore turbine generators. Therefore, the NRC staff concludes that the waste management impacts would be SMALL.

For the demand-side management component, there may be an increase in wastes generated during installation or implementation of energy conservation measures, such as appropriate disposal of old appliances, installation of control devices, and building modifications. New and existing recycling programs would help minimize the amount of generated waste. The NRC staff concludes that the impacts from the demand-side management portion of this alternative would be SMALL.

Based on the above, the NRC staff concludes that the waste impacts for the combination alternative would be SMALL.

3.14 Impacts Common to All Alternatives

This section describes the impacts that the NRC staff considers common to all alternatives discussed in this EIS, including the proposed action and replacement power alternatives. In addition, the following sections discuss termination of operations, the decommissioning of a power plant and potential replacement power facilities, and greenhouse gas emissions.

3.14.1 Fuel Cycle

This section describes the environmental impacts associated with the fuel cycles of both the proposed action and all replacement power alternatives that are analyzed in detail in this EIS.

3.14.1.1 Uranium Fuel Cycle

The following sections address the site-specific environmental impacts of Oconee Station SLR on the environmental issues identified in Table 3-1 that relate to the uranium fuel cycle.

<u>Offsite Radiological Impacts- Individual Impacts from Other Than the Disposal of Spent Fuel and High-Level Waste</u>

The primary indicators of offsite radiological impacts on individuals who live near uranium fuel cycle facilities are the concentrations of radionuclides in the effluents from the fuel cycle facilities and the radiological doses received by a maximally exposed individual on the site boundary or at some location away from the site boundary. The basis for establishing the significance of individual effects is the comparison of the releases in the effluents and the maximally exposed individual doses with the permissible levels in applicable regulations. The analyses performed by the NRC in the preparation of Table S-3 in 10 CFR Part 51.51 (TN250) indicate that if the facilities operate under a valid license issued by either the NRC or an Agreement State, the individual effects will meet the applicable regulations. Based on these considerations, the NRC has concluded that the impacts on individuals from radioactive gaseous and liquid releases during the SLR term would remain at or below the NRC's regulatory limits. Efforts needed to keep releases and doses ALARA will continue to apply to fuel cycle related activities. The NRC staff identified no information or situations that would result in different impacts for this issue for the SLR term at Oconee Station. Therefore, the NRC staff concludes that offsite radiological impacts of the uranium fuel cycle (individual effects from sources other than the disposal of spent fuel and high-level waste) due to continued nuclear plant operations at Oconee Station during the SLR term would be SMALL.

<u>Offsite Radiological Impacts-Collective Impacts from Other than the Disposal of Spent Fuel and High-Level Waste</u>

The focus of this issue is the collective radiological doses to and health impacts on the public resulting from uranium fuel cycle facilities over the SLR term. The radiological doses received by the public are calculated based on releases from the uranium fuel cycle facilities to the environment, as provided in Table S-3 (TN250). These estimates were provided in the 1996 LR GEIS for the gaseous and liquid releases listed in Table S-3 as well as for radon-222 and technetium-99 releases (Rn-222 and Tc-99), which are not listed in Table S-3. The population dose commitments were normalized for each year of operation of the model nuclear power plant (per reference reactor year).

Based on the analyses provided in the 2013 LR GEIS (NRC 2013-TN2654), the estimated involuntary 100- year dose commitment to the U.S. population resulting from the radioactive gaseous releases from uranium fuel cycle facilities (excluding the nuclear power plants and releases of Rn-222 and Tc-99) was estimated to be 400 person-rem (4 person-sievert [Sv]) per reference reactor year. Similarly, the environmental dose commitment to the U.S. population from the liquid releases was estimated to be 200 person-rem (2 person-Sv) per reference reactor year. As a result, the total estimated involuntary 100 year dose commitment to the U.S. population from radioactive gaseous and liquid releases listed in Table S-3 was estimated to be 600 person-rem (6 person-Sv) per reference reactor year (see Section 6.2.2 of the 1996 LR GEIS; NRC 1996-TN288).

The doses received by most members of the public would be so small that they would be indistinguishable from the variations in natural background radiation. There are no regulatory limits applicable to collective doses to the public from fuel cycle facilities. All regulatory limits are based on individual doses. All fuel cycle facilities are designed and operated to meet the applicable regulatory limits.

Based on its consideration of the available information, the Commission concluded that these impacts are acceptable in that they would not be sufficiently large to require the NEPA conclusion, for any nuclear power plant, that the option of extended operation under 10 CFR Part 54 (TN4878) should be eliminated. Accordingly, the Commission has not assigned a single level of significance for the collective effects of the fuel cycle. The NRC staff identified no information or situations that would result in different impacts for this issue for the SLR term. Therefore, the NRC staff concludes that offsite radiological impacts of the uranium fuel cycle (collective impacts from sources other than the disposal of spent nuclear fuel and high-level waste) due to continued nuclear power plant operations at Oconee Station during the SLR term would not be sufficiently large to require the NEPA conclusion that the option of Oconee Station SLR should be eliminated.

Nonradiological Impacts of the Uranium Fuel Cycle

Nonradiological impacts associated with the uranium fuel cycle as they relate to license renewal are provided in Table S-3 (TN250). The significance of the environmental impacts associated with land use, water use, fossil fuel use, and chemical effluents were evaluated in the LR GEIS (NRC 2013-TN2654) based on several relative comparisons. The land requirements were compared to those for a coal-fired power plant that could be built to replace the nuclear capacity if the operating license is not renewed. Water requirements for the uranium fuel cycle were compared to the annual requirements for a nuclear power plant. The amount of fossil fuel (coal and natural gas) consumed to produce electrical energy and process heat during the various phases of the uranium fuel cycle was compared to the amount of fossil fuel that would have been used if the electrical output from the nuclear power plant were supplied by a coal-fired plant. Similarly, the gaseous effluents SO_2, nitric oxide (NO), hydrocarbons, CO, and other PM released because of the coal-fired electrical energy used in the uranium fuel cycle were compared with equivalent quantities of the same effluents that would be released from a 45 MW electric coal-fired plant. It was noted that the impacts associated with uses of all resources would be SMALL. Any impacts associated with nonradiological liquid releases from the fuel cycle facilities would also be SMALL. The NRC staff identified no information or situations that would result in different impacts for this issue for the SLR term at Oconee Station. Therefore, the NRC staff concludes that the aggregate nonradiological impacts of the uranium fuel cycle due to continued nuclear power plant operations at Oconee Station during the SLR term would be SMALL.

Transportation

The environmental impacts associated with the transportation of fuel and waste to and from one model nuclear power plant as they relate to license renewal are addressed in Table S-4 (10 CFR Part 51-TN250). Table S-4 forms the basis for analysis of the environmental impacts of transportation of fuel and waste when evaluating applications for nuclear power plant license renewal. The applicability of Table S-4 to license renewal applications was extensively evaluated in the 1996 LR GEIS (NRC 1996-TN288) and its Addendum 1 (NRC 1999-TN289). The environmental impacts from the transportation of fuel and waste attributable to license renewal were found to be SMALL when they are within the parameters identified in 10 CFR 51.52 (TN250). The NRC staff identified no information or situations that would result in different impacts for this issue for the SLR term at Oconee Station and determined that Oconee

Station is within the parameters identified in 10 CFR Part 51.52 (TN250). Therefore, the NRC staff concludes that the transportation impacts of the uranium fuel cycle due to continued nuclear power plant operations at Oconee Station during the SLR term would be SMALL.

3.14.1.2 Replacement Nuclear Power Plant Fuel Cycles

New Nuclear Energy Alternatives

Uranium fuel cycle impacts for a nuclear power plant result from the initial extraction of fuel, transport of fuel to the facility, and management and ultimate disposal of spent fuel. The environmental impacts of the uranium fuel cycle are referenced above in Section 3.14.1.1.

Fossil Fuel Energy Alternatives

Fuel cycle impacts for a fossil fuel-fired power plant result from the initial extraction of fuel, cleaning and processing of fuel, transport of fuel to the facility, and management and ultimate disposal of any solid wastes from fuel combustion. These impacts are discussed in more detail in Section 4.12.1.2 of the LR GEIS (NRC 2013-TN2654) and can generally include the following:

- significant changes to land use and visual resources
- impacts to air quality, including release of criteria pollutants, fugitive dust, volatile organic compounds, and methane into the atmosphere
- noise impacts
- geology and soil impacts caused by land disturbances and mining
- water resource impacts, including degradation of surface water and groundwater quality
- ecological impacts, including loss of habitat and wildlife disturbances
- historic and cultural resources impacts within the mine or pipeline footprint
- socioeconomic impacts from employment of both the mining workforce and service and support industries
- environmental justice impacts
- health impacts to workers from exposure to airborne dust and methane gases
- generation of industrial wastes

Renewable Energy Alternatives

For renewable energy technologies that rely on the extraction of a fuel source (e.g., biomass), such alternatives may have fuel cycle impacts with some similarities to those associated with the uranium fuel cycle. Renewable energy technologies such as wind, solar, geothermal, and wave and ocean energy do not have a fuel cycle comparable to uranium fuel. This is because the natural resource exists (i.e., they are not consumed or irreversibly committed) regardless of any effort to use them for electricity production. Fuel cycle impacts for these renewable energy technologies cannot be determined.

3.14.2 Termination of Plant Operations and Decommissioning

This section addresses the environmental impacts of Oconee Station SLR associated with the termination of operations and the decommissioning of a nuclear power plant and replacement power alternatives. All operating nuclear power plants will terminate operations and be decommissioned at some point after the end of their operating life or after a decision is made to cease operations. For the proposed action at Oconee Station, SLR would delay this eventuality for an additional 20 years beyond the current license periods, to end in 2053 (Unit 1), 2053 (Unit 2), and 2054 (Unit 3).

3.14.2.1 Existing Nuclear Power Plant

The decommissioning process begins when a licensee informs the NRC that it has permanently ceased reactor operations, defueled, and intends to decommission the nuclear plant. The licensee may also notify the NRC of the permanent cessation of reactor operations prior to the end of the license term. Consequently, most nuclear plant activities and systems dedicated to reactor operations would cease after reactor shutdown. The environmental impacts of decommissioning a nuclear power plant are evaluated NUREG–0586, “Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities: Supplement 1, Regarding the Decommissioning of Nuclear Power Reactors” (NRC 2002-TN665). Additionally, Section 4.12.2.1 of the LR GEIS (NRC 2013-TN2654) summarizes the incremental environmental impacts associated with nuclear power plant decommissioning activities. As noted in Table 3-1, there is one Category 1 issue, “Termination of Plant Operations and Decommissioning,” applicable to Oconee Station decommissioning following the SLR term. The LR GEIS did not identify any site-specific (Category 2) decommissioning issues.

<u>Termination of Plant Operations and Decommissioning</u>

The NRC staff determined that license renewal would have a negligible effect on these impacts of terminating operations and decommissioning on all resources. The NRC staff identified no information or situations that would result in different environmental impacts for this issue for the SLR term at Oconee Station. Therefore, the NRC staff concludes that the incremental environmental impacts of termination of plant operations and decommissioning due to continued nuclear power plant operations at Oconee Station during the SLR term would be SMALL.

3.14.2.2 Replacement Power Plants

<u>New Nuclear and Fossil Fuel Alternatives</u>

The environmental impacts from the termination of power plant operations and decommissioning of a power generating facility are dependent on the facility’s decommissioning plan. Decommissioning plans generally outline the actions needed to restore the site to a condition equivalent in character and value to the site on which the facility was first constructed. General elements and requirements for a thermoelectric power plant decommissioning plan can include the removal of structures below grade, the removal of all accumulated waste materials, the removal of intake and discharge structures, and the cleanup and remediation of incidental spills and leaks at the facility.

The environmental consequences of decommissioning can generally include the following:

- short-term impacts on air quality and noise from the deconstruction of facility structures
- short-term impacts on land use and visual resources
- long-term reestablishment of vegetation and wildlife communities
- socioeconomic impacts caused by decommissioning the workforce and the long-term loss of jobs
- elimination of health and safety impacts on operating personnel and the general public

These impacts are representative of those associated with decommissioning any thermoelectric power generating facility.

Activities that are unique to the termination of operations and decommissioning of a nuclear power generating facility include the safe removal of the facility from service and the reduction of residual radioactivity to a level that permits release of the property under restricted conditions or unrestricted use and termination of the license.

Renewable Energy Alternatives

Termination of power plant operation and decommissioning for renewable energy facilities would generally be similar to the activities and impacts discussed for new nuclear and fossil fuel alternatives above. Decommissioning would involve the removal of facility components and any operational wastes and residues to restore sites to a condition equivalent in character and value to the site on which the facility was first constructed. In other circumstances, supporting infrastructure (e.g., buried utilities and pipelines) could be abandoned in place (NRC 2013-TN2654). The range of possible decommissioning considerations and impacts, depending on the renewable energy alternative considered, are discussed in Section 4.12.2.2 of the LR GEIS (see subsection, “Renewable Alternatives”) (NRC 2013-TN2654). The staff incorporates the information in NUREG-1437, Revision 1, Section 4.12.2.2 (NRC 2013-TN2654: 4-227, 4-228), herein by reference.

3.14.3 Greenhouse Gas Emissions and Climate Change

The following sections discuss GHG emissions and climate change impacts. Section 3.14.3.1 discusses the observed changes in climate and potential future climate change during the SLR term, based on climate model simulations under future global GHG emissions scenarios.

3.14.3.1 Greenhouse Gas Emissions from the Proposed Project and Alternatives

Gases found in the Earth’s atmosphere that trap heat and play a role in the Earth’s climate are collectively termed GHGs. These GHGs include CO_2, methane (CH_4), nitrous oxide (N_2O), water vapor (H_2O), and fluorinated gases, such as hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride. The Earth’s climate responds to changes in concentrations of GHGs in the atmosphere because these gases affect the amount of energy absorbed and heat trapped by the atmosphere. Increasing concentrations of GHGs in the atmosphere generally increase the Earth’s surface temperature. Atmospheric concentrations of CO_2, CH_4, and N_2O have significantly increased since 1750 (IPCC 2013-TN7434, IPCC 2021-TN7435). In 2019, atmospheric concentrations of CO_2 (measured at 410 ppm) were higher than any time in at least 2 million years (IPCC 2023-TN8557). Long-lived GHGs—CO_2, CH_4, N_2O, and fluorinated gases—are well mixed throughout the Earth’s atmosphere, and their impact on climate is longlasting and cumulative in nature as a result of their long atmospheric lifetimes (EPA 2016-TN7561). Therefore, the extent and nature of climate change is not specific to where GHGs are emitted. Carbon dioxide is of primary concern for global climate change because it is the primary gas emitted as a result of human activities.

The sixth assessment synthesis report from the Intergovernmental Panel on Climate Change (IPCC) states that "[i]t is unequivocal that human influence has warmed the atmosphere, ocean, and land" (IPCC 2023-TN8557). In 2019, global net GHG emissions were estimated to be 59±6.6 gigatons of CO_2 equivalents (CO_2eq), with the largest share in gross GHG emissions being CO_2 from fossil fuels combustion and industrial processes (IPCC 2023-TN8557). The EPA has determined that GHGs "may reasonably be anticipated both to endanger public health and to endanger public welfare."

Proposed Action

The operation of Oconee Station results in both direct and indirect GHG emissions. Duke Energy has calculated direct (i.e., stationary combustion sources) and indirect (i.e., workforce commuting) GHG emission, which are provided in Table 3-24. Duke Energy does not maintain an inventory of GHG emission resulting from visitors and delivery vehicles (Duke Energy 2021-TN8897). Fluorinated gas emissions from refrigerant sources and from electrical transmission and distribution systems can result from leakage, servicing, repair, or disposal of sources. In addition to being GHGs, chlorofluorocarbons and hydrochlorofluorocarbons are ozone-depleting substances that are regulated by the Clean Air Act under (42 U.S.C. 7401 et seq.; Clean Air Act-TN1141) Title VI, "Stratospheric Ozone Protection. Duke Energy maintains a program to manage stationary refrigeration appliances at Oconee Station to recycle, recapture, and reduce emissions of ozone-depleting substances. Therefore, Table 3-24 below does not account for any potential emissions from stationary refrigeration sources at Oconee Station (Duke Energy 2021-TN8897).

Table 3-24 Annual Greenhouse Gas Emissions[(a)] from Operation at Oconee Station Power Station, Units 1, 2, and 3

Year	Onsite Combustion Source	Workforce Commuting[(b)]	Total
2020	600	5,290	5,890
2021	210	5,290	5,500
2022	265	5,290	5,560

Note: The greenhouse gas (GHG) emissions are reported in metric tons and converted to short tons. All reported values are rounded. To convert tons per year, multiply by 0.90718. Expressed in carbon dioxide equivalents (CO_2eq), a metric used to compare the emissions of GHG based on their global warming potential (GWP). The GWP is a measure used to compare how much heat a GHG traps in the atmosphere. The GWP is the total energy that a gas absorbs during a period of time compared to carbon dioxide. CO_2eq is obtained by multiplying the amount of the GHG by the associated GWP. For example, the GWP of methane is 21; therefore, 1 ton of methane emission is equivalent to 21 tons of carbon dioxide emissions.

(a) Onsite combustion sources include boiler and generators. Emissions calculated using actual fuel usage and 40 CFR Part 98 (TN2170) emission factors. Values are rounded up.

(b) Emissions account for 1,068 passenger vehicles per day based on Oconee Station permanent full-time employees and 495 contingent non-outage workers (1,117) and a 4.4 percent carpool rate. Values are rounded up.

Source: Duke Energy 2023-TN8952.

No-Action Alternative

Under the no-action alternative, the NRC would not issue subsequent renewed licenses, and Oconee Station would permanently shut down on or before the expiration of the current renewed licenses. At some point, all nuclear power plants will terminate operations and undergo decommissioning. The decommissioning GEIS (NUREG-0586) (NRC 2002-TN665) considers the environmental impacts of decommissioning. Therefore, the scope of impacts considered under the no-action alternative includes the immediate impacts resulting from activities at Oconee Station that would occur between nuclear power plant shutdown and the beginning of decommissioning (i.e., activities and actions necessary to cease operation of Oconee Station). Facility operations would terminate at before the expiration of the current renewed licenses. When the facility stops operating, a reduction in GHG emissions from activities related to nuclear power plant operation, such as the use of generators and employee vehicles would occur. The NRC staff anticipates that GHG emissions for the no-action alternative would be less than those presented in Table 3-24 which shows the estimated direct GHG emissions from operation of Oconee Station and associated mobile emissions.

New Nuclear Alternative (Small Modular Reactors)

The LR GEIS (NRC 2013-TN2654) presents life-cycle GHG emissions associated with nuclear power generation. As presented in Tables 4.12-4 through 4.12-6 of the LR GEIS, life-cycle GHG emissions from nuclear power generation can range from 1 to 288 grams carbon equivalent per kilowatt-hour (g Ceq/kWh). Nuclear power plants do not burn fossil fuels to generate electricity. Sources of GHG emissions for the small modular reactor portion of the new nuclear alternative would include diesel generators, boilers, and gas turbines, similar to existing sources at Oconee Station (NRC 2019-TN6136). In NUREG-2226, the NRC estimated the total carbon footprint as a result of operating two or more small modular reactors with a maximum total electrical output of 800 MWe (NRC 2019-TN6136). In Section 5.7.1.2, of NUREG-2226 (p. 5-45) the NRC estimated that the carbon footprint for operations for 40 years is 199,500 tons of CO_2eq (181,000 MT) or 4,990 tons of CO_2eq annually (4,525 MT). Therefore, the NRC staff estimates that operating a 400 MWe small modular reactor would emit approximately 2,500 tons of CO_2eq annually (2,270 MT). In NUREG-2111, the NRC estimated the total carbon footprint as a result of operating two ALWR units with a total net electrical output capacity of 2,234 MWe at the W.S. Lee Nuclear Station site (NRC 2013-TN6435). In Section 5.7.2.2 of NUREG-2111 (pp. 5-66 through 5-67), the NRC estimated that the carbon footprint for 40 years of operation of two 2,234-MWe ALWRs would be 418,900 tons/year of CO_2eq (380,000 MT) or 10,500 tons per year of CO_2eq (9,500-MT/year). The NRC staff incorporates the analysis in Section 5.7.2.2 of NUREG-2111 (pp. 5-66 through 5-67) herein by reference. Therefore, operation of the new nuclear alternative, which would consist of a 400 MWe small modular reactor and two ALWR units providing 2,234 MWe of generating capacity, would emit 13,000 tons/year of CO_2eq (11,800 MT/year).

Natural Gas Alternative (Natural Gas Combined-Cycle)

The LR GEIS (NRC 2013-TN2654) presents life-cycle GHG emissions associated with natural gas power generation. As presented in Table 4.12-5 of the LR GEIS, life-cycle GHG emissions from natural gas can range from 120 to 930 g Ceq/kWh. Using emission factors developed by the U.S. Department of Energy's National Energy Technology Laboratory (NETL 2019-TN7484), the NRC staff estimates that direct emissions from the operation of six 500 MWe natural gas combined-cycle units would total 10.5 million tons (9.5 million MT) of CO_2eq per year.

Combination Alternative

For the combination alternative, GHGs would primarily be emitted from the new nuclear portion. The NRC staff estimates that direct GHG emissions from the combination alternative would total 7,500 tons/year of CO_2eq (6,800 MT/year).

Summary of Greenhouse Gas Emissions from the Proposed Action and Alternatives

Table 3-25 below presents the direct GHG emissions from facility operations under the proposed action of SLR and alternatives to the proposed action. The GHG emissions from the natural gas combined-cycle alternative are several orders of magnitude greater than those from continued operation of Oconee Station, the new nuclear alternative, or combination alternatives. If Oconee Station's generating capacity were to be replaced by the NGCC alternative, there would be an increase in GHG emissions. Therefore, the NRC staff concludes that the continued operation of Oconee Station (the proposed action) results in GHG emissions avoidance as compared to the natural gas combined-cycle alternative. However, the proposed action, the no-action alternative, the new nuclear alternative, and the combination alternative would have similar and comparable GHG emissions. If Oconee Station's generating capacity were to be replaced by either the new nuclear alternative or the combination alternative, there would be no significant increase in GHG emissions.

Table 3-25 Direct Greenhouse Gas Emissions from Facility Operations Under the Proposed Action and Alternatives

Technology/Alternative	CO_2eq[(a)] (tons/year)
Proposed Action (Oconee Station SLR)[(b)]	600
No-Action Alternative[(c)]	<600
New Nuclear	13,000
Natural Gas Combined-Cycle[(d)]	10.5 million
Combination Alternative[(e)]	7,500

CO_2eq = carbon dioxide equivalent; SLR = subsequent license renewal.
Note: All reported values are rounded. To convert tons per year to metric tons per year, multiply by 0.90718.
(a) CO_2eq is a metric used to compare the emissions of greenhouse gases (GHG) based on their global warming potential (GWP). The GWP is a measure used to compare how much heat a GHG traps in the atmosphere. The GWP is the total energy that a gas absorbs over a period of time compared to carbon dioxide. CO_2eq is obtained by multiplying the amount of the GHG by the associated GWP. For example, the GWP of methane is 21; therefore, 1 ton of methane emission is equivalent to 21 tons of carbon dioxide emissions.
(b) GHG emissions include direct emissions from onsite combustion sources. Highest value presented in Table 3-24 was used.
(c) Emissions resulting from activities at Oconee Station that would occur between nuclear power plant shutdown and the beginning of decommissioning and assumed not to be greater than greenhouse gas emissions from operation at Oconee Station.
(d) Emissions from direct combustion of natural gas. GHG emissions estimated using emission factors developed by the U.S. Department of Energy (DOE's) National Energy Technology Laboratory (NETL) (NETL 2019-TN7484).
(e) Emissions primarily from the new nuclear portion and scaled from 400-MWe small modular reactor (SMR) under the New Nuclear Alternative.

3.14.3.2 Climate Change

Climate change is the decades or longer change in climate measurements (e.g., temperature and precipitation) that has been observed on a global, national, and regional level (IPCC 2007-TN7421; EPA 2016-TN7561; USGCRP 2014-TN3472). Climate change research indicates that the cause of the Earth's warming over the last 50 to 100 years is due to the buildup of GHGs in the atmosphere resulting from human activities IPCC 2013-TN7434, IPCC 2021-TN7435; IPCC 2023-TN8557; USGCRP 2014-TN3472, USGCRP 2017-TN5848, USGCRP 2018-TN5847).

Observed Trends in Climate Change Indicators

Global surface temperature has increased faster since 1970 than in any other 50 year period over at least the last 2,000 years (IPCC 2023-TN8557). On a global level, from 1901 to 2016, the average temperature has increased by 1.8°F (1.0°C) (USGCRP 2018-TN5847). Since 1901, precipitation has increased at an average rate of 0.04 in. (0.0.1 cm) per decade on a global level (EPA 2022-TN9163). The USGCRP reports that from 1901 to 2016, average surface temperatures have increased by 1.8°F (1.0°C) across the contiguous United States (USGCRP 2018-TN5847). Since 1901, average annual precipitation has increased by 4 percent across the United States (USGCRP 2018-TN5847). Observed climate change indicators across the United States include increases in the frequency and intensity of heavy precipitation, earlier onset of spring snowmelt and runoff, rise of sea level and increased tidal flooding in coastal areas, an increased occurrence of heat waves, and a decrease in the occurrence of cold waves. Since the 1980s, data show an increase in the length of the frost-free season (i.e., the period between the last occurrence of 32°F (0°C) in the spring and first occurrence of 32°F (0°C) in the fall), across the contiguous United States. Over the period 1991 through 2011, the average frost-free season was 10 days longer (relative to the 1901 through 1960 time period) (USGCRP 2014-TN3472). Over just the past two decades, the number of high-temperature records observed in the United States has far exceeded the number of low-temperature records (USGCRP 2018-TN5847). Since the 1980s, the intensity, frequency, and duration of North Atlantic hurricanes have increased (USGCRP 2014-TN3472). The Southeast is one of the few places in the world where there has not been an overall increase in daily maximum temperatures since 1900 (NOAA 2013-TN7424; USGCRP 2018-TN5847). However, since the early 1960s, the southeast has been warming at a similar rate as the rest of the United States and has been accompanied by an increase in the number of hot days with maximum temperatures higher than 95°F (35°C) in the daytime and higher than 75°F (23.9°C) in the night-time (NOAA 2013-TN7424; USGCRP 2009-TN18, USGCRP 2014-TN3472, USGCRP 2018-TN5847). Average annual precipitation data for the southeast region does not exhibit an increasing or decreasing trend overall for the long-term period (1895–2011) (NOAA 2013-TN7424). Precipitation in the southeast region varies considerably throughout the seasons, and average precipitation has generally increased in the fall and decreased in the summer (NOAA 2013-TN7424; USGCRP 2009-TN18).

The NRC staff used the NOAA “Climate at a Glance” tool to analyze temperature and precipitation trends for the 1895–2021 period in South Carolina’s Northwest Climate Division (Climate Division No. 2). A trend analysis shows that the average annual temperature has increased at a rate of 0.1°F (0.06°C) per decade, while annual precipitation has decreased at a rate of 0.15 in. (38.1 cm) per decade (NOAA NCEI 2021-TN6902; NOAA NCEI 2021-TN6903).

Climate Change Projections

Future global GHG emission concentrations (emission scenarios) and climate models are commonly used to project possible climate change. Climate models indicate that during the next few decades, temperature increases will continue because of current GHG emission concentrations in the atmosphere (USGCRP 2014-TN3472). This increase is because it takes time for Earth’s climate system to respond to changes in GHG concentrations. If GHG concentrations were to stabilize at current levels, this would still result in at least an additional 1.1°F (0.6°C) of warming over this century (USGCRP 2018-TN5847). During the longer term, the magnitude of temperature increases and climate change effects will depend on future global

GHG emissions (IPCC 2021-TN7435; USGCRP 2009-TN18, USGCRP 2014-TN3472, USGCRP 2018-TN5847). Climate model simulations often use GHG emission scenarios to represent possible future social, economic, technological, and demographic development that, in turn, drive future emissions. Consequently, the GHG emission scenarios, their supporting assumptions, and the projections of possible climate change effects entail substantial uncertainty.

The IPCC has generated various representative concentration pathway (RCP) scenarios commonly used by climate modeling groups to project future climate conditions (IPCC 2000-TN7652, IPCC 2013-TN7434; USGCRP 2017-TN5848, USGCRP 2018-TN5847). For instance, the A2 scenario is representative of a high-emission scenario under which GHG emissions continue to rise during the 21st century from 40 gigatons (GT) of CO_2eq per year in 2000 to 140 GT of CO_2eq per year by 2100. The B1 scenario, on the other hand, is representative of a low-emission scenario in which emissions rise from 40 GT of CO_2eq per year in 2000, to 50 GT of CO_2eq per year mid-century before falling to 30 GT of CO_2eq per year by 2100 (IPCC 2000-TN7652; USGCRP 2014-TN3472). In the IPCC Fifth Assessment Report, four RCPs were developed and are based on predicted changes in radiative forcing (a measure of the influence that a factor, such as GHG emissions, has in changing the global balance of incoming and outgoing energy) in the year 2100, relative to preindustrial conditions. The four RCPs are numbered in accordance with the change in radiative forcing measured in watts per square meter (W/m^2) (i.e., +2.6 [very low], +4.5 [lower], +6.0 [mid-high], and +8.5 [higher]) (USGCRP 2018-TN5847). For example, RCP 2.6 is representative of a mitigation scenario aimed at limiting the increase of global mean temperature to 1.1°F (2°C) (IPCC 2014-TN7651). The RCP 8.5 reflects a continued increase in global emissions resulting in increased warming by 2100. The Fourth National Climate Assessment relies on the IPCC Fifth Assessment Report four RCPs (USGCRP 2018-TN5847). In the IPCC Working Group contribution to the Sixth Assessment Report, five shared socioeconomic pathways are used and associated modeling results as the basis for their climate change assessments (IPCC 2021-TN7435. These five scenarios cover a range of greenhouse pathways and climate change mitigation.

Because the effects of climate change can vary regionally, climate change information at the regional and local scale is necessary to assess the impacts on the human environment for a specific location. Therefore, the NRC staff considered the best available climate change studies performed by the U.S. Global Change Research Program (USGCRP) and partner agencies as part of the staff's assessment of potential changes in climate indicators during the Oconee Station SLR terms (2033–2053 for Units 1 and 2, and 2034–2054 for Unit 3). Reports from the USGCRP and partner agencies provide projected changes in temperature precipitation patterns, and other climate outcomes on a regional level. The results of these studies are summarized below.

As input to the Third National Climate Assessment report (USGCRP 2014-TN3472, NOAA analyzed future regional climate change scenarios based on climate model simulations using the high (A2) and low (B1) emission scenarios (NOAA 2013-TN7424). NOAA's climate model simulations (for the period between 2021 and 2050) relative to the reference period (1971–1999), indicate the following. Annual mean temperature is projected to increase by 1.5–2.5°F (0.83–1.3°C) across the majority of the southeast region under the low and high emission modeled scenario, with South Carolina in the lower end of the range (NOAA 2013-TN7424: Fig. 26). For the period between 2041 and 2070, annual mean temperature is projected to increase by 1.5–3.5°F (0.83–1.9°C) across the majority of the southeast region under the low emission modeled scenario and by 2.5–4.5°F (1.4–2.5°C) under high emission scenario.

Newer regional projections for annual mean temperature are available from the Fourth National Climate Assessment based on the RCP 4.5 and RCP 8.5 scenarios for the mid-century (2036–2065) as compared to the average for 1976–2005. The modeling predicts increases of 3.4–4.3°F (1.9–2.4°C) across the Southeast region by mid-century (USGCRP 2017-TN5848: Table 6.4). Specific to the portion encompassing South Carolina, predicted annual temperature increases range from 2–4°F (1.1–2.2°C) under the RCP 4.5 scenario and RCP 8.5 scenario (USGCRP 2017-TN5848: Fig, 6.7).

As for precipitation, the climate model simulations suggest spatial differences in annual mean precipitation change across the southeast with some areas experiencing an increase and others a decrease in precipitation, but generally models increase in the north and east and decreases in the south and west parts of the region. For the period 2021–2050, a 0 to 3 percent increase in annual mean precipitation is projected for a low-emission modeled scenario across South Carolina; however, under a high-emission modeled scenario, models do not agree on the change in precipitation across South Carolina. For the period 2041–2070, a 0 to 3 percent increase in annual mean precipitation is projected for both a low- and high-emission modeled scenario across South Carolina. The USGCRP predicts continued increases in the frequency and intensity of heavy or extreme precipitation events across the United States, including across the southeast region (USGCRP 2014-TN3472, USGCRP 2017-TN5848, USGCRP 2018-TN5847). For the southeast region, models predict a 9 percent average increase in extreme precipitation (representing change in the 20 year return period amount for daily precipitation) under the lower RCP 4.5 scenario and up to 12 percent under the higher RCP 8.5 scenario by mid-century (USGCRP 2017-TN5848: Fig. 7.7).

The effects of climate change on Oconee Station SSCs are outside the scope of the NRC staff’s license renewal environmental review. The environmental review documents the potential effects from continued nuclear power plant operation on the environment. Site-specific environmental conditions are considered when siting nuclear power plants. This includes the consideration of meteorological and hydrologic siting criteria as set forth in 10 CFR Part 100, “Reactor Site Criteria” (TN282). NRC regulations require that nuclear power plant SSCs important to safety be designed to withstand the effects of natural phenomena, such as flooding, without loss of capability to perform safety functions. Further, nuclear power plants are required to operate within technical safety specifications in accordance with the NRC operating license, including coping with natural phenomena hazards. The NRC conducts safety reviews before allowing licensees to make operational changes caused by changing environmental conditions. Additionally, the NRC evaluates nuclear power plant operating conditions and physical infrastructures to ensure ongoing safe operations under the nuclear power plant’s initial and renewed operating licenses through the NRC’s Reactor Oversight Program. If new information about changing environmental conditions (such as rising sea levels that threaten safe operating conditions or challenge compliance with the nuclear power plant’s technical specifications) becomes available, the NRC will evaluate the new information to determine if any safety-related changes are needed at licensed nuclear power plants.

Nonetheless, changes in climate could have broad implications for certain resource areas. As discussed below, the NRC staff considers the impacts of climate change on environmental resources that are incrementally affected by the proposed action.

Air Quality: Climate change can impact air quality as a result of changes in meteorological conditions. The formation, transport, dispersion, and deposition of air pollutants depend, in part, on weather conditions (IPCC 2007-TN7421). Ozone is particularly sensitive to climate change (IPCC 2007-TN7421; EPA 2009-TN9068). Ozone is formed by the chemical reaction of nitrogen oxides and volatile organic compounds in the presence of heat and sunlight. Sunshine, high temperatures, and air stagnation are favorable meteorological conditions for higher levels of ozone (IPCC 2007-TN7421; EPA 2009-TN9068). The emission of ozone precursors also depends on temperature, wind, and solar radiation (IPCC 2007-TN7421). According to the EPA, both nitrogen oxide and biogenic volatile organic compound emissions are expected to be higher in a warmer climate (EPA 2009-TN9068). Although surface temperatures are expected to increase in the Southeast region of the United States, this may not necessarily result in an increase in ozone. While some climate models project seasonal, short-term increases of ozone concentrations during summer months in the Southeast United States (e.g., Wu et al. 2007-TN8566), others (e.g., Tao et al. 2007-TN8567; Nolte et al. 2018-TN8571; Meehl et al. 2018-TN8574) found differences in future changes in ozone for the southeast with decreases in ozone concentrations under a low emission modeled scenario, increases under a high emission modeled scenario, or decreases in ozone on heat wave days. Among modeled studies of climate-related ozone changes, model simulations for the southeast region have the least consensus. Therefore, the potential impact on air quality ozone levels in the vicinity of Oconee Station caused by climate change is unknown.

Water Quality: The USGCRP projects that water demand across South Carolina will increase by 25 to 50 percent by 2060, relative to 2005, based on combined changes in population, socioeconomic conditions, and climate (USGCRP 2014-TN3472, Figure 3.11). Elevated surface water temperatures can decrease the cooling efficiency of thermoelectric power generating facilities and nuclear power plant capacity. Therefore, as intake water temperatures warm, the volume of surface water needed for nuclear power plant cooling can increase or plant efficiencies can decrease (USGCRP 2014-TN3472, USGCRP 2018-TN5847: Figure 4.1). Since 1958, heavy precipitation (i.e., the amount of annual precipitation falling in the heaviest 1 percent of events) has increased by an average of 27 percent across the southeast region (USGCRP 2018-TN5847: Fig. 2.6). Observed increases in heavy precipitation events are projected to continue across the southeast, including South Carolina. Increases in annual precipitation and heavy precipitation events can result in greater runoff from the land while increasing the potential for riverine flooding. In turn, these changes can result in the transport of a higher sediment load and other contaminants to surface waters with potential degradation of ambient water quality. Regulatory agencies would need to account for changes in water availability in their water resources allocation and environmental permitting programs. Regardless of water use permitting constraints, nuclear power plant operators would have to account for any changes in water temperature in operational practices and procedures.

3.15 Cumulative Effects of the Proposed Action

Actions considered in the cumulative effects (impacts) analysis include the proposed SLR action when added to the environmental effects from past, present, and reasonably foreseeable future actions. The analysis considers all actions including minor ones, because the effects of individually minor actions may be significant when considered collectively over a period of time. The goal of the cumulative effects analysis is to identify potentially significant impacts. The environmental effects of the proposed SLR action when combined with the effects of other actions could result in a cumulative impact.

The cumulative effects or impacts analysis only considers resources and environmental conditions that could be affected by the proposed license renewal action, including the effects of continued reactor operations during the SLR term and any refurbishment activities at a nuclear power plant. In order for there to be a cumulative effect, the proposed action (SLR) must have an incremental new, additive, or increased physical effect or impact on the resource or environmental condition beyond what is already occurring.

For the purposes of analysis, past and present actions include all actions that have occurred since the commencement of reactor operations up to the submittal of the SLR request. Older actions are accounted for in baseline assessments presented in the affected environment discussions in Sections 3.2 through 3.13. The timeframe for the consideration of reasonably foreseeable future actions is the 20-year SLR term. Reasonably foreseeable future actions include current and ongoing planned activities through the end of the period of extended operation.

The incremental effects of the proposed action (SLR) when added to the effects from past, present, and reasonably foreseeable future actions and other actions (including trends such as global climate change) result in the overall cumulative effect. A qualitative cumulative effects analysis is conducted in instances where the incremental effects of the proposed action (SLR) and past, present, and reasonably foreseeable future actions are uncertain or not well known.

Information from Duke Energy's ER (Duke Energy 2021-TN8897); responses to requests for additional information; information from other Federal, State, and local agencies; scoping comments; and information gathered during the environmental site audit at Oconee Station were used to identify past, present, and reasonably foreseeable future actions in the cumulative effects analysis.

The following sections discuss the cumulative effects on the environmental near Oconee Station —when the incremental environmental effects of the proposed license renewal action are compounded by the effects from past, present, and reasonably foreseeable future actions. For the most part, environmental conditions near Oconee Station are not expected to change appreciably during the SLR term beyond what is already being experienced. Consequently, no cumulative impacts analysis was performed for the following resource areas: land use, noise, geology and soils, terrestrial resources, aquatic resources, and historic and cultural resources.

Appendix E describes other actions, including new and continuing activities and specific projects that were identified during this environmental review and considered in the analysis of potential cumulative impacts.

3.15.1 Air Quality

The ROI in the cumulative air quality analysis consists of Oconee and Pickens Counties, where the Oconee Station site is located, because air quality designations in South Carolina are made at the County level. Duke Energy has not proposed any refurbishment related activities during the SLR term. As a result, air emissions from the nuclear power plant during the SLR term would be similar to those presented in Section 3.3. Consequently, cumulative changes to air quality in Oconee and Pickens Counties would be the result of future projects and actions that change present-day emissions within the counties, unrelated to the proposed action (SLR). Therefore, based on this information, the NRC staff concludes that the proposed action would have no cumulative effect on air quality beyond what is already being experienced.

Development activities identified in Appendix E could increase air emissions during their respective construction periods, but those air emissions would be temporary and localized.

Operation of existing facilities result in vehicular traffic and long-term air emissions. Fossil fuel energy facilities (e.g., W.S. Lee Nuclear Station, John S. Rainey Generating Station) can be significant sources of air emissions.

3.15.2 Water Resources

3.15.2.1 Surface Water Resources

The description of the affected environment in Section 3.5.1, "Surface Water Resources," serves as the baseline for the cumulative impacts assessment for surface water resources. Oconee Station Units 1, 2, and 3 withdraw cooling water from Lake Keowee and discharges return flows and comingled effluents back to the lake. As such, this cumulative impact review focuses on those projects and activities where water uses or effluent discharges to Lake Keowee, which is owned and managed by Duke Energy.

<u>Water Use Considerations</u>

With its once-through cooling system design (see Section 2.1.3), Oconee Station returns all but a small fraction of the water withdrawn for condenser and auxiliary cooling back to Lake Keowee. Duke Energy has not proposed to increase Oconee Station's surface water withdrawals or consumptive water use during the SLR term. In addition, Oconee Station's withdrawals from Lake Keowee are subject to the provisions of a Surface Water Withdrawal Permit, issued by the SCDHEC, as described in Section 3.5.1.2. Duke Energy would need to seek a permit modification from the State to increase Oconee Station's surface water withdrawals or consumptive water use during the SLR term.

Further, the SCDHEC's surface water quantity permitting program (SCDHEC 2022-TN9069) governs the registration and permitting of withdrawal and uses of surface water from within the State of South Carolina and those surface waters shared with adjacent states. It applies to entities withdrawing surface water in excess of 3 million gallons (11.4 million L) in any 1 month.

Lake Keowee was created to provide cooling water for Oconee Station Units 1, 2, and 3 and to operate Keowee Hydro Station, part of the Keowee-Toxaway Hydroelectric Project (see Appendix E, Table E-1). Duke Energy operates the project, including Lake Keowee in accordance with a license issued by FERC (Duke Energy 2021-TN8897) (see Section 3.2.1.1 of this EIS).

To manage the resources of the area and to ensure that Oconee Station's source of cooling water is secure, Duke Energy manages development around the lake through a property use permit process. This process covers construction or maintenance activities, such as installation of residential docks, facilities construction, modification and maintenance of existing structures, and modification or maintenance of existing shoreline stabilization. Similarly, Lake Jocassee, located upstream of Oconee Station, which is also owned and operated by Duke Energy. The spillway of the lake flows into the Keowee River and Lake Keowee. Duke Energy maintains a shoreline management plan for both lakes that in part regulates where future construction activities may be considered. Lake Hartwell is downstream from the Oconee Station facility (Duke Energy 2021-TN8897). Lake Hartwell reservoir is located south (downstream) of Oconee Station and receives flow from Lake Keowee. Lake Hartwell is owned and managed by the USACE (Duke Energy 2021-TN8897; USACE 2023-TN9070).

The watershed of Lake Keowee provides raw water supply to three municipalities, including the City of Greenville, the Town of Seneca, and the City of Walhalla (beginning in March 2021) and takes its raw water supplies from Lake Keowee (see Appendix E, Table E-1). Greenville's water intake is located approximately 2 mi (3 km) north of Oconee Station on Lake Keowee. Seneca's intake is located approximately 7 mi (11 km) south of the nuclear power plant on the Little River arm of Lake Keowee (Duke Energy 2019-TN8943, Duke Energy 2021-TN8897). The City of Walhalla's new intake is also located approximately 7 mi (11 km) south of Oconee Station on Lake Keowee.

Any future conflicts regarding water availability within the watersheds of the Keowee-Toxaway Hydroelectric Project would depend on the owners and operators of the permitted and licensed facilities for resolution. These facilities are subject to the regulatory authority of the State of South Carolina and other entities with jurisdiction over desired and beneficial uses of the affected waters.

No new or proposed projects (see Appendix E, Table E-1) with the potential to substantially impact surface water withdrawals or consumptive water use within the watershed of Lake Keowee where Oconee Station is located were identified during the review. Therefore, based on this information, the NRC staff concludes that the proposed action would have no cumulative effect on surface water use beyond what is already being experienced.

Water Quality Considerations

Ambient water quality within the waters of the Keowee-Toxaway Hydroelectric Project is the product of past and present activities (e.g., water withdrawals, effluent discharges, and accidental spills and releases) associated with urban development, industrial and commercial development, agricultural practices, and shoreline development.

Future development and facility operational changes can result in water quality degradation if those projects increase sediment loading and the discharge of other pollutants to nearby surface water bodies, including Lake Keowee. As described above, the State, Duke Energy, FERC, and the USACE have regulatory and planning processes in place to manage development within the affected watersheds. Appendix E, Table E-1 lists a number of ongoing and reasonably foreseeable future actions that could impact surface water quality in the watersheds that drain to Lake Keowee.

On an individual facility basis, State—issued permits (i.e., the NPDES permit process in South Carolina) under CWA Section 402 set limits on wastewater, stormwater associated with construction and industrial activity, and other point source discharges. Specific to Oconee Station, Duke Energy's proposed implementation of thermal recapture uprates of 1.64 percent for each nuclear unit, if approved by the NRC, could increase the temperature of cooling water return flows to Lake Keowee. However, Duke Energy would still be required to meet the temperature limits specified in Oconee Station's NPDES individual permit, as described in Section 3.5.1.3.

In summary, a substantial regulatory framework exists to address current and potential future sources of water quality degradation within the watershed of the Keowee-Toxaway Hydroelectric Project with respect to potential cumulative impacts on surface water quality. Therefore, based on this information, the NRC staff concludes that the proposed action would have no cumulative effect on surface water quality beyond what is already being experienced.

3.15.2.2 Groundwater Resources

Section 3.5.2, “Groundwater Resources,” describes regional groundwater water systems and water use. As discussed, onsite groundwater use includes groundwater withdrawn around the nuclear power plant’s standby shutdown facility and operation of a groundwater remediation system. Groundwater is withdrawn at an average rate of approximately 20 gpm (76 Lpm) from the aquifer by the onsite drawdown system. The groundwater remediation system with one recovery well began in February 2011. Between 2011 and 2016, just more than 25 million gallons of groundwater (less than approximately 10 gpm (38 Lpm)) have been extracted from the recovery well. This remedial system will cease operation as the tritium concentrations continue to decrease and when the remedial objective is achieved. Onsite groundwater use is not expected to increase significantly during the SLR term.

As discussed in Section 3.5.3, the impact of current nuclear power plant operations and groundwater withdrawals on the aquifer is considered to be SMALL and no new and significant information was identified to indicate the possibility of groundwater use conflicts during the renewal term. There are no known current or planned projects in addition to SLR requiring groundwater withdrawals in the vicinity of Oconee Station that, if implemented, would potentially cause an adverse impact on groundwater use and quality.

Section 3.5.3 also addressed the impact of past and future operation of the Oconee Station Units 1, 2, and 3 site on groundwater quality. Oconee Station has implemented a groundwater protection program to identify and monitor leaks through the installed monitoring well network. The NRC has determined that the groundwater protection program is robust enough that potential future releases into groundwater, while not expected, would likely be readily detected. In addition, there are currently no known water supply wells downgradient of Oconee Station (within a 2 mi [3.2 km] radius). Therefore, during the period of continued operations, there is unlikely significant impacts on the groundwater quality in onsite and offsite aquifers.

Therefore, based on this information, the NRC staff concludes that the proposed action would have no cumulative effect on groundwater use and quality beyond what is already being experienced.

3.15.3 Socioeconomics

As discussed in Section 3.10.7 continued operation of Oconee Station during the SLR term would have no impact on socioeconomic conditions in the region beyond what is already being experienced. Duke Energy has no planned activities at Oconee Station beyond continued reactor operations and maintenance.

Because Duke Energy has no plans to hire additional workers during the SLR term, overall expenditures and employment levels at Oconee Station would remain unchanged with no new or increased demand for housing and public services. Therefore, the only contributory effects would come from reasonably foreseeable future planned operational activities at Oconee Station and other planned offsite activities, unrelated to the proposed action (SLR). When combined with past, present, and reasonably foreseeable future activities, the NRC staff concludes that the proposed action would have no new or increased cumulative effect beyond what is already being experienced.

3.15.4 Human Health

The NRC and EPA have established radiological dose limits to protect the public and workers from both acute and long-term exposure to radiation and radioactive materials. These dose limits are specified in 10 CFR Part 20 (TN283) and 40 CFR Part 190, “Environmental Radiation Protection Standards for Nuclear Power Operations” (TN739). As discussed in Section 3.11.6, “Human Health,” of this EIS, the impacts on human health from continued nuclear power plant operations during the SLR term would be SMALL.

For the purposes of this cumulative impact analysis, the geographical area considered is the area within a 50 mi (80 km) radius of Oconee Station. There are no other operational nuclear power plants within this 50 mi (80 km) radius. As discussed in Section 2.1.4.4, “Radioactive Waste Storage,” of this EIS, Duke Energy stores spent nuclear fuel from Oconee Station in a storage pool and in an onsite ISFSI. Per the Oconee Station ER, the ISFSI may need to be expanded during the SLR period of extended operation. If the ISFSI expansion were needed, it is expected that there is enough land area available for expansion within the site boundary of the existing facility (Duke Energy 2021-TN8897).

The EPA regulations at 40 CFR Part 190 (TN739) limit the dose to members of the public from all sources in the nuclear fuel cycle, including nuclear power plants, fuel fabrication facilities, waste disposal facilities, and transportation of fuel and waste. As discussed in Section 2.1.4.5 in this EIS, Duke Energy has a radiological environmental monitoring program that measures radiation and radioactive materials in the environment from Oconee Station, its ISFSI, and all other sources. The NRC staff reviewed the radiological environmental monitoring results for the 5-year period from 2018 through 2022 as part of this cumulative impacts assessment (Duke Energy 2019-TN8943, Duke Energy 2020-TN8944, Duke Energy 2021-TN8945, Duke Energy 2022-TN8946, Duke Energy 2023-TN8947). The review of Duke Energy’s data showed no indication of an adverse trend in radioactivity levels in the environment from either Oconee Station or the ISFSI. The data showed that there was no measurable impact on the environment from operations at Oconee Station.

Based on this information, the NRC staff concludes that there would be no significant cumulative radiological effect on human health resulting from the proposed action (SLR), in combination with the cumulative effects from other sources. This conclusion is based on the review of radiological environmental monitoring program data, radioactive effluent release data, worker dose data; and the expectation that Oconee Station would continue to comply with Federal radiation protection standards during the period of extended operation; and the continued regulation of any future development or actions in the vicinity of Oconee Station by the NRC and the State of South Carolina.

3.15.5 Environmental Justice

This cumulative impact analysis evaluates the potential for disproportionate and adverse human health and environmental effects on minority and low-income populations that could result from past, present, and reasonably foreseeable future actions, including the continued operational effects of Oconee Station during the SLR term. Everyone living near Oconee Station, including minority and low-income populations, currently experience its operational effects. The NRC addresses environmental justice by identifying the location of minority and low-income populations, determining whether there would be any potential human health or environmental effects, and whether any of the effects may be disproportionate and adverse to these populations.

Adverse health effects are measured in terms of the risk and rate of fatal or nonfatal adverse impacts on human health. Disproportionate and adverse human health effects occur when the risk or rate of exposure to an environmental hazard for a minority or low-income population exceeds the risk or exposure rate for the general population or for another appropriate comparison group. Disproportionate environmental effects refer to impacts or risks of impacts in the natural or physical environment in a minority or low-income community that appreciably exceed the environmental impact on the larger community. Such effects may include biological, cultural, economic, or social impacts. Some of these potential effects have been identified in resource areas presented in preceding sections of this chapter. As previously discussed in this chapter, the SLR impacts for all resource areas (e.g., land, air, water, and human health) would be SMALL.

As discussed in Section 3.12.1, there would be no disproportionate and adverse human health and environmental effects on minority and low-income populations from the continued operation of Oconee Station during the SLR term. Because Duke Energy has no plans to hire additional workers during the SLR term, employment levels at Oconee Station would remain unchanged, and there would be no additional demand for housing or increase in traffic. Based on this information and the analysis of human health and environmental effects, it is not likely that there would be any disproportionate and adverse contributory effects on minority and low-income populations from the continued operation of Oconee Station during the SLR term beyond what is already being experienced. Therefore, the only contributory effects would come from reasonably foreseeable future planned activities at Oconee Station, and other reasonably foreseeable future offsite activities, unrelated to the proposed action (SLR).

When combined with past, present, and reasonably foreseeable future activities, the NRC staff concludes that the proposed action (SLR) would not likely cause disproportionate and adverse human health and environmental effects on minority and low-income populations near Oconee Station.

3.15.6 Waste Management and Pollution Prevention

This section considers the incremental waste management impacts of the SLR term when added to the contributory effects of other past, present, and reasonably foreseeable future actions. In Section 3.13.3, “Proposed Action,” the potential waste management impacts from continued operations at Oconee Station during the SLR term would be SMALL.

As discussed in Sections 2.1.4 and 2.1.5, Duke Energy maintains waste management programs for radioactive and nonradioactive waste generated at Oconee Station and is required to comply with Federal and State permits and other regulatory waste management requirements. All industrial facilities, including nuclear power plants and other facilities within a 50 mi (80 km) radius of Oconee Station, are also required to comply with appropriate NRC, EPA, and State requirements for the management of radioactive and nonradioactive waste. Current waste management activities at Oconee Station would likely remain unchanged during the SLR term, and continued compliance with Federal and State requirements for radioactive and nonradioactive waste is expected.

Therefore, the NRC staff concludes that the proposed action, including the continued radioactive and nonradioactive waste generation during the SLR term, would have no cumulative effect beyond what is already being experienced. This is based on Oconee Station’s expected continued compliance with Federal and State of South Carolina requirements for radioactive and nonradioactive waste management and the expected regulatory compliance of other waste producers in the area.

3.16 Resource Commitments Associated with the Proposed Action

This section describes the NRC's consideration of potentially unavoidable adverse environmental impacts that could result from implementation of the proposed action and alternatives; the relationship between short-term uses of the environment and the maintenance and enhancement of long-term productivity; and the irreversible and irretrievable commitments of resources.

3.16.1 Unavoidable Adverse Environmental Impacts

Unavoidable adverse environmental impacts are impacts that would occur after implementation of all workable mitigation measures. Carrying out any of the replacement energy alternatives considered in this EIS, including the proposed action, would result in some unavoidable adverse environmental impacts.

Minor unavoidable adverse impacts on air quality would occur because of the emission and release of various chemical and radiological constituents from nuclear power plant operations. Nonradiological emissions resulting from nuclear power plant operations are expected to comply with Federal EPA and State emissions standards. Chemical and radiological emissions would not exceed the national emission standards for hazardous air pollutants.

Continued nuclear power plant operation would result in industrial wastewater discharges to Lake Keowee containing small amounts of water treatment chemical additives and other pollutants. Discharges are expected to comply with limits set in the NPDES permit.

During nuclear power plant operations, workers and members of the public would face unavoidable exposure to low levels of radiation as well as hazardous and toxic chemicals. Workers would be exposed to radiation and chemicals associated with routine nuclear power plant operations and the handling of nuclear fuel and waste material. Workers would have higher levels of exposure than members of the public, but doses would be administratively controlled and would not exceed regulatory standards or administrative control limits. In comparison, the alternatives involving the construction and operation of a nonnuclear power generating facility would also result in unavoidable exposure to hazardous and toxic chemicals, for workers and the public.

The generation of spent nuclear fuel and waste material, including low-level radioactive waste, hazardous waste, and nonhazardous waste, would be unavoidable. Hazardous and nonhazardous wastes would be generated at some nonnuclear power generating facilities. Wastes generated during nuclear power plant operations would be collected, stored, and shipped for suitable treatment, recycling, or disposal in accordance with applicable Federal and State regulations. Because of the costs of handling these materials, the NRC expects that nuclear power plant operators would optimize all waste management activities and operations in a way that generates the smallest possible amount of waste.

3.16.2 Relationship between Short-Term Use of the Environment and Long-Term Productivity

The operation of power generating facilities would result in short-term uses of the environment, as described in Sections 3.2 through 3.13 (see Sections titled, “Proposed Action,” “No-Action,” and “Replacement Power Alternatives: Common Impacts”). Short term is the period of time that continued power generating activities take place.

Nuclear power plant operations require short-term use of the environment and commitment of resources (e.g., land and energy), indefinitely or permanently. Certain short-term resource commitments are substantially greater under most energy alternatives, including license renewal, than under the no-action alternative because of the continued generation of electrical power and the continued use of generating sites and associated infrastructure. During operations, all energy alternatives require similar relationships to be sustained between local short-term uses of the environment and the maintenance and enhancement of long-term productivity.

Air emissions from nuclear power plant operations introduce small amounts of radiological and nonradiological emissions to the region around the nuclear power plant site. Over time, these emissions would result in increased concentrations and exposure, but the NRC does not expect that these emissions would impact air quality or radiation exposure to the extent that they would impair public health and long-term productivity of the environment.

Continued employment, expenditures, and tax revenues generated during nuclear power plant operations directly benefit local, regional, and state economies over the short term. Local governments investing project-generated tax revenues into infrastructure and other required services could enhance economic productivity over the long term.

The management and disposal of spent nuclear fuel, low-level radioactive waste, hazardous waste, and nonhazardous waste require an increase in energy and consume space at treatment, storage, or disposal facilities. Regardless of the location, the use of land to meet waste disposal needs would reduce the long-term productivity of the land.

Nuclear power plant facilities are committed to electricity production over the short term. After these facilities are decommissioned and the area restored, the land could be available for other future productive uses.

3.16.3 Irreversible and Irretrievable Commitment of Resources

Resource commitments are irreversible when primary or secondary impacts limit the future options for a resource. For example, the consumption or loss of nonrenewable resources is irreversible. An irretrievable commitment refers to the use or consumption of resources for a period of time (e.g., for the duration of the action under consideration) that are neither renewable nor recoverable for future use. Irreversible and irretrievable commitments of resources for electrical power generation include the commitment of land, water, energy, raw materials, and other natural and human-made resources required for nuclear power plant operations. In general, the commitments of capital, energy, labor, and material resources are also irreversible.

The implementation of any of the replacement energy alternatives considered in this site–specific EIS would entail the irreversible and irretrievable commitments of energy, water, chemicals, and—in some cases—fossil fuels. These resources would be committed during the SLR term and during the entire life cycle of the nuclear power plant, and they would be unrecoverable.

Energy expended would be in the form of fuel for equipment, vehicles, and nuclear power plant operations and electricity for equipment and facility operations. Electricity and fuel would be purchased from offsite commercial sources. Water would be obtained from existing water supply systems or withdrawn from surface water or groundwater. Continued nuclear power plant operation would result in continued consumptive water use from Lake Keowee, but the withdrawn cooling water is returned to Lake Keowee through a once-through cooling system and water loss is minimal. These resources are readily available, and the NRC does not expect that the amounts required would deplete available supplies or exceed available system capacities.

4 CONCLUSION

This EIS contains the NRC staff's environmental review of Duke Energy's application to renew the Oconee Station operating licenses for an additional 20 years, as required by 10 CFR Part 51 (TN250), "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions." The regulations in 10 CFR Part 51 implement the National Environmental Policy Act of 1969, as amended (42 U.S.C. 4321 et seq.-TN661). This chapter briefly summarizes the environmental impacts of SLR, lists and compares the environmental impacts of alternatives to SLR, and presents the NRC staff's preliminary conclusions and recommendation.

4.1 Environmental Impacts of License Renewal

After reviewing the site-specific environmental issues in this EIS and conducting an impacts determination consistent with Commission direction in CLI-22-02 and CLI-22-03, the NRC staff concluded that issuing subsequent renewed licenses for the Oconee Station would have SMALL environmental impacts. The NRC staff considered mitigation measures for each environmental issue, as applicable, and concluded that no additional mitigation measure is warranted.

4.2 Comparison of Alternatives

In Chapter 3 of this EIS, the NRC considered the following alternatives to renewing the Oconee Station operating licenses:

- no-action
- new nuclear (advanced light-water reactor and a small modular reactor)
- natural gas-fired combined-cycle
- combination – small modular reactor, solar photovoltaic, offshore wind, and demand-side management

Based on the review presented in this EIS, the NRC staff concludes that the environmentally preferred alternative is the proposed action. The NRC staff recommends that the subsequent renewed operating licenses be issued for the Oconee Station. As shown in Table 2-2, all other power-generation alternatives have environmental impacts that are greater than license renewal, in addition to the environmental impacts inherent to new construction. To make up for the lost power generation in case the NRC does not renew the Oconee Station operating licenses (i.e., the no-action alternative), energy decisionmakers may implement one of the replacement energy-generating alternatives discussed in Chapter 2, or a comparable combination alternative capable of replacing the power generated by Oconee Station.

4.3 Recommendation

The NRC staff's preliminary recommendation is that the adverse environmental impacts of SLR for Oconee Station are not so great that preserving the option of continued reactor operations for energy-planning decisionmakers would be unreasonable. This preliminary recommendation is based on the following:

- Duke Energy's environmental report, as supplemented
- consultation with Federal, State, Tribal, and local governmental agencies
- the NRC staff's independent environmental review
- consideration of public comments received during the scoping processes

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Table 6-1 List of Preparers

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Leah Parks, NRC	PhD Environmental Management MS Environmental Engineering BS Systems and Information Engineering 17 years of academic and government experience including nuclear power plant operations, health physics, decommissioning, waste management, environmental impact analysis, and performance assessment	Radiological and Nonradiological Waste Management, Spent Nuclear Fuel
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Leah Hare, PNNL	MS Geographic Information Science BS Environmental Studies 10 years of experience in environmental monitoring, regulatory compliance, project management, and environmental assessment	Deputy Project Management, Nonradiological Waste, Nonradiological Human Health, Cumulative Impacts
Kim Leigh, PNNL	BS Environmental Science 20 years of experience in NEPA compliance, project management and human health	Nonradiological Waste
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Table 6-1 List of Preparers (Continued)

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BA = Bachelor of Arts; BE = Bachelor of Engineering; BS = Bachelor of Science; DOE = Department of Energy; MBA = Master of Business Administration; MRP = Master of Regional Planning; MS = Master of Science; NEPA = National Environmental Policy Act of 1969; NRC = U.S. Nuclear Regulatory Commission; PhD = Doctor of Philosophy; PNNL = Pacific Northwest National Laboratory.

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Mary Louise Worthy	Piedmont American Indian Association Lower Eastern Cherokee Nation of SC

(a) The NRC staff has listed the names of commenters during the scoping periods in the scoping summary reports (Agencywide Documents Access and Management System (ADAMS) Accession No. ML21357A040 (NRC 2022-TN8905) and ML23304A138 (NRC 2024-TN9478). The staff sent a copy of this EIS to those commenters who provided contact information. Appendix C, “Consultation Correspondence,” lists the correspondences to agencies and Tribes, including distribution of this EIS.

APPENDIX A

COMMENTS RECEIVED ON THE OCONEE NUCLEAR POWER STATION, UNITS 1, 2, AND 3 ENVIRONMENTAL REVIEW

A.1 Comments Received During the First Scoping Period

The U.S. Nuclear Regulatory Commission (NRC) staff began the scoping process for the environmental review of the Oconee Nuclear Station, Units 1, 2, and 3 (Oconee Station) subsequent license renewal (SLR) application in August 2021, in accordance with the National Environmental Policy Act of 1969, as amended (42 U.S.C. 4321 et seq.) (NEPA-TN661). On August 10, 2021, the NRC published a notice of intent in the Federal Register to conduct an environmental scoping process for SLR of Oconee Station (86 FR 43684-TN8902). In its notice of intent, the NRC staff requested that members of the public and stakeholders submit comments on the environmental review for the Oconee Station SLR to the Federal Rulemaking Website at Regulations.gov.

The Oconee Station scoping process also included a public meeting that was held on August 25, 2021. Because of the COVID-19 public health emergency, the public meeting took the form of an online webinar that was accessible by phone and computer. To advertise this public meeting, the NRC issued press releases, posted on NRC social media and on the NRC public website, and purchased newspaper advertisements in The Journal – Upstate Today. In addition to NRC staff, Duke Energy Carolinas, LLC (Duke Energy) staff, local officials, and members of the public participated in the public meeting. After the NRC staff presented the prepared statements on the license renewal process, the staff opened the meeting for public comments. Attendees made oral statements that were recorded and transcribed by a certified court reporter. A summary and a transcript of the public scoping meeting are available in the NRC's Agencywide Documents Access and Management System (ADAMS) under ADAMS Accession No. ML21278A670. The ADAMS Public Electronic Reading Room is accessible at http://www.nrc.gov/reading-rm/adams.html.

At the conclusion of the scoping period, the staff issued the Oconee Station Scoping Summary Report, dated January 2022 (NRC 2022-TN8905). The report contains a summary of the comments received during the scoping period grouped by subject area and significant issues of concern that are in scope and considered as part of the environmental review.

A.2 Comments Received During the Second Scoping Period

Consistent with Commission direction, to prepare this environmental impact statement for Oconee Station, NRC expanded the original scope of its efforts to review all applicable Category 1 (generic) issues listed in the 2013 Generic Environmental Impact Statement for the purpose of making site-specific findings (e.g., SMALL, MODERATE, LARGE) on those issues. The NRC staff also reviewed all applicable Category 2 (site-specific) issues listed in the 2013 Generic Environmental Impact Statement to address the new information. To support this expanded scope, the NRC staff began a second scoping process in December 2020. On December 19, 2020, the NRC published a notice of intent in the *Federal Register* to conduct a second environmental scoping process for SLR of Oconee Station (87 FR 77643-TN8903). The public was asked to provide environmental scoping comments that fit within the two categories noted above; comments that did not fit into the categories were not considered. At the conclusion of the scoping period, the staff issued the Oconee Station Second Scoping Summary Report, dated February 2024 (NRC 2024-TN9478). The report contains a summary of the comments received during the second scoping period grouped by subject area and significant issues of concern that are in scope and considered as part of the environmental review.

A.3 References

86 FR 43684. August 10, 2021. "Notice of Intent To Conduct Scoping Process and Prepare Environmental Impact Statement; Duke Energy Carolina, LLC; Duke Energy; Oconee Nuclear Station, Units 1, 2, and 3." *Federal Register*, Nuclear Regulatory Commission. TN8902.

87 FR 77643. December 19, 2022. "Notice of Intent To Conduct a Supplemental Scoping Process and Prepare a Draft Environmental Impact Statement; Duke Energy Carolinas, LLC; Oconee Nuclear Station, Units 1, 2, and 3." *Federal Register*, Nuclear Regulatory Commission. TN8903.

National Environmental Policy Act of 1969 (NEPA), as amended. 42 U.S.C. § 4321 *et seq.* TN661.

NRC (U.S. Nuclear Regulatory Commission). 2022. Letter from L.J. Rakovan, Acting Chief Environmental Review License Renewal Branch Division of Rulemaking, Environment, and Financial Support Office of Nuclear Material Safety and Safeguards, to S.M. Snider, Site Vice President Oconee Nuclear Station, dated January 10, 2022, regarding "Issuance of Environmental Scoping Summary Report Associated with the U.S. Nuclear Regulatory Commission Staff's Review of the Oconee Nuclear Station, Units 1, 2 And 3, Subsequent License Renewal Application (EPID No. L-2021-Sle-0002) (Docket Nos. 50-269, 50-270 And 50-287)." Washington, D.C. ADAMS Accession No. ML21357A040. TN8905.

NRC (U.S. Nuclear Regulatory Commission). 2024. Letter from S.S. Koenick, Chief Environmental Project Manager Branch 1 Division of Rulemaking, Environment, and Financial Support Office of Nuclear Material Safety and Safeguards, to S.M. Snider, Site Vice President Oconee Nuclear Station, dated February 1, 2024, regarding "Issuance of Environmental Scoping Summary Report Associated with the U.S. Nuclear Regulatory Commission Staff's Review of the Oconee Nuclear Station, Units 1, 2, & 3, Subsequent License Renewal Application (EPID Number: L-2021-SLE- 0002) (Docket Numbers: 50-269, 50-270 AND 50-287)." Washington, D.C. ADAMS Accession No. ML23304A138. TN9478.

APPENDIX B

APPLICABLE LAWS, REGULATIONS, AND OTHER REQUIREMENTS

There are several Federal laws and regulations that affect environmental protection, health, safety, compliance, and consultation at every U.S. Nuclear Regulatory Commission (NRC)-licensed nuclear power plant. Some of these laws and regulations require permits by or consultations with other Federal agencies or State, Tribal, or local governments. Certain Federal environmental requirements have been delegated to State authorities for enforcement and implementation. Furthermore, States also have enacted laws to protect public health and safety and the environment. It is NRC policy to make sure nuclear power plants are operated in a manner that provides adequate protection of public health and safety and protection of the environment through compliance with applicable Federal and State laws, regulations, and other requirements, as appropriate.

The Atomic Energy Act of 1954, as amended (AEA) (42 U.S.C. 2011 et seq.-TN663), authorizes the NRC to enter into an agreement with any State that allows the State to assume regulatory authority for certain activities (see 42 U.S.C. 2021). A State that enters into such an agreement with the NRC is called an Agreement State. South Carolina is one such NRC Agreement State. In South Carolina, the Bureau of Radiological Health in the South Carolina Department of Health and Environmental Control has regulatory responsibility over certain byproducts, sources, and quantities of special nuclear materials that are not sufficient to form a nuclear critical mass. The South Carolina Emergency Management Division provides response capabilities to radiological accidents or emergencies at the commercial nuclear power plants in and near the State of South Carolina.

In addition to carrying out some Federal programs, State legislatures develop their own laws. State statutes can supplement, as well as implement, Federal laws for protection of air, surface water, and groundwater. State legislation may address solid waste management programs, locally rare or endangered species, and historic and cultural resources.

The U.S. Environmental Protection Agency (EPA) has the primary responsibility to administer the Clean Water Act (CWA) (33 U.S.C. 1251 et seq.-TN662). The National Pollutant Discharge Elimination System (NPDES) program addresses water pollution by regulating the discharge of potential pollutants to waters of the United States. The CWA, as administered by the EPA, allows for primary enforcement and administration through State agencies, as long as the State program is at least as stringent as the Federal program.

The EPA has delegated the authority to issue NPDES permits to the State of South Carolina. The South Carolina Department of Health and Environmental Control provides oversight for public water supplies, provides permits to regulate the discharge of industrial and municipal wastewaters—including discharges to groundwater—and monitors State water resources for water quality.

B.1 <u>Federal and State Requirements</u>

Oconee Nuclear Station, Units 1, 2, and 3 (Oconee Station) is subject to various Federal and State requirements. Table B-1 lists the principal Federal and State regulations and laws that are used or mentioned in this supplemental environmental impact statement for Oconee Station.

Table B-1 Federal and State Requirements

Law or Regulation	Requirements
Current Operating License and License Renewal	
Atomic Energy Act, (42 U.S.C. 2011 et seq.-TN663)	The AEA of 1954, as amended, and the Energy Reorganization Act (ERA) of 1974 (42 U.S.C. 5801 et seq.-TN4466) give the NRC the licensing and regulatory authority for commercial nuclear energy use. They allow the NRC to establish dose and concentration limits for protection of workers and the public for activities under NRC jurisdiction. The NRC implements its responsibilities under the AEA through regulations set forth in Title 10, “Energy,” of the *Code of Federal Regulations* (CFR).
Archeological and Historic Preservation Act of 1974, as amended (54 U.S.C. § 312501 et seq.-TN4844)	The Archeological and Historic Preservation Act establishes procedures for preserving historical and archaeological resources. Analysis of environmental compliance includes assessing the energy alternatives for possible impacts on prehistoric, historic, and traditional cultural resources.
Antiquities Act of 1906, as amended (54 U.S.C. §§ 320301–320303 and 18 U.S.C. § 1866(b)-TN6602)	The Antiquities Act protects historic and prehistoric ruins, monuments, and antiquities, including paleontological resources, on federally controlled lands from appropriation, excavation, injury, and destruction without permission.
American Indian Religious Freedom Act of 1978 (42 U.S.C. § 1996-TN5281)	The American Indian Religious Freedom Act protects Native Americans’ rights of freedom to believe, express, and exercise traditional religions.
Bald and Golden Eagle Protection Act of 1940, as amended (16 U.S.C. §§ 668–668d-TN1447)	The Bald and Golden Eagle Protection Act makes it unlawful to take, pursue, molest, or disturb bald and golden eagles, their nests, or their eggs anywhere in the United States. The U.S. Fish and Wildlife Service (FWS), under the authority of the U.S. Secretary of the Interior, may issue take permits to individuals, government agencies, or other organizations to authorize limited, non-purposeful disturbance of eagles, in the course of conducting lawful activities such as operating utilities or conducting scientific research.
Native American Graves Protection and Repatriation Act of 1990 (25 U.S.C. § 3001-TN1686)	The Native American Graves Protection and Repatriation Act, in part, establishes provisions for the treatment of inadvertent discoveries of Indian remains and cultural objects. When discoveries are made during ground-disturbing activities, the activity in the area must immediately stop, and reasonable protective efforts, proper notifications, and appropriate disposition of the discovered items must be pursued.
Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended by the Superfund Amendments and Reauthorization Act (42 U.S.C. § 9601 et seq.-TN6592)	The CERCLA includes an emergency response program to respond to releases of hazardous substances to the environment. Releases of source, byproduct, or special nuclear material from a nuclear incident are excluded from CERCLA requirements if the releases are subject to the financial protection requirements of the AEA. CERCLA is intended to provide a response to, and cleanup of, environmental problems that are not covered adequately by the permit programs of the many other environmental laws, including the Clean Air Act (CAA); CWA; Safe Drinking Water Act, Marine Protection, Research, and Sanctuaries Act (33 U.S.C. § 1401 et seq.-TN4479); Resource Conservation and Recovery Act RCRA);

Table B-1 Federal and State Requirements (Continued)

Law or Regulation	Requirements
	and AEA. Under Section 120 of CERCLA, each department, agency, and instrumentality (e.g., a municipality) of the United States is subject to, and must comply with, CERCLA in the same manner as any nongovernmental entity (except for requirements for bonding, insurance, financial responsibility, or applicable time period). Under CERCLA, the EPA would have the authority to ~~regulate~~ hazardous substances at a facility in the event of a release or a "substantial threat of a release" of those materials. Releases greater than reportable quantities would be reported to the National Response Center. Assessment of alternatives for environmental compliance includes consideration of whether hazardous substances, in reportable quantity amounts, could be present at nuclear power plants during the license renewal term.
Emergency Planning and Community Right-to-Know Act (EPCRA) of 1986 (42 U.S.C. § 11001 et seq.-TN6603) (also known as "SARA Title III")	The EPCRA, which is an amendment to the CERCLA (42 U.S.C. § 9601 et seq.-TN6592*)*, establishes the requirements for Federal, State, and local governments; Tribes; and industry regarding emergency planning and "Community Right-to-Know" reporting on hazardous and toxic chemicals. The "Community Right-to-Know" provisions increase the public's knowledge of and access to information about chemicals at individual facilities, their uses, and releases into the environment. States and communities working with facilities can use the information to improve chemical safety and protect public health and the environment. The EPCRA requires emergency planning and notice to communities and government agencies concerning the presence and release of specific chemicals. The EPA implements the EPCRA under regulations found in 40 CFR Part 355 (TN5493), Part 370 (TN6612), and Part 372 (TN6613).
Pollution Prevention Act of 1990 (42 U.S.C. § 13101 et seq.-TN6607)	The Pollution Prevention Act establishes a national policy for waste management and pollution control that focuses first on source reduction, then on environmental issues, safe recycling, treatment, and disposal.
National Environmental Policy Act of 1969, (42 U.S.C. 4321 et seq.-TN661)	The NEPA requires Federal agencies to integrate environmental values into their decision-making process by considering the environmental impacts of proposed Federal actions and reasonable alternatives to those actions. The NEPA establishes policy, sets goals (in Section 101), and provides means (in Section 102) for carrying out the policy. Section 102(2) contains provisions that force actions to make sure Federal agencies follow the letter and spirit of the act. For major Federal actions significantly affecting the quality of the human environment, Section 102(2)(c) of the NEPA requires Federal agencies to prepare a detailed statement that includes the environmental impacts of the proposed action and other specified information. This environmental impact statement has been prepared in accordance with NEPA requirements and NRC regulations (10 CFR Part 51-TN250) for implementing the NEPA to assure compliance with Section 102(2).
10 CFR Part 20 (TN283)	Regulations in 10 CFR Part 20, "Standards for Protection Against Radiation," establish standards for protection against

Table B-1 Federal and State Requirements (Continued)

Law or Regulation	Requirements
	ionizing radiation resulting from activities conducted under licenses issued by the NRC. These regulations are issued under the AEA, as amended, and the ERA, as amended. The purpose of these regulations is to control the receipt, possession, use, transfer, and disposal of licensed material by any licensee in such a manner that the total dose to an individual (including doses resulting from licensed and unlicensed radioactive material and from radiation sources other than background radiation) does not exceed the standards for protection against radiation prescribed in the regulations in this part.
10 CFR Part 50 (TN249)	Regulations in 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," are NRC regulations issued under the AEA, as amended, and Title II of the ERA of 1974 to provide for the licensing of production and utilization facilities, including power reactors.
10 CFR Part 51 (TN250)	Regulations in 10 CFR Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions," contain the NRC regulations that implement NEPA.
10 CFR Part 54 (TN4878)	The NRC regulations in 10 CFR Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants," govern the issuance of renewed operating licenses and renewed combined licenses for nuclear power plants licensed under Sections 103 or 104b of the AEA, as amended, and Title II of the ERA of 1974. The regulations focus on managing adverse effects of aging. The rule is intended to make sure that important systems, structures, and components will continue to perform their intended functions during the period of extended operation.
	Air Quality Protection
Clean Air Act, (42 U.S.C. 7401 et seq.-TN1141)	The CAA is intended to "protect and enhance the quality of the Nation's air resources so as to promote the public health and welfare and the productive capacity of its population." The CAA establishes regulations to ensure maintenance of air quality standards and authorizes individual States to manage permits. Section 118 of the CAA requires each Federal agency, with jurisdiction over properties or facilities engaged in any activity that might result in the discharge of air pollutants, to comply with all Federal, State, inter-State, and local requirements regarding the control and abatement of air pollution. Section 109 of the CAA directs the EPA to set National Ambient Air Quality Standards (NAAQS) for criteria pollutants. The EPA has identified and set NAAQSs for the following criteria pollutants: particulate matter, sulfur dioxide, carbon monoxide, ozone, nitrogen dioxide, and lead. Section 111 of the CAA requires the establishment of national performance standards for new or modified stationary sources of atmospheric pollutants. Section 160 of the CAA requires that specific emission increases must be evaluated before permit approval to prevent significant deterioration of air quality. Section 112 requires specific standards for release of hazardous air

Table B-1 Federal and State Requirements (Continued)

Law or Regulation	Requirements
	pollutants (including radionuclides). These standards are implemented through plans developed by each State and approved by the EPA. The CAA requires sources to meet standards and obtain permits to satisfy those standards. Nuclear power plants may be required to comply with the CAA Title V, Sections 501–507, for sources subject to new source performance standards or sources subject to National Emission Standards for Hazardous Air Pollutants. The EPA regulates the emissions of air pollutants using 40 CFR Parts 50–99 (TN5264).
Occupational Safety and Health Act of 1970 (29 U.S.C. § 651 et seq.-TN4453)	The Occupational Safety and Health Act (OSHA) establishes standards to enhance safe and healthy working conditions in places of employment throughout the United States. The Act is administered and enforced by the Occupational Safety and Health Administration, a U.S. Department of Labor agency. Employers who fail to comply with OSHA standards can be penalized by the Federal Government. The act allows States to develop and enforce OSHA standards if such programs have been approved by the U.S. Secretary of Labor.
Noise Control Act of 1972 (42 U.S.C. § 4901 et seq.-TN4294)	The Noise Control Act delegates the responsibility of noise control to State and local governments. Commercial facilities are required to comply with Federal, State, inter-State, and local requirements regarding noise control. Section 4 of the Noise Control Act directs Federal agencies to carry out programs in their jurisdictions "to the fullest extent consistent with their authority" and in a manner that furthers a national policy of promoting an environment free from noise that jeopardizes health and welfare.
Water Resources Protection	
Clean Water Act (33 U.S.C. § 1251 et seq.-TN662)	The CWA (formerly the Federal Water Pollution Control Act) was enacted to restore and maintain the chemical, physical, and biological integrity of the Nation's water. The act requires all branches of the Federal Government with jurisdiction over properties or facilities engaged in any activity that might result in a discharge or runoff of pollutants to surface waters to comply with Federal, State, inter-State, and local requirements. As authorized by the CWA, the NPDES permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States. The NPDES program requires all facilities that discharge pollutants from any point source into waters of the United States to obtain a NPDES permit. An NPDES permit is developed with two levels of controls: (1) technology-based limits and (2) water quality-based limits. NPDES permit terms may not exceed 5 years, and the applicant must reapply at least 180 days prior to the permit expiration date. A nuclear power plant may also participate in the NPDES General Permit for Industrial Stormwater due to stormwater runoff from industrial or commercial facilities to waters of the United States. The EPA is authorized under the CWA to directly implement the NPDES program, but the EPA

Table B-1 Federal and State Requirements (Continued)

Law or Regulation	Requirements
	has authorized many States to implement all or parts of the National program. Section 316(a) of the CWA addresses thermal effects and requires that facilities operate under effluent limitations that assure the protection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife in and on the receiving body of water. Section 316(b) of the CWA requires that cooling-water intake structures of regulated facilities must reflect the best technology available for minimizing impingement mortality and entrainment of aquatic organisms. These sections of the CWA are implemented and enforced through the NPDES program. Section 401 of the CWA requires States to certify that the permitted discharge would comply with all limitations necessary to meet established State water quality standards, treatment standards, or schedule of compliance. Under this section, the EPA or a delegated State agency has the authority to review and approve, condition, or deny all permits or licenses that might result in a discharge to waters of the State, including wetlands. CWA Section 401 [33 U.S.C. 1341(a)(1)] states: “No license or permit shall be granted until the certification required by this section has been obtained or has been waived as provided in the preceding sentence. No license or permit shall be granted if certification has been denied by the State, interstate agency, or the Administrator, as the case may be.” Therefore, the NRC cannot issue its license without a Section 401 Certification or an NRC determination that a waiver has occurred, in accordance with 40 CFR 121.9(c) (TN6718). In accordance with 10 CFR 50.54(aa) (TN249), conditions in the Section 401 Certification become a condition of the NRC’s license. The U.S. Army Corps of Engineers (USACE) is the lead agency for enforcement of CWA wetland requirements (33 CFR Part 320-TN424). A Section 404 permit would need to be obtained from the USACE before implementing any action, such as earthmoving activities and certain erosion controls, which could disturb wetlands. Federal and State permits/certifications are obtained using the same form and permit applications for activities affecting waterways and wetlands and are reviewed by the USACE in consultation with the FWS, the Soil Conservation Service, the EPA, and the delegated State agency.
Coastal Zone Management Act of 1972 (CZMA), as amended (16 U.S.C. 1451 et seq.-TN1243)	Congress enacted the CZMA in 1972 to address the increasing pressures of over-development on the nation’s coastal resources. The National Oceanic and Atmospheric Administration administers the act. The CZMA encourages States to preserve, protect, develop, and, where possible, restore or enhance valuable natural coastal resources such as wetlands, floodplains, estuaries, beaches, dunes, barrier islands, and coral reefs, as well as the fish and wildlife using those habitats. Participation by States is voluntary. To

Table B-1 Federal and State Requirements (Continued)

Law or Regulation	Requirements
	encourage States to participate, the CZMA makes Federal financial assistance available to any coastal State or territory, including those on the Great Lakes that are willing to develop and implement a comprehensive coastal management program. Section 307(c)(3)(A) of the CZMA requires that applicants for Federal licenses who conduct activities in a coastal zone provide certification that the proposed activity complies with the policies of the State’s coastal zone program. The NRC cannot issue its license without CZMA compliance by the applicant.
Safe Drinking Water Act of 1974 (42 U.S.C. § 300(f) et seq.-TN1337)	The Safe Drinking Water Act (SDWA) was enacted to protect the quality of public water supplies and sources of drinking water and establishes minimum national standards for public water supply systems in the form of maximum contaminant levels for pollutants, including radionuclides. Other programs established by the SDWA include the Sole Source Aquifer Program, the Wellhead Protection Program, and the Underground Injection Control Program. In addition, the SDWA protects underground sources of drinking water from releases and spills of contaminants. If a nuclear power plant is located within an area designated as a sole source aquifer pursuant to Section 1424(e) of the SDWA, the supplemental EIS would be subject to review by the EPA. If the EPA review raises concerns that nuclear power plant operations are not protective of groundwater quality, specific mitigation recommendations or additional pollution prevention requirements may be required.
Rivers and Harbors Act of 1899, Section 10 (33 U.S.C. § 401 et seq.-TN660)	The Rivers and Harbors Act of 1899 (33 U.S.C. § 401 et seq.) requires USACE authorization in order to protect navigable waters during the development of harbors and other construction and excavation. Section 10 of the act prohibits the unauthorized obstruction or alteration of any navigable water of the United States. That section provides that the construction of any structure in or over any navigable water of the United States, or the accomplishment of any other work affecting the course, location, condition, or physical capacity of such waters is unlawful unless the work has been recommended by the USACE Chief of Engineers and authorized by the Secretary of the Army through the USACE. Activities requiring Section 10 permits include structures (e.g., piers, wharves, breakwaters, bulkheads, jetties, weirs, transmission lines) and work such as dredging or disposal of dredged material, or excavation, filling, or other modifications to the navigable waters of the United States.
Wild and Scenic Rivers Act, (16 U.S.C. 1271 et seq.-TN1811)	The Wild and Scenic Rivers Act created the National Wild and Scenic Rivers System that was established to protect the environmental values of free-flowing streams from degradation by impacting activities, including water resources projects.
South Carolina Regulation (SCR) 61-9, “Water Pollution Control Permits” (TN9121)	Implements the NPDES Program under the CWA.

Table B-1 Federal and State Requirements (Continued)

Law or Regulation	Requirements
South Carolina Regulation (SCR) 61-119, "Surface Water Withdrawal, Permitting, Use and Reporting" (TN9069)	Implements the South Carolina Code of Laws, Section 49-4-10 et seq. "The South Carolina Surface Water Withdrawal, Permitting, Use, and Reporting Act" and "establishes a system and rules for permitting and registering the withdrawal and use of surface water from within the State of South Carolina and those surface water shared with adjacent states."
Waste Management and Pollution Prevention	
Resource Conservation and Recovery Act, (42 U.S.C. 6901 et seq.-TN1281)	The RCRA requires the EPA to define and identify hazardous waste; establish standards for its transportation, treatment, storage, and disposal; and require permits for persons engaged in hazardous waste activities. Section 3006 (42 U.S.C. 6926) allows States to establish and administer these permit programs with EPA approval. The EPA regulations implementing the RCRA are found in 40 CFR Parts 260–283 (TN6617). Regulations imposed on a generator or on a treatment, storage, and/or disposal facility vary according to the type and quantity of material or waste generated, treated, stored, and/or disposed. The method of treatment, storage, and/or disposal also affects the extent and complexity of the requirements.
Nuclear Waste Policy Act of 1982 (42 U.S.C. § 10101 et seq.-TN740)	The Nuclear Waste Policy Act provides for the research and development of repositories for the disposal of high-level radioactive waste, spent nuclear fuel, and low-level radioactive waste. Title I includes provisions for disposal and storage of high-level radioactive waste and spent nuclear fuel. Subtitle A of Title I delineates requirements for site characterization and construction of the repository and participation of States and other local governments in the selection process. Subtitles B, C, and D of Title I deal with specific issues for interim storage, monitored retrievable storage, and low-level radioactive waste.
Low-Level Radioactive Waste Policy Act of 1980, as amended (42 U.S.C. § 2021b et seq.-TN6606)	The Low-Level Radioactive Waste Policy Act amended the AEA to improve the procedures for the implementation of compacts providing for the establishment and operation of regional low-level radioactive waste disposal facilities. It also allows Congress to grant consent for certain inter-State compacts. The amended Act sets forth the responsibilities for disposal of low-level waste by States or inter-State compacts. The act states the amount of waste that certain low-level waste recipients can receive over a set period of time. The amount of low-level radioactive waste generated by both pressurized and boiling water reactor types is allocated over a transition period until a local waste facility becomes operational.
Hazardous Materials Transportation Act, as amended (49 U.S.C. § 5101 et seq.-TN6605)	The Hazardous Materials Transportation Act regulates the intrastate and interstate transportation of hazardous material (including radioactive material). According to the act, States may regulate the transport of hazardous material as long as their regulation is consistent with the act or U.S. Department of Transportation regulations provided in 49 CFR Parts 171–177 (TN5466). Other regulations regarding packaging for transportation of radionuclides are contained in 49 CFR Part 173, Subpart I.

Table B-1 Federal and State Requirements (Continued)

Law or Regulation	Requirements
	Protected Species
Endangered Species Act, 16 U.S.C. 1531 et seq.-TN1010	The Endangered Species Act (ESA) was enacted to prevent the further decline of endangered and threatened species and to restore those species and their critical habitats. Section 7, "Interagency Cooperation," of the act requires Federal agencies to consult with the FWS or the National Marine Fisheries Service (NMFS) on Federal actions that may affect listed species or designated critical habitats.
Fish and Wildlife Coordination Act of 1934, as amended (16 U.S.C. §§ 661–666e-TN4467)	The Fish and Wildlife Coordination Act requires Federal agencies that construct, license, or permit water resource development projects to consult with the FWS (or NMFS, when applicable) and State wildlife resource agencies for any project that involves an impoundment of more than 10 ac (4 ha), diversion, channel deepening, or other water body modification regarding the impacts of that action on fish and wildlife and any mitigative measures to reduce adverse impacts.
Federal Insecticide, Fungicide, and Rodenticide Act, as amended (7 U.S.C. § 136 et seq.-TN4535)	The Federal Insecticide, Fungicide, and Rodenticide Act, as amended, by the Federal Environmental Pesticide Control Act and subsequent amendments, requires the registration of all new pesticides with the EPA before they are used in the United States.
Fish and Wildlife Conservation Act of 1980 (16 U.S.C. § 2901 et seq.-TN6604)	The Fish and Wildlife Conservation Act provides Federal technical and financial assistance to States for the development of conservation plans and programs for nongame fish and wildlife. The Fish and Wildlife Conservation Act conservation plans identify significant problems that may adversely affect nongame fish and wildlife species and their habitats and appropriate conservation actions to protect the identified species. The act also encourages Federal agencies to conserve and promote the conservation of nongame fish and wildlife and their habitats.
Magnuson–Stevens Fishery Conservation and Management Act (16 U.S.C. 1801 et seq.-TN7841)	The Magnuson–Stevens Fishery Conservation and Management Act, as amended, governs marine fisheries management in Federal waters. The act created eight regional fishery management councils and includes measures to rebuild overfished fisheries, protect essential fish habitat, and reduce bycatch. Under Section 305 of the act, Federal agencies are required to consult with the NMFS for any Federal actions that may adversely affect essential fish habitat.
National Marine Sanctuaries Act of 1966, as amended (16 U.S.C. § 1431 et seq.-TN7197)	The National Marine Sanctuaries Act (NMSA) establishes provisions for the designation and protection of marine areas that have special national significance. The NMSA authorizes the Secretary of Commerce to designate national marine sanctuaries and establish the National Marine Sanctuary System. Pursuant to Section 304(d) of the NMSA, Federal agencies must consult with the National Oceanic and Atmospheric Administration's Office of National Marine Sanctuaries when their proposed actions are likely to destroy, cause the loss of, or injure a sanctuary resource.
Toxic Substances Control Act (15 U.S.C. § 2601 et seq.-TN4454)	The Toxic Substances Control Act (TSCA) regulates the manufacture, processing, distribution, and use of certain

Table B-1 Federal and State Requirements (Continued)

Law or Regulation	Requirements
	chemicals not regulated by RCRA or other statutes, including asbestos-containing material and polychlorinated biphenyls. Any TSCA-regulated waste removed from structures (e.g., polychlorinated biphenyls-contaminated capacitors or asbestos) or discovered during the implementation phase (e.g., contaminated media) would be managed in compliance with the TSCA. EPA's implementing regulations can be found in 40 CFR Part 761 (TN6610).
Migratory Bird Treaty Act of 1918, as amended (16 U.S.C. § 703 et seq.-TN3331)	The Migratory Bird Treaty Act is intended to protect birds that have common migration patterns between the United States and Canada, Mexico, Japan, and Russia. The Act stipulates that, except as permitted by regulations, it is unlawful at any time, by any means, or in any manner to pursue, hunt, take, capture, or kill any migratory bird.
Marine Mammal Protection Act of 1972 (16 U.S.C. § 1361 et seq.-TN4478)	The Marine Mammal Protection Act was enacted to protect and manage marine mammals and to prevent marine mammal populations from declining beyond the point where they ceased to be significant functioning elements of the ecosystems of which they are a part. The primary authority for implementing the act belongs to the FWS and the NMFS. The FWS manages walruses, polar bears, sea otters, dugongs, marine otters, and the West Indian, Amazonian, and West African manatees. The NMFS manages whales, porpoises, seals, and sea lions. The two agencies may issue permits under Section 104 (16 U.S.C. 1374) to persons, including Federal agencies, that authorize the taking or importing of specific species of marine mammals. After the Secretary of the Interior or the Secretary of Commerce approves a State's program, the State can take responsibility for managing one or more marine mammals. The act also established a Marine Mammal Commission whose duties include reviewing laws and international conventions related to marine mammals, studying the condition of these mammals, and recommending steps to Federal officials (e.g., listing a species as endangered) that should be taken to protect marine mammals. Federal agencies are directed by Section 205 (16 U.S.C. 1405) to cooperate with the commission by permitting it to use their facilities or services.
Environmental Standards for Uranium Fuel Cycle (40 CFR Part 190, Subpart B-TN739)	These regulations establish maximum doses to the body or organs of members of the public because of normal operational releases from uranium fuel cycle activities, including uranium enrichment. These regulations were promulgated by the EPA under the authority of the AEA, as amended, and have been incorporated by reference in the NRC regulations in 10 CFR 20.1301(e) (TN283).
Historic Preservation and Cultural Resources	
National Historic Preservation Act, (54 U.S.C. 300101 et seq.-TN4157) (formerly 16 U.S.C. 470 et seq.)	The National Historic Preservation Act was enacted to create a national historic preservation program, including the National Register of Historic Places and the Advisory Council on Historic Preservation. Section 106 of the act requires Federal agencies to account for the effects of their undertakings on historic properties. The Advisory Council on Historic Preservation

Table B-1 Federal and State Requirements (Continued)

Law or Regulation	Requirements
	regulations implementing Section 106 of the act are found in 36 CFR Part 800, "Protection of Historic Properties" (TN513). The regulations call for public involvement in the Section 106 consultation process, including involvement from Indian Tribes and other interested members of the public, as applicable.

ac = acers; AEA = Atomic Energy Act; CAA = Clean Air Act; CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act; CFR = *U.S. Code of Federal Regulations*; CWA = Clean Water Act; CZMA = Coastal Zone Management Act; EPA = U.S. Environmental Protection Agency; ERA = Energy Reorganization Act; EPCRA = Emergency Planning and Community Right-to-Know Act; FWS = U.S. Fish and Wildlife Service; ha = hectares; NAAQS = National Ambient Air Quality Standards; NEPA = National Environmental Policy Act; NMFS = National Marine Fisheries Service; NMSA = National Marine Sanctuaries Act; NPDES = National Pollutant Discharge Elimination System; OSHA = Occupational Safety and Health Act; RCRA = Resource Conservation and Recovery Act; SCR = South Carolina Regulation; SCDHEC = South Carolina Department of Health and Environmental Control; SDWA = Safe Drinking Water Act of 1974; TSCA = Toxic Substances Control Act; USACE = United States Army Corp of Engineers.

B.2 Operating Permits and Other Requirements

Table B-2 lists the permits and licenses issued by Federal, State, and local authorities for operational activities at Oconee Station, as identified in Chapter 9 of Duke Energy's environmental report.

Table B-2 Operating Permits and Other Requirements

Permit	Responsible Agency	Number	Expiration Date	Authorized Activity
Operating license	NRC	DPR-38, DPR-47, and DPR-55	02/06/2033, 10/6/2033, and 07/19/2034	Operation of Oconee Station
Independent Spent Fuel Storage Installation (ISFSI) Authorization	NRC	SNM-2503	01/31/2050	Operation of a dry storage ISFSI under a site-specific license
ISFSI	NRC	N/A	07/19/2034	Operation of a dry storage ISFSI under the Oconee Station licenses
Low-Level Radioactive Waste Interstate permit	Atlantic Compact Commission	N/A	N/A	Atlantic Interstate does not require import or export permits
Keowee-Toxaway Hydroelectric Project license	Federal Energy Regulatory Commission	2503-154	08/31/2046	Operate Hydroelectric Project
Operating agreement	USACE	N/A	08/31/2046	Agrees to a new critical reservoir elevation for Lake Keowee

Table B-2 Operating Permits and Other Requirements (Continued)

Permit	Responsible Agency	Number	Expiration Date	Authorized Activity
Migratory Bird Special Purpose Utility	FWS	MB00257 Version 1	03/31/2025	Authorization to collect, transport and possess remains of migratory birds
Hazardous waste transportation/ shipment registration	U.S. Department of Transportation;	051922550025E	06/30/2023	Hazardous materials shipments
Registration	EPA	SCD043979822	12/31/2023	Hazardous waste generator registration
Federal Coastal Zone Management Act permit and reporting	South Carolina Department of Health and Environmental Control (SCDHEC)	N/A	N/A	Oconee Station is not located in the South Carolina coastal zone
Surface water withdrawal permit	SCDHEC	37PN001	10/29/2043	Surface water withdrawal from Lake Keowee
Coastal plain groundwater withdrawal permit	SCDHEC	N/A	N/A	Oconee Station is not located in the coastal plain and is not required to permit and report groundwater withdrawals
Air permit	SCDHEC	CM-1820-0041	12/31/2027	Operation of auxiliary boiler
Small-quantity hazardous waste generator (SQG) annual declaration	SCDHEC	DHEC 2701 form	Annual submittal	Annual SQG declaration
Class 2 landfill post-closure permit	SCDHEC	373303-1601	01/11/2038	Post-closure permit for closed and capped onsite landfill
Registration	SCDHEC	Registration 11174 and 11843	07/31/2023	Operation of underground storage tanks
NPDES permit	SCDHEC	SC0000515	9/30/2013. Because of submittal of a timely renewal application, the permit is administratively extended and remains in effect until a final permit decision is made on the renewal.	Discharge of wastewaters to surface water

Table B-2 Operating Permits and Other Requirements (Continued)

Permit	Responsible Agency	Number	Expiration Date	Authorized Activity
NPDES permit for discharges from pesticide application	SCDHEC	SCG160000 Facility Coverage No. SCG16006	03/31/2021	Discharge to surface waters from pesticide application
NPDES permit for construction activities	SCDHEC	SCR100000	12/31/2017. This general permit remains in effect until the subsequent general permit becomes effective.	Discharge of stormwater
NPDES for industrial activities	SCDHEC	SCR000000 Facility Coverage No. SCR000074	06/30/2027	Discharge of industrial stormwater
Operation of a satellite sewer system	SCDHEC	Permit Coverage No. SSS000909	01/04/2017. This general permit remains in effect until the subsequent general permit becomes effective.	Notification of satellite sewer owner
Migratory Bird depredation permit	SCDNR	MB-4-20	12/31/2023	State authorization associated with FWS MB000257-0 permit
Environmental laboratory certification	SCDHEC	37756001 and 37761001	03/05/2024	Certifies testing methods
Registration	SCDHEC	SC37-0051G	03/31/2026	Registers Oconee Station as a generator of infectious waste
License for asbestos abatement	SCDHEC	8045	01/12/2024	Licenses for asbestos abatement activities
South Carolina radioactive waste transport permit	SCDHEC	0020-39-20-X	12/31/2023	Transport of radioactive waste within South Carolina
Radioactive waste license-for-delivery	Tennessee Department of Environmental Control	T-SC007-L23	12/31/2023	Shipment of radioactive material within Tennessee
Significant industrial wastewater discharge permit	Oconee Joint Regional Sewer Authority	IW-000003	03/31/2024	Discharge of industrial wastewater into treatment facility

ISFSI = independent spent fuel storage installation; MB = migratory birds; N/A = not applicable; NPDES = National Pollutant Discharge Elimination System; NRC = U.S. Nuclear Regulatory Commission; SCDHEC = South Carolina Department of Health and Environmental Control; SQG = Small Quantity Generators; USACE = U.S. Army Corps of Engineers; FWS = U.S. Fish and Wildlife Service.
Source: Duke Energy 2021-TN8897.

B.3 References

10 CFR Part 20. *Code of Federal Regulations*, Title 10, *Energy*, Part 20, "Standards for Protection Against Radiation." TN283.

10 CFR Part 50. *Code of Federal Regulations*, Title 10, *Energy*, Part 50, "Domestic Licensing of Production and Utilization Facilities." TN249.

10 CFR Part 51. *Code of Federal Regulations*, Title 10, *Energy*, Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions." TN250.

10 CFR Part 54. *Code of Federal Regulations*, Title 10, *Energy*, Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants." TN4878.

33 CFR Part 320. *Code of Federal Regulations*, Title 33, *Navigation and Navigable Waters*, Part 320, "General Regulatory Policies." TN424.

36 CFR Part 800. *Code of Federal Regulations*, Title 36, *Parks, Forests, and Public Property*, Part 800, "Protection of Historic Properties." TN513.

40 CFR Parts 50-99. *Code of Federal Regulations*, Title 40, *Protection of the Environment*, Subchapter C, Parts 50-99, "Air Programs." TN5264.

40 CFR Part 121. *Code of Federal Regulations*, Title 40, *Protection of Environment*, Part 121, "State Certification of Activities Requiring a Federal License or Permit." TN6718.

40 CFR Part 190. *Code of Federal Regulations*, Title 40, *Protection of Environment*, Part 190, "Environmental Radiation Protection Standards for Nuclear Power Operations." TN739.

40 CFR Parts 260–283. *Code of Federal Regulations*, Title 40, *Protection of Environment*, Parts 260–283, EPA Regulations Implementing RCRA. TN6617.

40 CFR Part 355. *Code of Federal Regulations*, Title 40, *Protection of Environment*, Part 302, "Emergency Planning and Notification." TN5493.

40 CFR Part 370. *Code of Federal Regulations*, Title 40, *Protection of Environmen*t, Part 370, "Hazardous Chemical Reporting: Community Right-To-Know." TN6612.

40 CFR Part 372. *Code of Federal Regulations*, Title 40, *Protection of Environment*, Part 372, "Toxic Chemical Release Reporting: Community Right-To-Know." TN6613.

40 CFR Part 761. *Code of Federal Regulations*, Title 40, *Protection of Environment*, Part 761, "Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions." TN6610.

49 CFR Parts 171-177. *Code of Federal Regulations*, Title 49, *Transportation*, Subchapter C, "Hazardous Materials Regulations (49 CFR Parts 171-177)." TN5466.

American Indian Religious Freedom Act, as amended. 42 U.S.C. § 1996 *et seq*. TN5281.

Antiquities Act of 1906, as amended. 54 U.S.C. § 320301–320303 and 18 U.S.C. § 1866(b). TN6602.

Archeological and Historic Preservation Act of 1974, as amended. 54 U.S.C. § 312501 *et seq*. TN4844.

Atomic Energy Act of 1954. 42 U.S.C. § 2011 et seq. Public Law 112-239, as amended. TN663.

Bald and Golden Eagle Protection Act. 16 U.S.C. § 668-668d *et seq.* TN1447.

Clean Air Act. 42 U.S.C. § 7401 *et seq*. TN1141.

Coastal Zone Management Act of 1972. 16 U.S.C. § 1451 *et seq*. TN1243.

Comprehensive Environmental Response, Compensation, and Liability Act, as amended. 42 U.S.C. § 9601 *et seq*. TN6592.

Duke Energy. 2021. Letter from S.M. Snider, Vice President, Oconee Nuclear Station, to NRC Document Control Desk, dated June 7, 2021, regarding "Duke Energy Carolinas, LLC (Duke Energy) Oconee Nuclear Station (ONS), Units 1, 2, and 3 Docket Numbers 50-269, 50-270, 50-287 Renewed License Numbers DPR-38, DPR-47, DPR-55 Application for Subsequent Renewed Operating Licenses." Seneca, South Carolina. ADAMS Accession No. ML21158A193. TN8897.

Emergency Planning and Community Right-to-Know Act of 1986. 42 U.S.C. § 11001 *et seq*. TN6603.

Endangered Species Act of 1973. 16 U.S.C. § 1531 *et seq.* TN1010.

Energy Reorganization Act of 1974, as amended. 42 U.S.C. § 5801 *et seq*. TN4466.

Federal Insecticide, Fungicide, and Rodenticide Act, as amended. 7 U.S.C. § 136 *et seq*. TN4535.

Federal Water Pollution Control Act of 1972 (commonly referred to as the Clean Water Act). 33 U.S.C. § 1251 *et seq.* TN662.

Fish and Wildlife Conservation Act of 1980. 16 U.S.C. § 2901 *et seq.* TN6604.

Fish and Wildlife Coordination Act, as amended. 16 U.S.C. § 661 *et seq*. TN4467.

Hazardous Materials Transportation Act. 49 U.S.C. § 5101 *et seq*. TN6605.

Low-Level Radioactive Waste Policy Act of 1980. 42 U.S.C. § 2021b *et seq*. Public Law 96-573. TN6606.

Magnuson Stevens Fishery Conservation and Management Reauthorization Act of 2006. 16 U.S.C. 1801 Note. Public Law 109-479, January 12, 2007, 120 Stat. 3575. TN7841.

Marine Mammal Protection Act of 1972, as amended. 16 U.S.C. § 1361 *et seq*. TN4478.

Marine Protection, Research, and Sanctuaries Act of 1972, as amended. 33 U.S.C. § 1401 et seq. TN4479.

Migratory Bird Treaty Act of 1918. 16 U.S.C. § 703 *et seq.* TN3331.

National Environmental Policy Act of 1969 (NEPA), as amended. 42 U.S.C. § 4321 *et seq.* TN661.

National Historic Preservation Act. 54 U.S.C. § 300101 *et seq*. TN4157.

Native American Graves Protection and Repatriation Act. 25 U.S.C. § 3001 *et seq*. TN1686.

NMSA (National Marine Sanctuaries Act). 2000. "National Marine Sanctuaries Act, Title 16, Chapter 32 § 1431 et seq. United States Code as amended by Public Law 106-513." Silver Spring, M.D. Available at https://nmssanctuaries.blob.core.windows.net/sanctuaries-prod/media/archive/library/national/nmsa.pdf. TN7197.

Noise Control Act of 1972. 42 U.S.C. § 4901 *et seq*. TN4294.

Nuclear Waste Policy Act of 1982. 42 U.S.C. § 10101 *et seq*. TN740.

Occupational Safety and Health Act of 1970, as amended. 29 U.S.C. § 651 *et seq*. TN4453.

Pollution Prevention Act of 1990. 42 U.S.C. § 13101 *et seq*. TN6607.

Resource Conservation and Recovery Act of 1976. 42 U.S.C 6901 Note. Public Law 94-580, 90 Stat. 2795. TN1281.

Rivers and Harbors Appropriation Act of 1899. 33 U.S.C. § 401 *et seq*. TN660.

Safe Drinking Water Act of 1974, as amended. 42 U.S.C. § 300f *et seq*. TN1337.

SCDHEC (South Carolina Department of Health and Environmental Control). 2019. *Regulation 61-9, Water Pollution Control Permits*. Columbia, South Carolina. Available at https://scdhec.gov/sites/default/files/Library/Regulations/R.61-9.pdf. TN9121.

SCDHEC (South Carolina Department of Health and Environmental Control). 2022. *Regulation 61-119, Surface Water Withdrawal, Permitting, Use, and Reporting*. Columbia, South Carolina. Available at https://scdhec.gov/sites/default/files/media/document/R.61-119.pdf. TN9069.

Toxic Substances Control Act, as amended. 15 U.S.C. § 2601 *et seq.* TN4454.

Wild and Scenic Rivers Act. 16 U.S.C. § 1271 et seq. TN1811.

APPENDIX C

CONSULTATION CORRESPONDENCE

C.1 Endangered Species Act Section 7 Consultation

As a Federal agency, the U.S. Nuclear Regulatory Commission (NRC) must comply with the Endangered Species Act of 1973 (ESA), as amended (16 U.S.C. 1531 et seq.; TN1010), as part of any action authorized, funded, or carried out by the agency. In this case, the proposed agency action is whether to issue subsequent renewed facility operating licenses for the continued operation of Oconee Nuclear Station, Units 1, 2, and 3 (Oconee Station). The proposed action would authorize Duke Energy Carolinas, LLC (Duke Energy) to operate Oconee Station for an additional 20 years beyond the current renewed operating license term. Under Section 7 of the ESA, the NRC must consult with the U.S. Fish and Wildlife Service (FWS) and the National Marine Fisheries Service (NMFS) ("the Services" [collectively] or "Service" [individually]), as appropriate, to ensure that the proposed action is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of designated critical habitat.

C.1.1 Federal Agency Obligations under Section 7 of the Endangered Species Act

The ESA and the regulations that implement ESA Section 7 at Title 50 of the *Code of Federal Regulations* Part 402 (50 CFR Part 402-TN4312) describe the consultation process that Federal agencies must follow in support of agency actions. As part of this process, the Federal agency shall either request that the Services: (1) provide a list of any listed or proposed species or designated or proposed critical habitats that may be present in the action area or (2) request that the Services concur with a list of species and critical habitats that the Federal agency has created (50 CFR 402.12(c)). If any such species or critical habitats may be present, the Federal agency prepares a biological assessment to evaluate the potential effects of the action and determine whether the species or critical habitats are likely to be adversely affected by the action (50 CFR 402.12(a); 16 U.S.C. 1536(c)-TN4459).

Biological assessments are required for any agency action that is a "major construction activity" (50 CFR 402.12(b)) (TN4312). A major construction activity is a construction project or other undertaking having construction-type impacts that is a major Federal action significantly affecting the quality of the human environment under the National Environmental Policy Act of 1969, as amended (42 U.S.C. 4321 et seq.) (NEPA) (51 FR 19926-TN7600). Federal agencies may fulfill their obligations to consult with the Services under ESA Section 7 and to prepare a biological assessment, if required, in conjunction with the interagency cooperation procedures required by other statutes, including NEPA (50 CFR 402.06(a)) (TN4312). In such cases, the Federal agency should include the results of ESA Section 7 consultation(s) in the NEPA document (50 CFR 402.06(b)).

C.1.2 Biological Evaluation

Subsequent license renewal (SLR) does not require the preparation of a biological assessment because it is not a major construction activity. Nonetheless, the NRC staff must consider the impacts of its actions on federally listed species and designated critical habitats. In cases where the staff finds that subsequent license renewal "may affect" ESA-protected species or habitats, ESA Section 7 requires the NRC to consult with the relevant Service(s).

To support such consultations, the NRC staff has incorporated its analysis of the potential impacts of the proposed subsequent license renewal into Section 3.8 of this environmental impact statement (EIS). The NRC staff refers to its ESA analysis as a "biological evaluation."

The NRC staff structured its evaluation in accordance with the Services' suggested biological assessment contents described at 50 CFR 402.12(f) (TN4312). Section 3.8.1 of this EIS describes the action area as well as the ESA-protected species and habitats potentially present in the action area. Section 3.8.4 assesses the potential effects of the proposed Oconee Station SLR on the ESA-protected species and habitats present in the action area and contains the NRC's effect determinations for each of those species and habitat. This section also addresses cumulative effects. Finally, Sections 3.8.5 through 3.8.9 address the potential effects of the no-action alternative and power replacement alternatives. The results of the NRC staff's analysis are summarized below in Table C-1.

Table C-1 Effect Determinations for Federally Listed Species Under U.S. Fish and Wildlife Service Jurisdiction for Oconee Station Subsequent License Renewal

Species	Federal Status[(a)]	Potentially Present in the Action Area?	Effect Determination[(b)]	FWS Concurrence Date[(c)]
monarch butterfly	FC	Yes	NLAA	N/A
Indiana bat	FE	No	NE	N/A
northern long-eared bat	FE	No	NE	TBD
tricolored bat	FPE	Yes	NLAA	N/A
bog turtle	FT	No	NE	N/A
persistent trillium	FE	No	NE	N/A
small whorled pogonia	FT	No	NE	N/A
smooth coneflower	FT	No	NE	N/A
dwarf-flowered heartleaf	FT	No	NE	N/A
mountain sweet pitcher-plant	FE	No	NE	N/A

(a) Indicates protection status under the Endangered Species Act (ESA). FC = candidate for Federal listing; FE = federally endangered; FPE = proposed for federal listing as endangered; FT = federally threatened.
(b) The NRC staff makes its effect determinations for federally listed species in accordance with the language and definitions specified in the U.S. Fish and Wildlife Service (FWS) and National Marine Fisheries Service (NMFS) Endangered Species Consultation Handbook (FWS and NMFS 1998-TN1031). NLAA = may affect but is not likely to adversely affect; NE = no effect.
(c) The ESA does not require Federal agencies to seek FWS concurrence for "no effect" determinations or for conclusions regarding effects on candidate species. N/A = not applicable; TBD = to be determined; the NRC will seek the FWS's concurrence following the issuance of this EIS.

C.1.3 Chronology of Endangered Species Act Section 7 Consultation

Endangered Species Act Section 7 Consultation with the U.S. Fish and Wildlife Service

Following issuance of this EIS, the NRC staff will seek the FWS's concurrence for the species for which the NRC determined that the Oconee Station SLR may affect but is not likely to adversely affect (see Table C-1) in accordance with 50 CFR 402.13(c) (TN4312). Table C-2 lists the correspondence between the NRC and the FWS pursuant to ESA Section 7 that has transpired to date.

Table C-2 Endangered Species Act Section 7 Consultation Correspondence with the U.S. Fish and Wildlife Service

Date	Description	ADAMS Accession No.[(a)]
Nov 18, 2019	T.D. McCoy (FWS) to J.E. Burchfield, Jr. (Duke Energy), Determination that there are no federally listed species or designated critical habitats within 6 mi of the Oconee Station site	ML21158A193
Jan 11, 2022	South Carolina Ecological Services Field Office (FWS) to B. Arlene (NRC), Updated list of threatened and endangered species for the proposed Oconee Station SLR	ML22011A082
July 27, 2023	South Carolina Ecological Services Field Office (FWS) to B. Arlene (NRC), Updated list of threatened and endangered species for the proposed Oconee Station SLR	ML23208A097

ADAMS = Agencywide Documents Access and Management System; FWS = U.S. Fish and Wildlife Service; Duke Energy Carolinas, LLC = Duke Energy; NRC = U.S. Nuclear Regulatory Commission.
(a) Access these documents through the NRC's ADAMS at http://adams.nrc.gov/wba/.

Endangered Species Act Section 7 Consultation with the National Marine Fisheries Service

As discussed in Section 3.8.1.3 and 3.8.4.2 of this EIS, no federally listed species or critical habitats under NMFS 's jurisdiction occur within the action area. Therefore, the NRC staff did not engage the NMFS pursuant to ESA Section 7 for the proposed Oconee Station SLR.

C.2 Magnuson–Stevens Act Essential Fish Habitat Consultation

The NRC must comply with the Magnuson–Stevens Fishery Conservation and Management Act of 1996 (MSA), as amended (16 U.S.C. 1801 et seq.-TN7841), for any actions authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken that may adversely affect any essential fish habitat (EFH) identified under the MSA. In Sections 3.8.2 and 3.8.4.4 of this EIS, the NRC staff concludes that the NMFS has not designated any EFH under the Magnuson–Stevens Fishery Conservation and Management Act in Lake Keowee and that the proposed Oconee Station SLR would have no effect on EFH. Thus, the Magnuson–Stevens Fishery Conservation and Management Act does not require the NRC to consult with the NMFS for the proposed action.

C.3 National Marine Sanctuaries Act Consultation

The National Marine Sanctuaries Act of 1966, as amended (16 U.S.C. § 1431 et seq.-TN7197), authorizes the Secretary of Commerce to designate and protect areas of the marine environment with special national significance due to their conservation, recreational, ecological, historical, scientific, cultural, archaeological, educational, or aesthetic qualities as national marine sanctuaries. Under Section 304(d) of the act, Federal agencies must consult with the National Oceanic and Atmospheric Administration's Office of National Marine Sanctuaries if a Federal action is likely to destroy, cause the loss of, or injure any sanctuary resources.

In Sections 3.8.3 and 3.8.4.5 of this EIS, the NRC staff concludes that no coastal or marine waters or Great Lakes occur near Oconee Station and that the Oconee Station SLR would have no effect on sanctuary resources. Thus, the National Marine Sanctuaries Act does not require the NRC to consult with National Oceanic and Atmospheric Administration for the proposed action.

C.4 National Historic Preservation Act Section 106 Consultation

The National Historic Preservation Act of 1966, as amended (54 U.S.C. 100101 et seq.) (NHPA), requires Federal agencies to consider the effects of their undertakings on historic properties and consult with applicable State and Federal agencies, Tribal groups, individuals, and organizations with a demonstrated interest in the undertaking before taking action. Historic properties are defined as resources that are eligible for listing on the National Register of Historic Places. The historic preservation review process (Section 106 of the NHPA) is outlined in regulations issued by the Advisory Council on Historic Preservation in 36 CFR Part 800, "Protection of Historic Properties" (TN513). In accordance with 36 CFR 800.8(c), "Use of the NEPA Process for Section 106 Purposes," the NRC has elected to use the NEPA process to comply with its obligations under Section 106 of the NHPA.

Table C-3 lists the chronology of consultation and consultation documents related to the NRC's NHPA Section 106 review of the Oconee Station SLR. The NRC staff is required to consult with the noted agencies and organizations in accordance with the above discussion.

Table C-3 National Historic Preservation Act Correspondence

Date	Sender and Recipient	Description	ADAMS Accession No.[(a)]
8/23/2021	R. Elliott (NRC) to R. Nelson, Director, Office of Federal Agency Programs, Advisory Council on Historic Preservation	Request for Scoping Comments Concerning the Environmental Review of Oconee Nuclear Station, Unit Nos. 1, 2, and 3, Subsequent License Renewal Application	ML21232A609
8/23/2021	R. Elliott (NRC) to E. Johnson, Director, Historical Services, D-SHPO, South Carolina Department of Archives and History	Request for Scoping Comments Concerning the Environmental Review of Oconee Nuclear Station, Unit Nos. 1, 2, and 3, Subsequent License Renewal Application	ML21232A617
8/23/2021	R. Elliott (NRC) to W. Harris, Chief, Catawba Indian Nation	Request for Scoping Comments Concerning the Environmental Review of Oconee Nuclear Station, Unit Nos. 1, 2, and 3, Subsequent License Renewal Application	ML21232A610
8/23/2021	R. Elliott (NRC) to C. Hoskin, Jr., Principal Chief, Cherokee Nation	Request for Scoping Comments Concerning the Environmental Review of Oconee Nuclear Station, Unit Nos. 1, 2, and 3, Subsequent License Renewal Application	ML21232A610

Table C-3 National Historic Preservation Act Correspondence (Continued)

Date	Sender and Recipient	Description	ADAMS Accession No.[(a)]
8/23/2021	R. Elliott (NRC) to R. Sneed, Principal Chief, Eastern Band of Cherokee Indians	Request for Scoping Comments Concerning the Environmental Review of Oconee Nuclear Station, Unit Nos. 1, 2, and 3, Subsequent License Renewal Application	ML21232A610
8/23/2021	R. Elliott (NRC) to D. Hill, Principal Chief, Muscogee (Creek) Nation	Request for Scoping Comments Concerning the Environmental Review of Oconee Nuclear Station, Unit Nos. 1, 2, and 3, Subsequent License Renewal Application	ML21232A610
8/23/2021	R. Elliott (NRC) to J. Bunch, Chief, United Keetoowah Band of Cherokee Indians in Oklahoma	Request for Scoping Comments Concerning the Environmental Review of Oconee Nuclear Station, Unit Nos. 1, 2, and 3, Subsequent License Renewal Application	ML21232A610
8/23/2021	R. Elliott (NRC) to M.L. Worthy, Chief, Piedmont American Indian Association, Lower Eastern Cherokee Nation of South Carolina	Request for Scoping Comments Concerning the Environmental Review of Oconee Nuclear Station, Unit Nos. 1, 2, and 3, Subsequent License Renewal Application	ML21232A624
9/20/2021	E. Johnson, Director, Historical Services, D-SHPO, State Historic Preservation Office, South Carolina Department of Archives and History, to R. Hoffman (NRC)	Response to NRC Request for Scoping Comments Concerning the Environmental Review of Oconee Nuclear Station, Unit Nos. 1, 2, and 3, Subsequent License Renewal Application	ML22056A134
3/15/2023	T. Smith (NRC) to R. Nelson, Director, Office of Federal Agency Programs, Advisory Council on Historic Preservation	Request for Scoping Comments Concerning the Environmental Review of Oconee Nuclear Station, Unit Nos. 1, 2, and 3, Subsequent License Renewal Supplement	ML23045A133
3/15/2023	E. Johnson, Director, Historical Services, D-SHPO, State Historic Preservation Office, South Carolina Department of Archives and History, to R. Hoffman (NRC)	Request for Scoping Comments Concerning the Environmental Review of Oconee Nuclear Station, Units 1, 2, and 3, Subsequent License Renewal Application Site-Specific Supplement	ML23045A140

Table C-3 National Historic Preservation Act Correspondence (Continued)

Date	Sender and Recipient	Description	ADAMS Accession No.[(a)]
3/15/2023	T. Smith (NRC) to W. Harris, Chief, Catawba Indian Nation	Request for Scoping Comments Concerning the Environmental Review of Oconee Nuclear Station, Unit Nos. 1, 2, and 3, Subsequent License Renewal Supplement	ML23045A135
3/15/2023	T. Smith (NRC) to C. Hoskin, Jr., Principal Chief, Cherokee Nation	Request for Scoping Comments Concerning the Environmental Review of Oconee Nuclear Station, Unit Nos. 1, 2, and 3, Subsequent License Renewal Supplement	ML23045A135
3/15/2023	T. Smith (NRC) to R. Sneed, Principal Chief, Eastern Band of Cherokee Indians	Request for Scoping Comments Concerning the Environmental Review of Oconee Nuclear Station, Unit Nos. 1, 2, and 3, Subsequent License Renewal Supplement	ML23045A135
3/15/2023	T. Smith (NRC) to D. Hill, Principal Chief, Muscogee (Creek) Nation	Request for Scoping Comments Concerning the Environmental Review of Oconee Nuclear Station, Unit Nos. 1, 2, and 3, Subsequent License Renewal Supplement	ML23045A135
3/15/2023	T. Smith (NRC) to J. Bunch, Chief, United Keetoowah Band of Cherokee Indians in Oklahoma	Request for Scoping Comments Concerning the Environmental Review of Oconee Nuclear Station, Unit Nos. 1, 2, and 3, Subsequent License Renewal Supplement	ML23045A135
3/15/2023	T. Smith (NRC) to M.L Worthy, Piedmont American Indian Association, Lower Eastern Cherokee Nation of South Carolina	Request for Scoping Comments Concerning the Environmental Review of Oconee Nuclear Station, Units 1, 2, and 3, Subsequent License Renewal Application Site-Specific Supplement	ML23045A143

ADAMS = Agencywide Documents Access and Management System; NRC = U.S. Nuclear Regulatory Commission; SHPO = State Historic Preservation Officer.
(a) Access these documents through the NRC's ADAMS at https://adams.nrc.gov/wba/.

C.5 References

36 CFR Part 800. *Code of Federal Regulations*, Title 36, *Parks, Forests, and Public Property*, Part 800, "Protection of Historic Properties." TN513.

50 CFR Part 402. *Code of Federal Regulations,* Title 50, *Wildlife and Fisheries*, Part 402, "Interagency Cooperation—Endangered Species Act of 1973, as amended." TN4312.

51 FR 19926. 1986. “Interagency Cooperation – Endangered Species Act of 1973, as amended.” Final Rule, *Federal Register*, Fish and Wildlife Service, Interior; National Marine Fisheries Service, National Oceanic and Atmospheric Administration, Commerce. TN7600.

16 U.S.C. § 1536. Endangered Species Act, Section 7, “Interagency Cooperation.” TN4459.

Endangered Species Act of 1973. 16 U.S.C. § 1531 *et seq.* TN1010.

FWS and NMFS (U.S. Fish and Wildlife Service and National Marine Fisheries Service). 1998. *Endangered Species Act Consultation Handbook, Procedures for Conducting Section 7 Consultation and Conference*. Washington, D.C. ADAMS Accession No. ML14171A801. TN1031.

Magnuson Stevens Fishery Conservation and Management Reauthorization Act of 2006. 16 U.S.C. 1801 Note. Public Law 109-479, January 12, 2007, 120 Stat. 3575. TN7841.

NMSA (National Marine Sanctuaries Act). 2000. “National Marine Sanctuaries Act, Title 16, Chapter 32 § 1431 et seq. United States Code as amended by Public Law 106-513.” Silver Spring, M.D. Available at https://nmssanctuaries.blob.core.windows.net/sanctuaries-prod/media/archive/library/national/nmsa.pdf. TN7197.

APPENDIX D

CHRONOLOGY OF ENVIRONMENTAL REVIEW CORRESPONDENCE

This appendix contains a chronological listing of correspondence between the U.S. Nuclear Regulatory Commission (NRC) and external parties as part of the agency's environmental review of the Oconee Nuclear Station Units 1, 2, and 3 (Oconee Station) subsequent license renewal application. This appendix does not include consultation correspondence or comments received during the scoping process. For a list and discussion of consultation correspondence, see Appendix C of this environmental impact statement. For scoping comments, see Appendix A of this environmental impact statement and the NRC's "Scoping Summary Report" (Agencywide Documents Access and Management System [ADAMS] Accession No. ML21357A089; NRC 2022-TN8905) and "Second Summary Report" (ML23304A138; NRC 2024-TN9478). All documents are available electronically from the NRC's Public Electronic Reading Room found at: http://www.nrc.gov/reading-rm.html. From this site, the public can gain access to ADAMS, which provides text and image files of the NRC's public documents. The ADAMS accession number for each document is included in the following table.

D.1 Environmental Review Correspondence

Table D-1 lists the environmental review correspondence, by date, beginning with the request by Duke Energy Carolinas, LLC (Duke Energy) for subsequent renewal of the operating license for Oconee Station.

Table D-1 Environmental Review Correspondence

Date	Correspondence Description	ADAMS Accession No. or *Federal Register* Citing
06/07/2021	Oconee Nuclear Station, Units 1, 2, and 3–Application for Subsequent Renewed Operating Licenses	ML21158A193
07/22/2021	Letter to Steven M. Snider – Oconee Nuclear Station Units 1, 2, and 3–Determination of Acceptability and Sufficiency for Docketing, Proposed Review Schedule, and Opportunity for a Hearing Regarding Duke Energy Carolinas' Application for Subsequent License Renewal	ML21194A245
07/28/2021	Duke Energy Carolinas, LLC; Duke Energy; Oconee Nuclear Station, Units 1, 2, and 3	86 FR 40662
07/22/2021	Letter to Steven M. Snider – Oconee Nuclear Station, Units 1, 2, and 3–Subsequent License Renewal Application Online Reference Portal	ML21189A139
08/05/2021	Letter to Steven M. Snider – Oconee Nuclear Station Units 1, 2, and 3–Notice of Intent to Prepare an Environmental Impact Statement and Conduct Scoping Process	ML21208A410
08/09/2021	Public Meeting Announcement: Environmental Scoping Meeting Related to the Oconee Nuclear Station, Units 1, 2, and 3, Subsequent License Renewal Application	ML21221A217

Table D-1 Environmental Review Correspondence (Continued)

Date	Correspondence Description	ADAMS Accession No. or *Federal Register* Citing
08/10/2021	Notice of Intent to Conduct Scoping Process and Prepare Environmental Impact Statement; Duke Energy Carolinas, LLC; Duke Energy; Oconee Nuclear Station, Units 1, 2, and 3	86 FR 43684
09/06/2021	August 25, 2021, Oconee Nuclear Station, Units 1, 2, and 3, Subsequent License Renewal Application Public Environmental Scoping Meeting Presentation	ML21235A045
09/21/2021	Letter to Steven M. Snider – Oconee Nuclear Station Units 1, 2, and 3–License Renewal Regulatory Audit Regarding the Environmental Review of the Subsequent License Renewal Application	ML21263A031
11/02/2021	August 25, 2021, Oconee Nuclear Station, Units 1, 2, and 3 Subsequent License Renewal Application Public Environmental Scoping Meeting Summary and Transcript	ML21278A670
11/23/2021	Letter to Steven M. Snider – Oconee Nuclear Station Units 1, 2, and 3–Subsequent License Renewal Environmental Review Requests for Additional and Subsequent Information	ML21323A066
12/01/2021	Letter to Steven M. Snider – Oconee Nuclear Station, Units 1, 2, and 3 – Subsequent License Renewal Environmental Review Requests for Additional and Subsequent Information – Supplemental Letter	ML21335A285
01/07/2022	Oconee Nuclear Station, Units 1, 2, and 3, Subsequent License Renewal Application, Appendix E, Responses to Requests for Additional Information and Requests for Confirmation of Information	ML22019A137
01/10/2022	Letter to Steven M. Snider – Oconee Nuclear Station Units 1, 2, and 3–Subsequent License Renewal Environmental Scoping Report	ML21357A040
11/07/2022	Oconee Nuclear Station Units 1, 2, and 3, Subsequent License Renewal – Appendix E Environmental Report Supplement 2.	ML22311A036
01/12/2023	Oconee Nuclear Station Units 1, 2, and 3, Subsequent License Renewal–Environmental Report Supplement – Proposed Review Schedule	ML22363A394
01/17/2023	Notice of Intent to Conduct a Supplemental Scoping Process and Prepare a Draft Environmental Impact Statement; Duke Energy Carolinas, LLC; Oconee Nuclear Station, Units 1, 2, and 3	88 FR 2645
04/05/2023	Letter to Steven M. Snider – Oconee Nuclear Station, Units 1, 2, And 3 – License Renewal Regulatory Audit Regarding the Environmental Review of the Subsequent License Renewal Application Supplement	ML23075A073
06/20/2023	Oconee Nuclear Station Units 1, 2, and 3 Subsequent License Renewal Application, Appendix E, Responses to Requests for Additional Information and Requests for Confirmation of Information	ML23171B108

Table D-1 Environmental Review Correspondence (Continued)

Date	Correspondence Description	ADAMS Accession No. or *Federal Register* Citing
10/06/2023	Letter to Steven M. Snider –Revised Schedule for the Environmental Review of the Oconee Nuclear Station, Units 1, 2, and 3, Subsequent License Renewal Application	ML23269A110
10/12/2023	Oconee Nuclear Station Units 1, 2, and 3 Subsequent License Renewal Application, Appendix E, Responses to Requests for Additional Information and Requests for Confirmation of Information	ML23285A185

APPENDIX E

PROJECTS AND ACTIONS CONSIDERED IN THE CUMULATIVE IMPACTS ANALYSIS

E.1 <u>Overview</u>

Table E-1 identifies other past, present, and reasonably foreseeable projects and actions the U.S. Nuclear Regulatory Commission (NRC) staff considered when analyzing potential cumulative environmental impacts related to the continued operation of the Oconee Nuclear Station, Units 1, 2, and 3 (Oconee Station) for an additional 20 years. The staff generally considered projects and actions within a 50 mi (80 km) radius of the Oconee Station site. The staff's analysis of potential cumulative impacts associated with the proposed action (subsequent license renewal) is presented in Section 3.15 of this environmental impact statement. However, because of the uniqueness of each environmental resource area evaluated and its associated geographic area of analysis, Section 3.15 does not consider or explicitly evaluate every project and action listed in Table E-1.

Table E-1 Projects and Actions NRC Staff Considered in the Oconee Station Impacts Analysis

Project Name	Summary of Project	Location (Relative to Oconee)	Status	Source
Onsite Facilities/Projects				
Bad Creek Pump Storage Hydro Station	Ongoing project to upgrade the Bad Creek pump storage hydro station.	Onsite	Scheduled to be completed by March 2024.	Duke Energy 2021-TN8897
Bullet Trap System	Installation of a bullet trap system within the footprint of the existing Oconee Station firing range.	Onsite	Completed in November 2022.	Duke Energy 2021-TN8897, Duke Energy 2023-TN8952
Chemical Treatment Pond Liner Upgrade	Project to add two additional liners with an interstitial space for leak detection to Chemical Treatment Ponds 1 and 2.	Onsite	Scheduled to be completed October 2023.	Duke Energy 2023-TN8952

Table E-1 Projects and Actions NRC Staff Considered in the Oconee Station Impacts Analysis (Continued)

Project Name	Summary of Project	Location (Relative to Oconee)	Status	Source
Complex Administrative Building (formerly known as CMD-South) Underground Storage Tank Abandonment	Abandonment of 500-gal (1,893-L) tank used to collect used oil from oil-water separator. Existing drains have been capped, and tank is no longer needed.	Onsite	Scheduled to be completed by June 2023.	Duke Energy 2023-TN8952
Communications Tower Project	Construction of a new communications tower that will provide a paging base for the site and location for Security IAC and South Carolina Highway Control Repeater.	Onsite	Scheduled to be completed by February 2024.	Duke Energy 2023-TN8952
ISFSI Phase X	Project to add more spent fuel storage for the site.	Onsite	Scheduled to be completed by March 2026.	Duke Energy 2023-TN8952
Keowee Hydro Dam Watercraft Barrier	Installation of a watercraft barrier below Keowee Hydro Dam.	Onsite	Completed in December 2020.	Duke Energy 2023-TN8952
Maintenance Training Facility stormwater drain line replacement	Planned project for the replacement of a 582-ft (177-m) segment of existing Maintenance Training Facility stormwater drain line, and the removal of approximately 0.8 ac (0.32 ha) of trees within transmission right of ways that travel between the 230 kV switchyard and Keowee hydro as part of right of way maintenance.	Onsite	Scheduled to be completed by December 2023.	Duke Energy 2021-TN8897, Duke Energy 2023-TN8952

Table E-1 Projects and Actions NRC Staff Considered in the Oconee Station Impacts Analysis (Continued)

Project Name	Summary of Project	Location (Relative to Oconee)	Status	Source
Outdoor Employee Recreation Area Project	Project will involve pouring a concrete pad for two pickleball courts for recreational use. Project will disturb 0.12 ac (0.05 ha) of existing gravel parking lot and will be used only by employees.	Onsite	Scheduled to be completed by August 2023.	Duke Energy 2023-TN8952
Plant Drinking Water Upgrade Project	Planned project for the relocation of a potable water line totaling approximately 7,500 ft (2,286 m) and stretching from the intersection of Hwy 183 and 130 past the site security check point, and along the site entrance road to the Oconee Station garage.	Onsite	Scheduled to be completed by December 2023.	Duke Energy 2021-TN8897, Duke Energy 2023-TN8952
Relay House Project	Ongoing project for addition of a new relay house and a 2,200-ft (671-m) cable tray within the 230 kV switchyard.	Onsite	Scheduled to be completed by December 2024.	Duke Energy 2021-TN8897, Duke Energy 2023-TN8952
Security Towers Project	Installation of five new security towers on the project site.	Onsite	Completed in December 2020.	Duke Energy 2023-TN8952
Thermal Margin Recapture Implementation Project	Ongoing project for implementation of Oconee Station thermal margin recapture uprates of 15 MWe for the three units.	Onsite	Scheduled to be completed by January 2024.	Duke Energy 2021-TN8897

Table E-1 Projects and Actions NRC Staff Considered in the Oconee Station Impacts Analysis (Continued)

Project Name	Summary of Project	Location (Relative to Oconee)	Status	Source
Fossil Fuel Energy Facilities				
Georgia Renewable Power-Franklin Power Plant	"Biomass Power Plant will produce 65 MW of power using a stoker grate boiler and condensing turbine utilizing locally available wood fuel."	Carnesville, Georgia, approximately 37 mi (60 km) west	Operational	https://designergrp.com/case-study/franklin-power-plant/
Rainey Generating Station (977 MW)	Combined cycle natural gas-fuel oil turbine power plant	Iva, South Carolina, approximately 32 mi (51 km) south	Operational	https://www.flipsnack.com/santeecooper/2021-fingertip-facts/full-view.html
Renewable Energy Facilities				
Clemson University Central Power and Steam Facility	15 MW combined heat and power plant owned and operated by Duke Energy.	Clemson, South Carolina, approximately 8 mi (13 km) southeast	Operational	https://nccleantech.ncsu.edu/2021/03/01/duke-energy-combined-heat-and-power-system-powering-the-tigers-pack-on-clemson-universitys-campus/
Keowee-Toxaway Hydroelectric Project	Project consists of two hydroelectric developments: Keowee Hydro Facility and Jocassee Pumped Storage Facility. The project provides 868 MW of power.	Pickens County, South Carolina	Operational	https://dms.psc.sc.gov/Attachments/Matter/db1b7381-8809-403c-bcb3-ccebdda19598
Bad Creek Hydro	Hydroelectric generating facility operated by Duke Energy's. Turbines and generators can produce up to 1,400 MW. Upgrade project will provide 280 MWe in generation and 236 MWe in pumping storage.	Salem, South Carolina, approximately 16 mi (26 km) north	Operational, upgrade scheduled for completion in March 2024.	https://badcreekpumpedstorage.com/; Duke Energy 2023-TN8952

Table E-1 Projects and Actions NRC Staff Considered in the Oconee Station Impacts Analysis (Continued)

Project Name	Summary of Project	Location (Relative to Oconee)	Status	Source
Bluebird Solar Farm	Proposed 100 MW solar energy facility.	Pendleton, South Carolina, approximately 16 mi (26 km) southeast	Application submitted in 2021 to construct a solar facility within a 1,728 ac area.	https://www.klickitatcounty.org/1096/Solar-Projects
Georgia Power Hydroelectric Power Dam: Burton	6 MW	Clarksville, Georgia, approximately 37 mi (60 km) west	Operational	https://hydroreform.org/hydro-project/burton-p-2354/ https://www.georgiapower.com/company/energy-industry/generating-plants.html
Georgia Power Hydroelectric Power Dam: Nacoochee	4.8 MW	Lakemont, Georgia, approximately 35 mi (56 km) west	Operational	https://hydroreform.org/hydro-project/nacoochee-p-2354/
Georgia Power Hydroelectric Power Dam: Terrora	16 MW	Lakemont, Georgia, approximately 29 mi (47 km) west	Operational	https://hydroreform.org/hydro-project/terrora-p-2354/
Georgia Power Hydroelectric Power Dam: Tallulah Falls	72 MW	Tallulah Falls, Georgia, approximately 28 mi (45 km) W	Operational	https://hydroreform.org/hydro-project/tallulah-falls-p-2354/
Georgia Power Hydroelectric Power Dam: Tugalo	44.8 MW	Tallulah River, Georgia, approximately 27 mi (43 km) west	Operational	https://hydroreform.org/hydro-project/tugalo-p-2354/
Georgia Power Hydroelectric Power Dam: Yonah	22.5 MW	Toccoa, Georgia, approximately 24 mi (39 km) west	Operational	https://hydroreform.org/hydro-project/yonah-p-2354/
Mining and Manufacturing Facilities				
Baxter Manufacturing	Engineering, design and development, injection molding company.	Westminster, South Carolina, approximately 11 mi (18 km) southwest	Operational	https://www.baxterent.com/

Table E-1 Projects and Actions NRC Staff Considered in the Oconee Station Impacts Analysis (Continued)

Project Name	Summary of Project	Location (Relative to Oconee)	Status	Source
CRM Manufacturing	Provides custom production of carbon steel, stainless steel, exotics, plastics, and alloy components.	Seneca, South Carolina, approximately 10 mi (16 km) south	Operational	http://crmglobalmanufacturing.com/
Greenfield Industries	Manufacturing and supply of cutting tools.	Seneca, South Carolina, approximately 6.5 mi (10 km) south	Operational	https://www.gfii.com/
Horton Holding	Engine cooling manufacturing plant.	Westminster, South Carolina, approximately 12 mi (19 km) southwest	Operational	Duke Energy 2023-TN8952
Lift Technologies	Supplies mobile material handling equipment. Capable of in-house fabrication, machining, and painting.	Westminster, South Carolina, approximately 12 mi (19 km) southwest	Operational	https://www.lift-tek.com/
Oconee County Rock Quarry	Quarry operations.	Walhalla, South Carolina, approximately 12 mi (19 km) west	Operational	https://oconeesc.com/departments/rock-quarry
Plastic Products Co.	Thermoplastic, metal, and ceramic injection molder	Seneca, South Carolina, approximately 9 mi (15 km) south	Operational	https://www.plasticproductsco.com/
Pmi2 Inc	Machining and fabrication, welding, laser marking, painting, polishing, heat treating.	Seneca, South Carolina, approximately 8.5 mi (14 km) south	Operational	https://pmi2sc.com/
U.S. Waffle Company	Frozen food processing facility.	Liberty, South Carolina, approximately 12 mi (19 km) east	Operational	Duke Energy 2023-TN8952

Table E-1 Projects and Actions NRC Staff Considered in the Oconee Station Impacts Analysis (Continued)

Project Name	Summary of Project	Location (Relative to Oconee)	Status	Source
Landfills				
Anderson County Landfill	Solid waste landfill and biogas powered generating station, which has the capacity to produce 3.2 MW.	Anderson, South Carolina, approximately 28 mi (45 km) southeast	Operational	https://www.wasteconnections.com/anderson-landfill/how-trash-becomes-energy/
Macon County Landfill	Solid waste landfill.	Franklin, North Carolina, approximately 40 mi (64 km) northwest	Operational	https://maconnc.org/solid-waste-rules.html
Pickens County Landfill	Solid waste landfill.	Liberty, South Carolina, approximately 13.5 mi (22 km) east	Operational	https://www.co.pickens.sc.us/departments/solid_waste/index.php
Oconee County Landfill	Construction and Demolition landfill.	Seneca, South Carolina, approximately 10 mi (16 km) south	Operational	https://oconeesc.com/solid-waste-home
Parks and Recreation Sites				
High Falls County Park	46 ac (19 ha) park with camping on Lake Keowee.	Seneca, South Carolina, approximately 2 mi (3 km) west	Operational	https://www.reserveamerica.com/explore/high-falls-county-park/OCSC/920012/overview
Keowee Toxaway State Park	1,000 ac (404 ha) park with camping, cabins, hiking, and lakes.	Sunset, South Carolina, approximately 11 mi (18 km) north	Operational	https://southcarolinaparks.com/keowee-toxaway
Chau Ram County Park	County park with over 400 ac (162 ha) of woodlands, hiking, camping, and waterfalls.	Westminster, South Carolina, approximately 16 mi (26 km) southwest	Operational	https://visitoconeesc.com/destination-oconee-south-carolina-chau-ram-county-park/
Oconee State Park	1,165 acre (471 ha) state park with camping, cabins, and swimming.	Mountain Rest, South Carolina, approximately 13 mi (21 km) NW	Operational	https://southcarolinaparks.com/oconee

Table E-1 Projects and Actions NRC Staff Considered in the Oconee Station Impacts Analysis (Continued)

Project Name	Summary of Project	Location (Relative to Oconee)	Status	Source
Clemson Experimental Forest	17,500 ac (7,082 ha) dedicated to education, research, and demonstration.	Central, South Carolina, approximately 5 mi (8 km) southeast	Operational	https://www.clemson.edu/public/experimental-forest/
South Cove County Park	15 ac (6 ha) peninsula offering 86 campsites with water and electricity on each site with 41 sites on the waterfront.	Seneca, South Carolina, approximately 7 mi (12 km) southwest	Operational	https://www.reserveamerica.com/explore/south-cove-county-park/OCSC/920013/overview
Various private marinas and campgrounds surrounding Lake Keowee	-	-	Operational	-
Water Supply and Treatment Facilities				
Westminster Water	City of Westminster draws water from the Chauga River and treats wastewater at the County's Coneross Creek Wastewater Treatment Plant with a capacity to treat 7 mgd.	Westminster, South Carolina, approximately 15 mi (25 km) southwest	Operational	https://www.westminstersc.org/utilities
Oconee Joint Regional Sewer Authority	Wastewater Treatment Facility that can process 5.0 mgd.	Seneca, South Carolina, approximately 11.5 mi (19 km) south	Operational	https://www.ojrsa.org/
Pendleton-Clemson Waste Treatment	Wastewater Treatment Facility that can process 2.0 mgd.	Pendleton, South Carolina, approximately 12 mi (19 km) southeast	Operational	https://townofpendleton.org/wastewater-treatment-facility/
Anderson Regional Joint Water System	Supplies surface water from Lake Hartwell Reservoir with a capacity of 45 mgd.	Anderson, South Carolina, approximately 18.5 mi (30 km) southeast	Operational	https://arjwater.com/

Table E-1 Projects and Actions NRC Staff Considered in the Oconee Station Impacts Analysis (Continued)

Project Name	Summary of Project	Location (Relative to Oconee)	Status	Source
Walhalla Water Treatment Plant	Water treatment plant that can process 4 mgd.	Walhalla, South Carolina, approximately 11.5 mi (19 km) west	Operational	Duke Energy 2023-TN8952
Anderson County Wastewater Treatment Plant: Six & Twenty	County wastewater treatment plant. Serves the corridor of highway 81N and I-85.	Anderson, South Carolina, approximately 18 mi (29 km) southeast	Operational	https://www.andersoncountysc.org/departments-a-z/wastewater/
Greenville Water System	Water treatment plant rated at 75 mgd.	Greenville, South Carolina, approximately 28 mi (45 km) east	Operational	https://www.greenvillewater.com/water-resources/greenville-water-treatment-plants
Witty Adkins	Water treatment plant rated at 60 mgd.	Six Mile, South Carolina, approximately 3 mi (5 km) north	Operational	https://www.greenvillewater.com/water-resources/greenville-water-treatment-plants
City of Pickens Water Treatment Plant and water distribution system	250 million gallon reservoir on the North Folk of Twelve Mile Creek. Water Treatment Plant has a pumping capacity of 4 mgd.	Pickens, South Carolina, approximately 12 mi (19 km) northeast	Operational	https://www.cityofpickens.com/watertreatmentplant
Pickens Wastewater Treatment Plant	0.95 mgd average flow extended aeration tertiary plant.	Pickens, South Carolina, approximately 12 mi (19 km) NE	Operational	https://www.cityofpickens.com/index.asp?SEC=61780E98-61CC-44D9-8E4C-53EA03B2C02E
Seneca Water Treatment Plant	Draws water from Lake Keowee and treated at the treatment plant. Pumping capacity is 20 mgd.	Seneca, South Carolina, approximately 6.5 mi (10 km) south	Operational	https://seneca.sc.us/seneca-light-and-water-home/water-treatment-plant
Transportation Facilities				
Oconee County Regional Airport	Public airport with single runway.	Seneca, South Carolina, approximately 8 mi (13 km) southwest	Operational	https://oconeecountyairport.com/

Table E-1 Projects and Actions NRC Staff Considered in the Oconee Station Impacts Analysis (Continued)

Project Name	Summary of Project	Location (Relative to Oconee)	Status	Source
Pickens County Airport	Public airport with single runway.	Liberty, South Carolina, approximately 11 mi (18 km) east	Operational	https://www.co.pickens.sc.us/departments/airport/index.php
Greenville-Spartanburg International Airport	Public airport with single runway.	Greer, South Carolina, approximately 39 mi (63 km) east	Operational	https://gspairport.com/
Asheville Regional Airport	Public airport with single runway.	Fletcher, North Carolina, approximately 49 mi (79 km) north	Operational	https://flyavl.com/about-the-airport/general-info
Anderson Regional Airport	Public airport with two runways.	Anderson, South Carolina, approximately 22.5 mi (36 km) southeast	Operational	https://www.andersoncountysc.org/work-live/for-businesses/airport/

ER = environmental report; Oconee Station = Oconee Nuclear Station, Units 1, 2, and 3; ISFSI = independent spent fuel storage installation.
No table entry has been denoted by "-".

E.2 References

Duke Energy. 2021. Letter from S.M. Snider, Vice President, Oconee Nuclear Station, to NRC Document Control Desk, dated June 7, 2021, regarding "Duke Energy Carolinas, LLC (Duke Energy) Oconee Nuclear Station (ONS), Units 1, 2, and 3 Docket Numbers 50-269, 50-270, 50-287 Renewed License Numbers DPR-38, DPR-47, DPR-55 Application for Subsequent Renewed Operating Licenses." Seneca, South Carolina. ADAMS Accession No. ML21158A193. TN8897.

Duke Energy. 2023. Letter from S.M. Snider, Vice President, Oconee Nuclear Station, to NRC Document Control Desk, dated June 20, 2023, regarding "Duke Energy Carolinas, LLC (Duke Energy) Oconee Nuclear Station (ONS), Units 1, 2, and 3 Docket Numbers 50-269, 50-270, 50-287 Renewed License Numbers DPR-38, DPR-47, DPR-55 Subsequent License Renewal Application, Appendix E, Responses to Requests for Additional Information (RAI), and Request for Confirmation of Information (RCI)." Seneca, South Carolina. ADAMS Accession No. ML23171B108. TN8952.

APPENDIX F

ENVIRONMENTAL IMPACTS OF POSTULATED ACCIDENTS

This appendix describes the environmental impacts from postulated accidents that may occur at Oconee Power Station, Units 1, 2, and 3 (Oconee Station) during the subsequent license renewal (SLR) period. The term “accident” refers to any unintentional event outside the normal nuclear power plant operational envelope that could result in either (1) an unplanned release of radioactive materials into the environment or (2) the potential for an unplanned release of radioactive materials into the environment. Postulated accidents include design-basis accidents and severe accidents (e.g., those involving core damage).

The NUREG-1437, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (LR GEIS) (NRC 1996-TN288, NRC 2013-TN2654), evaluates in detail the following two classes of postulated accidents as they relate to license renewal. The LR GEIS conclusions are codified in Title 10 of the *Code of Federal Regulations* (10 CFR) Part 51, “Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions:”

- Design-Basis Accidents (DBAs): Postulated accidents that a nuclear facility must be designed and built to withstand without loss to the systems, structures, and components necessary to ensure public health and safety.
- Severe Accidents: Postulated accidents that are more severe than DBAs because they could result in substantial damage to the reactor core, with or without serious offsite consequences.

This environmental impact statement (EIS) considers the impacts of SLR issues applicable to Oconee Station on a site-specific basis. The U.S. Nuclear Regulatory Commission (NRC) staff prepared this EIS in accordance with CLI-22-03 (NRC 2022-TN8272), that references CLI-22-02 (NRC 2022-TN8182).

This appendix describes (1) the NRC staff’s evaluation of new and significant information related to design-basis accidents at Oconee Station, (2) the staff’s evaluation of new and significant information for postulated severe accidents at Oconee Station, and (3) the staff’s evaluation of new and significant information related to the Oconee Station severe accident mitigation alternative (SAMA) evaluation performed during initial license renewal. The NRC staff conducted this site-specific new and significant evaluation to verify that the environmental impacts of DBAs and the probability-weighted consequences of postulated severe accidents for Oconee Station continue to be SMALL.

F.1 Background

Although this EIS documents the NRC staff’s review of a subsequent license renewal application (SLRA), it is helpful to keep in mind that long before any license renewal actions, an operating reactor has already completed the NRC licensing process for the original 40-year operating license. To receive a license to operate a nuclear power reactor, an applicant must submit to the NRC an operating license application that includes, among many other requirements, a safety analysis report. The applicant’s safety analysis report presents the design criteria and design information for the proposed reactor and includes comprehensive data on the proposed site. The applicant’s safety analysis report also describes various DBAs and the safety features designed to prevent or mitigate their impacts. The NRC staff reviews the operating license application to determine if the nuclear power plant’s design—including designs for preventing or mitigating accidents—meets the NRC's regulations and requirements. At the conclusion of that review, an operating license would be issued only if the NRC finds, in part, reasonable assurance that the activities authorized by the license can be conducted without endangering the health and safety of the public and that the activities will be conducted in accordance with the NRC regulations.

F.1.1 Design-Basis Accidents

DBAs are postulated accidents that a nuclear power plant must be designed and built to withstand without loss to the systems, structures, and components necessary to ensure public health and safety. Planning for DBAs ensures that the proposed nuclear power plant can withstand normal transients (e.g., rapid changes in the reactor coolant system temperature or pressure, or rapid changes in reactor power), as well as a broad spectrum of postulated accidents without undue hazard to the health and safety of the public. Many of these DBAs may occur but are unlikely to occur even once during the life of the nuclear power plant; nevertheless, carefully evaluating each DBA is crucial to establishing the design basis for the preventive and mitigative safety systems of the proposed nuclear power plant. 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities" (TN249), and 10 CFR Part 100, "Reactor Site Criteria" (TN282), describe the NRC's acceptance criteria for DBAs.

Before the NRC will issue an operating license for a new nuclear power plant, the applicant must demonstrate the ability of its proposed reactor to withstand all DBAs. The applicant and the NRC staff evaluate the environmental impacts of DBAs for the hypothetical individual exposed to the maximum postulated amount of radiation (maximum exposed individual member of the public). The results of these evaluations of DBAs are found in the reactor's original licensing documents, such as the applicant's final safety analysis report, the NRC staff's safety evaluation report, and the NRC staff's final environmental impact statement. The consequences of DBAs are evaluated for the hypothetical maximum exposed individual; changes in the nuclear power plant environment over time will not affect these evaluations. Once the NRC issues the operating license for the new reactor, the licensee is required to maintain the acceptable design and performance criteria (which includes withstanding DBAs) throughout the operating life of the nuclear power plant, including any license renewal periods of extended operation.

Pursuant to 10 CFR 54.29(a) (TN4878), license renewal applicants are required to manage the effects of aging and perform any required time-limited aging analyses (as further described in the regulation), such that there is reasonable assurance that the activities authorized by the renewed license will continue to be conducted in accordance with the plant's current licensing basis (CLB), and any changes made to the plant's CLB to comply with Section 54.29 are in accordance with the Atomic Energy Act of 1954, as amended (42 U.S.C. § 2011 et seq., TN663) and the Commission's regulations. Under the NRC's rules in 10 CFR Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plans," applicants for initial license renewal and SLR must take adequate steps to account for aging during the period of extended operation either by updating time-limited aging analyses or implementing appropriate aging management plans. Based on these activities, the NRC expects that operation during an initial license renewal or SLR term would continue to provide a level of safety equivalent to that provided during the initial operating license period of operations. Further, as provided in the statement of considerations for Part 54, considerable experience has demonstrated that the NRC's regulatory process, including the performance-based requirements of the maintenance rule, provide adequate assurance that degradation due to the aging of structures, systems, and components that perform active safety functions will be appropriately managed to ensure their continued functionality during the period of extended operation.

In addition, the staff notes that in the 2013 LR GEIS, the NRC reexamined the information from the 1996 LR GEIS regarding design-basis accidents and concluded that this information is still valid. The NRC found that the environmental impacts of design-basis accidents are of SMALL significance for all nuclear plants. This conclusion was reached because the plants were designed to successfully withstand these accidents, and a licensee is required to maintain the plant within acceptable design and performance criteria, including during the license renewal term. It also stated that the environmental impacts during a license renewal term should not differ significantly from those calculated for the design-basis accident assessments conducted as part of the initial plant licensing process. Impacts from design-basis accident would not be affected by changes in plant environment because such impacts (1) are based on calculated radioactive releases that are not expected to change, (2) are not affected by plant environment because they are evaluated for the hypothetical maximally exposed individual, and (3) have been previously determined to be acceptable (NRC 1996-TN288, NRC 2013-TN2654). For SLR of Oconee Station, the NRC staff finds that the same considerations apply.

In its environmental report (ER) for the Oconee Station SLRA, as supplemented, Duke Energy did not identify any new and significant information related to design-basis accidents at Oconee Station (Duke Energy 2021-TN8897, Duke Energy 2022-TN8899). In addition, the NRC staff did not identify any new and significant information related to design-basis accidents during its independent review of Duke Energy's ER, as supplemented, through the scoping process, or in its evaluation of other available information. Therefore, the NRC staff concludes that the environmental impacts related to DBAs at Oconee Station during the SLR period would be SMALL. In this regard, the staff notes that Oconee Station was designed to successfully withstand design-basis accidents. Because of the requirements for Oconee Station to maintain the licensing basis and implement appropriate aging management programs during the SLR term, the environmental impacts during the SLR term are not expected to differ significantly from those calculated for design-basis accidents as part of the initial plant licensing process. Based on the discussion above, the NRC staff concludes that the impacts of design-basis accidents during the SLR term for Oconee Station would be SMALL.

F.1.2 Design-Basis Accidents and Oconee Station License Renewal

Consistent with Regulatory Issue Summary (RIS)-2014-06, "Consideration of Current Operating Issues and Licensing Actions in License Renewal," (NRC 2014-TN7851), DBAs are a part of the CLB of the nuclear power plant as defined at 10 CFR 54.3(a), "Current licensing basis (CLB)," (TN4878).The NRC requires licensees to maintain the CLB of the nuclear power plant under the current operating license, as well as during any license renewal period. Therefore, under the provisions of 10 CFR 54.30, "Matters not subject to a renewal review," DBAs are not subject to review under the safety aspects of license renewal.

In Section 4.15.1.2.1, "Design-Basis Accidents," of its ER, Duke Energy summarized the site-specific requirements needed to operate a nuclear power facility, such as the Oconee Station safety analysis report (Duke Energy 2020-TN9001). The Oconee Station safety analysis report presents the design criteria and design information for Oconee Station. The Oconee Station safety analysis report also discusses various hypothetical DBAs and the safety features designed to prevent and mitigate accidents. A number of the postulated accidents are not expected to occur during the life of the plant but are evaluated to establish the design basis for the preventive and mitigative safety systems of the facility. The acceptance criteria for DBAs are described in 10 CFR Part 50 and 10 CFR Part 100. The NRC has reviewed Oconee's design basis on several occasions following the issuance of the initial operating licenses.

For example, Duke Energy determined the consequences for a hypothetical maximum exposed individual, which was evaluated by the NRC staff in 2004 (NRC 2004-TN9164). The NRC staff determined that the radiological consequences estimated by Duke Energy for the Oconee Station (various DBAs) would comply with the requirements of 10 CFR 50.67, "Accident source term," and the guidelines of RG 1.183, "Alternative Radiological Source Terms for Evaluating design-basis accidents at Nuclear Reactors," and were, therefore, acceptable (NRC 2004-TN9164).

Another example of NRC's review of Oconee Station design-basis is its review of external hazards information for all operating power reactors, including Oconee, as ordered by the Commission following the Fukushima accident. On November 17, 2020, the NRC staff completed its review for Oconee Station and concluded that no further regulatory actions were needed to ensure adequate protection or compliance with regulatory requirements, including site-specific external hazards information, re-confirming the acceptability of Oconee Station's design basis (NRC 2020-TN8995).

For the SLRA, Duke Energy evaluated the systems, structures, and components and conducted time-limited aging analyses of Oconee Station to ensure that systems, structures, and components remain capable of performing their functions consistent with existing plant design and performance criteria specified in the Oconee licensing basis. Duke Energy indicated that the current design and performance criteria will be maintained during the subsequent period of extended operation (SPEO) (Duke Energy 2021-TN8897).

The environmental impacts during a license renewal term do not differ significantly from those calculated for the DBA assessments conducted as part of the initial plant licensing process. Impacts from DBAs are not affected by changes in plant environment because such impacts (1) are based on calculated radioactive releases that are not expected to change; (2) are not affected by plant environment because they are evaluated for the hypothetical maximally exposed individual; and (3) have been previously determined acceptable (NRC 1996-TN288; NRC 2013-TN2654).

Under the NRC's License Renewal (LR) rules in 10 CFR Part 54 (TN4878), "Requirements for Renewal of Operating Licenses for Nuclear Power Plants," applicants for initial license renewal (LR) and SLR must take adequate steps to account for aging during the period of extended operation either through updating time-limited aging analyses or implementing aging management plans. Based on these activities, the NRC staff expects that operation during an initial license renewal or SLR term would continue to provide an equivalent level of safety as during the current operating period. Furthermore, as provided in the statement of considerations for Part 54, the Commission stated that considerable experience has demonstrated that its regulatory process, including the performance-based requirements of the maintenance rule (10 CFR 50.65 [TN249], 64 FR 38551-TN7847, provide adequate assurance that degradation due to aging of structures, systems, and components that perform active safety functions will be appropriately managed to ensure their continued functionality during the period of extended operation. Furthermore, although the definition of CLB in 10 CFR Part 54 is broad and encompasses various aspects of the NRC regulatory process (e.g., operation and design requirements), the Commission concluded that a specific focus on functionality is appropriate for performing the license renewal review. Reasonable assurance that the function of important structures, systems, and components will be maintained throughout the renewal period, combined with the rule's stipulation that all aspects of a plant's CLB (e.g., technical specifications) and the NRC's regulatory process carry forward into the renewal period, support a conclusion that the CLB (which represents an acceptable level of safety) will be maintained.

Functional capability is the principal emphasis for much of the CLB and is the focus of the maintenance rule and other regulatory requirements to ensure that aging issues are appropriately managed in the current license term. The LR rule assures this management into any subsequent term.

As stated in Section 5.3.2 of the 1996 LR GEIS (NRC 1996-TN288), the NRC staff assessed the environmental impacts from DBAs in individual nuclear power plant-specific EISs at the time of the initial license application review. The environmental impacts of design-basis accidents and severe accidents are assessed in Sections 5.3.2 and 5.3.3 of the 1996 LR GEIS, respectively. Because licensees are required to maintain the plant within acceptable design and performance criteria consistent with the current licensing basis, regardless of initial license renewal or SLR term, these impacts are not expected to change. Specifically, 10 CFR 54.21(a)(3) (TN4878) requires a license renewal application, for either the initial license renewal or SLR term, to “demonstrate that the effects of aging will be adequately managed [for structures and components identified in 10 CFR 54.21(a)(1)] so that the intended function(s) will be maintained consistent with the [current licensing basis] for the period of extended operation.” Furthermore, 10 CFR 54.29(a)(1) requires that a renewed license may be issued if the Commission, in part, finds that actions have been identified and have been or will be taken with respect to managing the effects of aging during the period of extended operation such that there is reasonable assurance that activities authorized by the renewed license will continue to be conducted in accordance with the current licensing basis.

In its ER for the Oconee SLR application, Duke Energy did not identify any new and significant information related to DBAs at Oconee (Duke Energy 2021-TN8897 and Duke Energy 2022-TN8899). The NRC staff also did not identify any new and significant information related to DBAs during its independent review of Duke Energy’s ER, through the scoping process, or in its evaluation of other available information. Therefore, the NRC staff concludes that the environmental impacts related to DBAs at Oconee Station during the SLR period is SMALL.

Duke Energy stated, and the NRC staff confirmed, that impacts due to DBAs are SMALL. The environmental impacts of DBAs are SMALL for Oconee Station because the plant was designed to successfully withstand these accidents. Because of the requirements for Oconee Station to maintain the licensing basis and implement aging management programs during the SLR term, the environmental impacts during the SLR term are not expected to differ significantly from those calculated for the DBA assessments conducted as part of the initial plant licensing process. Therefore, the NRC staff concludes that there are no environmental impacts related to DBAs at Oconee Station during the SLR period beyond those already discussed generically for all nuclear power plants in the LR GEIS. In accordance with the Commission’s decisions in CLI-22-02 and CLI-22-03, the NRC staff has evaluated the applicable Category 1 issue conclusions from the LR GEIS on a site-specific basis for Oconee Station SLR. Based on this evaluation, and based on the discussion above, the NRC staff concludes that impacts regarding DBAs with respect to an SLR term for Oconee Station are SMALL.

F.1.3 Severe Accidents

Severe accidents are postulated accidents that are more severe than DBAs because severe accidents can result in substantial damage to the reactor core, with or without serious offsite consequences. Severe accidents can entail multiple failures of equipment or functions.

F.1.4 Severe Accidents and License Renewal

Chapter 5 of the 1996 LR GEIS (NRC 1996-TN288) conservatively predicted the environmental impacts of postulated severe accidents that may occur during the period of extended operations at nuclear power plants, including Oconee Station. Since that time, the NRC staff's prediction has been confirmed to be conservative by a plant-specific SAMA evaluation (which includes the Oconee Station Level 3 PRA that determines probability-weighted consequences or population dose risk) at Oconee Station which is in the Oconee Station initial license renewal application (NRC 1998-TN8991).

In the 1996 LR GEIS, the NRC considered impacts of severe accidents including:

- dose and health effects of accidents
- economic impacts of accidents
- effect of uncertainties on the results

The NRC staff calculated these estimated impacts by studying the risk analysis of severe accidents as reported in the EISs and/or final EISs that the NRC staff had prepared in support of each nuclear power plant's original reactor operating license review. When the NRC staff prepared the 1996 LR GEIS, 28 nuclear power plant sites (44 units) had EISs or final EISs that contained a severe accident analysis. To assess the impacts of severe accidents from the airborne pathway, representing the most likely pathway for significant doses to the public, the 1996 LR GEIS relied on severe accident analyses provided in the plant-specific EISs where available. Table 5-1 in the 1996 LR GEIS lists the 28 nuclear power plants, representing 44 units, that included severe accident analyses in their plant-specific EISs. These plant-specific EISs used plant-specific meteorology, land topography, population distributions, and offsite emergency response parameters, along with generic or plant-specific source terms, to calculate offsite health and economic impacts. The offsite health effects included those from airborne releases of radioactive material and contamination of surface water and groundwater. The 1996 LR GEIS assessed the environmental impacts of severe accidents during the license renewal period for several nuclear power plants by using the results of existing analyses and site-specific information to make conservative predictions. The 1996 LR GEIS Table 5.6 values for the predicted early and latent fatalities and dose estimates per reactor-year for Oconee Station in the middle year of the LR period, which were used in the consequence analysis to determine that the impacts are SMALL, are provided in Table F-1 below.

Table F-1 Predicted Early and Latent Fatalities and Dose Estimates per Reactor-Year for Oconee Station at the Middle Year of the License Renewal Period

Nuclear Power Plant	Predicted UCB Total Early Fatalities/RY (95% UCB)	Non-Normalized Predicted Latent Total Fatalities/RY (95% UCB)	Non-Normalized Predicted Total Dose (person-rem/RY) (95% UCB)
Oconee Nuclear Station	1.1×10^{-2}	1.0×10^{-1}	1311

rem = roentgen equivalent(s) man; RY = reactor year; UCB = Upper-Confidence Bound.

For its severe accident environmental impact analysis for each nuclear power plant, the 1996 LR GEIS used very conservative 95^{th}-percentile upper-confidence bound (UCB) estimates for environmental impact whenever available. When dealing with risk assessment, use of 95^{th} percentile values provides a more conservative estimate than 50^{th} percentile or mean values. Using the 95^{th} percentile value reduces the likelihood of underestimating risk. This 95^{th}

percentile approach provides conservatism to cover uncertainties, as described in Section 5.3.3.2.2 of the 1996 LR GEIS (NRC 1996-TN288). The 1996 LR GEIS concluded that the probability-weighted consequences of severe accidents, as related to LR, are SMALL compared to other risks to which the populations surrounding nuclear power plants are routinely exposed. Since issuing the 1996 LR GEIS, the NRC's understanding of severe accident risk has continued to evolve.

During Oconee Station's initial license renewal, a site-specific Level 3 PRA analysis was performed to (1) determine the site-specific population dose risk or probability-weighted consequences to the environment, and (2) determine the cost effectiveness of mitigation alternatives that might reduce the risk. The Oconee Station SAMA analysis used a full-scope, Level 3 PRA with analysis of both the internal and external event Level 1 PRAs as well as the Level 2 PRA. This examination identified the most likely severe accident sequences, both internally and externally induced, with quantitative perspectives on their likelihood and fission product release potential. The update provides a relatively current profile of the severe accident risk for Oconee Station characterized by (1) core damage frequency (CDF) (i.e., the risk of core damage severe accidents which could release substantial fission products using Level 1 PRA) and (2) person-rem risk (or population dose risk) (i.e., the risk of release of significant fission products offsite given a core damage accident using Level 2 and 3 PRA).

The staff documented its initial license renewal review in NUREG-1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 2, Regarding the Oconee Nuclear Station" (NRC 1999-TN8942). For the Oconee Station SLR, the NRC staff considered any new and significant information that might alter the conclusions of that analysis, as discussed below.

The 1996 LR GEIS used the environmental impact information from the 28 plant-specific EISs and a metric called the exposure index (EI) to (1) scale up the radiological impact of severe accidents on the population due to demographic changes from the time the original EIS was done until the year representing the mid-license renewal period and (2) estimate the severe accident environmental impacts for the other plants (for which EISs did not include a quantitative assessment of severe accidents). The EI method uses the projected population distribution around each nuclear power plant site at the middle of its license renewal period and meteorology data for each site to provide a measure of the degree to which the population would be exposed to the release of radioactive material resulting from a severe accident (i.e., the EI method weights the population in each of 16 sectors around a nuclear power plant by the fraction of time the wind blows in that direction on an annual basis). The EI metric also was used to project economic impacts at the mid-year of the license renewal period. A more detailed description of the EI method is contained in Appendix G of the 1996 LR GEIS. The plant-specific EISs (which are a function of population and wind direction), in conjunction with the plant-specific total probability-weighed consequences or risk values from the Final EISs, were used to predict the 95 percent UCB consequences for 74 nuclear power plants (including Oconee Station), representing 118 units, from atmospheric releases due to severe accidents. Predicted 95 percent UCB values were developed for (1) early fatalities per reactor-year, (2) latent fatalities per reactor-year, and (3) total population dose per reactor-year. The results of this assessment for each plant, for each of these impact metrics, are provided in 1996 LR GEIS Table 5.10, Table 5.11, and Table 5.6, respectively. These results from the 1996 LR GEIS are repeated in Table F.1 for Oconee Station in the columns titled "Predicted Total Early Fatalities/RY (95 % UCB)," "Non-normalized Predicted Latent Total Fatalities/RY (95% UCB)," and "Non-normalized Predicted Total Dose (person-rem/RY) (95% UCB)," respectively. In Section 5.5.2.5 of the 1996 LR GEIS, the NRC staff concluded that the generic analysis summarized in the 1996 LR GEIS "applies to all plants and that the probability-weighted consequences of atmospheric releases, fallout onto open bodies of water, releases to ground water, and societal and economic impacts of severe accidents are of small significance for all plants."

The SAMA analysis with Oconee Station Level 3 PRA performed for Oconee Station at the time of initial LR (NRC 1998-TN8991) sought to identify mitigation alternatives that have the potential to reduce severe accident risk and to determine if implementation of the mitigation was potentially cost-beneficial. Similar to the 1996 LR GEIS, the consequence analysis software that was used for the Oconee Station Level 3 PRA in the SAMA analysis was the MELCOR Accident Consequence Code System (MACCS) code (SNL 2021-TN7810).[1] As such, the initial LR application for Oconee Station included a more recent plant-specific estimate of the total population dose risk (PDR) due to severe accidents, which is an update of the non-normalized predicted total dose (person-rem/RY) (95 percent UCB) consequences provided in the 1996 LR GEIS. This included plant-specific updated core damage frequencies for internal and external event hazards, plant-specific updated analyses of containment performance under severe accident conditions, and updated consequence analyses using plant-specific information about radionuclide source terms, radionuclide releases, projected population distribution during the license renewal period, meteorological data, and emergency response.

The total population dose risk value of 5 person-rem/RY calculated by Duke Energy in the Oconee Station Level 3 PRA analysis performed during initial license renewal is orders of magnitude less than the corresponding predicted or estimated 95 percent UCB value of 1311 person-rem/RY presented by NRC in the 1996 LR GEIS. Specifically, the predicted 95 percent UCB population dose value from the 1996 LR GEIS population is higher by a factor of 266. The 1996 LR GEIS 95 percent UCB predicted values for early fatalities and latent fatalities were derived from the estimated radiological doses to the population. Therefore, the NRC staff concludes that the 1996 LR GEIS predicted 95 percent UCB results for early fatalities and latent fatalities are conservative based on the updated information from the license renewal SAMA analyses regarding population dose risk and the state-of-the-art reactor consequence analysis (SOARCA) results (NRC 2012-TN3092). The Oconee Station-specific license renewal calculated values for population dose risk demonstrated the magnitude of conservatism used in the 1996 LR GEIS predicted values, both from the standpoint of reduced consequences using more recent plant-specific information and the conservatism built into the 1996 LR GEIS methodology and reinforced the conclusion that the probability-weighted consequences due to severe accidents are SMALL.

In the 2013 LR GEIS, the NRC staff evaluated the NRC's severe accident environmental impact assessments in 1996 LR GEIS considering new information that might affect the evaluation and confirmed that the determination regarding probability-weighted consequences of atmospheric releases, fallout onto open bodies of water, releases to groundwater, and socioeconomic impacts from severe accidents are small for all plants (NRC 2013-TN2654, Appendix E). This EIS for Oconee Station evaluates new information regarding severe accidents using a similar approach to the 2013 LR GEIS and considers whether the new information would, collectively, change the conclusion that the probability-weighted consequences of a severe accident at Oconee Station are small. As explained below, while several factors at Oconee Station may result in modest increases in severe accident risk, other new information regarding these factors

[1] MACCS was developed at and continues to be maintained by Sandia National Laboratories for the NRC. It is used to model estimates of the health risks and economic impacts of offsite radiological releases from potential severe accidents at nuclear facilities.

suggests that the risk of severe accidents may be, on average, substantially lower than previously estimated. As a result, the following NRC staff review and independent analysis overall further supports the findings from the 1996 and 2013 LR GEIS that the probability-weighted impacts of severe accidents would be SMALL.

F.2 Severe Accident Mitigation Alternatives

During initial license renewal, applicants consider the environmental impacts of severe accidents, their probability and frequency of occurrence (using Level 1, Level 2 and Level 3 PRA), and potential means to mitigate those accidents (NRC 2013-TN2654).

F.2.1 Oconee Station Initial License Renewal SAMA Analysis with Oconee Station Level 3 PRA Results Submitted in 1998

As part of its initial license renewal application submitted in 1998, Duke Energy's ER included an analysis of SAMAs including the Oconee Station Level 3 PRA results (NRC 1998-TN8991). Duke Energy based this SAMA analysis on (1) the Oconee Station PRA for total accident frequency, CDF, and containment large early release frequency (LERF); and (2) a supplemental analysis of offsite consequences and economic impacts for risk determination. The Oconee Station PRA included a Level 1 analysis to determine the CDF from internally initiated events and a Level 2 analysis to determine containment performance during severe accidents. The offsite consequences and economic impacts analyses (Level 3 PRA) used site-specific data for meteorology, population, and evacuation modeling to determine the offsite risk impacts on the surrounding environment and the public. Inputs for the latter analysis included projected population distribution (based on 1990 census data, projected out to 2030 for Oconee Station),[2] emergency response evacuation modeling, and economic data.

In its 1998 ER, Duke Energy started with a listing of the top 100 cut sets (severe accident sequences) on internal initiators and the top 100 cut sets from the external initiators ranked by contribution to total core damage. Duke Energy then performed a qualitative screening of those SAMAs, eliminating SAMAs that were not applicable to Oconee Station or had already been implemented at Oconee Station. Several of the SAMAs were qualitatively screened, leaving 16 SAMAs subject to the final quantitative evaluation process. The 16 remaining SAMAs are listed in Table 6-1 of Attachment K of the 1998 Duke ER (NRC 1998-TN8991). Ultimately, Duke Energy concluded that there were no potentially cost-beneficial SAMAs associated with the initial Oconee Station license renewal (NRC 1998-TN8991).

As part of its review of the initial Oconee Station license renewal application, the NRC staff reviewed Duke Energy's 1998 SAMA analysis for Oconee Station, as documented in Supplement 2 to NUREG-1437 (NRC 1999-TN8942). Chapter 5 of Supplement 2 to NUREG-1437 contains the NRC staff's evaluation of the potential environmental impacts of nuclear power plant accidents and examines each SAMA (individually and, in some cases, in combination) to determine the SAMA's individual risk reduction potential. The NRC staff then compared this potential risk reduction against the cost of implementing the SAMA to quantify the SAMA's cost-benefit value.

The value-impact results for the 16 SAMAs are presented in Tables 5-5 and 5-6 of the Oconee Station LR ER. All of the SAMAs had a negative net value, even when bounding risk reduction

[2] In contrast, as discussed in the population sensitivity later in this EIS, Duke Energy's ER for SLR used projected population values for the year 2054 (Duke Energy 2021-TN8897).

benefits are assumed. In Section 5.2.7 of NUREG-1437, Supplement 2, the NRC staff concluded that Duke Energy used a systematic process for identifying potential design improvements for Oconee Station and that the set of potential design improvements identified by Duke Energy is reasonably comprehensive and, therefore, acceptable. Based on its review of SAMAs for Oconee Station, the NRC staff concluded that none of the candidate SAMAs were cost beneficial. Both the conditional probability of an early release of fission products and the total offsite risk at Oconee Station were already quite small (less than 4 percent and 5 person-rem per year, respectively). Given the low residual level of risk and the large cost of enhancements necessary to substantially reduce risk, cost-beneficial enhancements that can significantly reduce risk were unlikely. The margins in the analysis were considered ample to cover uncertainties in risk and cost estimates given that, in general, estimates for these factors were conservatively evaluated (NRC 1999-TN8942).

F.2.2 Subsequent License Renewal Application and New and Significant Information as it Relates to the Probability-Weighted Consequences of Severe Accidents

Since publication of the 1996 LR GEIS, 2013 LR GEIS, and completion of the Oconee Station LR SAMA analyses, new information and developments in plant operation and accident analysis have unfolded that could affect the assumptions made in these previous analyses. The Oconee Station new information and developments are evaluated specifically for Oconee Station similar to the grouping approach for all plants used in the 2013 LR GEIS. These changes are grouped into the following areas and are each covered in this appendix:

- internal event risk
- external event risk
- updates in the quantification of accident source terms
- increases in licensed reactor power levels, i.e., power uprates
- increases in fuel burnup levels
- consideration of reactor accidents at low power and shutdown conditions
- consideration of accidents in Spent Fuel Pools
- the Biological Effects of Ionizing Radiation (BEIR) VII report on the risk of fatal cancers posed by exposure to radiation

Sections discussing uncertainties, SAMAs, and conclusions are also provided. Below, the NRC staff summarizes possible areas of new and significant information and assesses Duke Energy's conclusions.

F.3 Evaluation of New Information Concerning Probability-Weighted Consequences of a Severe Accident at Oconee Station

The 2013 LR GEIS considers developments in nuclear power plant operation and accident analysis that could have changed the assumptions made in the 1996 LR GEIS concerning severe accident consequences. The 2013 LR GEIS confirmed the determination in the 1996 LR GEIS that the probability-weighted consequences of severe accidents are SMALL for all nuclear power plants. Appendix E in the 2013 LR GEIS provides the NRC staff's evaluation of the environmental impacts of postulated accidents. Table E-19, "Summary of Conclusions," of the 2013 LR GEIS shows the developments that the NRC staff considered, as well as the staff's conclusions. Consideration of the items listed in Table E-19 of the 2013 LR GEIS was the basis for the NRC staff's overall determination in the 2013 LR GEIS that the probability-weighted consequences of severe accidents remain SMALL for all nuclear power plants.

For issues that are applicable to Oconee Station, the discussion below follows the format of the generic new and significant analysis approach that was used for all plants in the 2013 LR GEIS using Oconee Station site-specific information for the SPEO. The site-specific analysis evaluates the impact of any relevant new site-specific information on the environmental consequences of continued plant operation during the SPEO for Oconee Station.

For the Oconee Station SLR, the NRC staff confirmed that there is no new and significant information that would change the 2013 LR GEIS conclusions on the probability-weighted consequences of severe accidents. The NRC staff evaluated Duke Energy's information related to the 2013 LR GEIS, Table E-19, "Summary of Conclusions," during the Oconee Station audit (NRC 2021-TN8910), during the scoping process, and through the evaluation of other available information. The results of that review follow.

F.3.1 New Internal Events Information (Section E.3.1 of the 2013 LR GEIS)

The Oconee Station internal events CDF in the initial license renewal SAMA was 2.6×10^{-5}/year (NRC 1998-TN8991). The Oconee Station internal events CDF provided in the Oconee Station SLR ER is approximately 2.4×10^{-5}/year (Duke Energy 2021-TN8897). Specifically, the current internal events CDF of 2.4×10^{-5}/year is approximately 8 percent lower than the internal events CDF of 2.6×10^{-5}/year from the initial license renewal SAMA analysis and Oconee Station Level 3 PRA analysis.

The impacts from the 1996 LR GEIS were based on the original license EISs for the 28 nuclear power plant sites listed in Table 5.1 of the 1996 LR GEIS. Oconee Station is not one of the original nuclear power plant sites; however, a comparison with the original internal event CDF values that the 1996 LR GEIS was based on can be made. The Oconee Station internal events CDF provided in the ER (2.4×10^{-5}/year) is below the mean value (8.4×10^{-5}/yr), median value (4.8×10^{-5}/yr), and below the range of the original pressurized water reactor (PWR) internal events CDFs (3.5×10^{-4}/yr to 4.4×10^{-5}/yr) values on which the 1996 LR GEIS was based (see Table E-1 of the 2013 LR GEIS). This represents Oconee Station's relatively lower value for internal event CDFs in comparison to the mean, median and maximum value of internal events of other PWRs by a factor of 3.5, 2, and 14, respectively, as represented below in Table F-2.

Additional comparisons can be made of the estimated total population dose from severe accidents initiated by internal events, which were estimated in both the 1996 LR GEIS (referred to as the expected total population dose – non-normalized) and in the Oconee Station license renewal Level 3 PRA analyses. These comparisons are shown in Table F-3 below. The data in these tables show that the Oconee Station plant-specific population dose risk calculated in the Oconee Station Level 3 PRA analyses is significantly less (by a factor of 266) than the expected value estimated for Oconee Station in the 1996 LR GEIS.

Thus, the population dose risk of severe accidents is significantly less for Oconee Station than that used as the basis for the 1996 LR GEIS.

Table F-2 Pressurized Water Reactor Internal Event (Full Power) Core Damage Frequency Comparison

Nuclear Power Plant	1996 LR GEIS Estimated CDF[(a)]	IPE CDF[(b)]	SAMA Internal Event CDF[(c)]
Oconee Nuclear Station	N/A	2.3×10^{-5}/yr[(d)]	2.6×10^{-5}/yr[(d)]
PWR Mean value	8.4×10^{-5}/yr	5.9×10^{-5}/yr	2.2×10^{-5}/yr
PWR Median value	4.8×10^{-5}/yr	4.9×10^{-5}/yr	1.7×10^{-5}/yr

CDF = core damage frequency; IPE = individual plant examination; LR GEIS = Generic Environmental Impact Statement for License Renewal of Nuclear Plants; SAMA = severe accident mitigation alternative; N/A = not applicable.

(a) The estimated CDF was obtained by summing individual atmospheric release sequences, including intact containment sequences.

(b) Data were obtained from NRC 1997-TN7812, unless otherwise noted.

(c) Data were obtained from the applicable plant-specific supplement to NUREG-1437, unless otherwise noted.

(d) The internal events initiated CDF value includes contribution from internal flooding events.

Table F-3 Pressurized Water Reactor Internal Event (Full Power) Population Dose Risk Comparison

Nuclear Power Plant	1996 LR GEIS Estimated Expected Total Population Dose – Non-normalized (person-rem/reactor-year)[(a)]	SAMA PDR (person-rem/reactor-year)[(b)]
Oconee Nuclear Station	1311	5
Other Mean value	986	31.3
Other Median value	175	16.0

LR GEIS = Generic Environmental Impact Statement for License Renewal of Nuclear Plants; PDR = population dose risk; SAMA = severe accident mitigation alternative.

(a) Data were obtained from NRC 1996-TN288.

(b) The SAMA PDR was obtained from the Oconee plant-specific supplement to NUREG-1437.

From Oconee Station's 1998 ER, the annual person-rem risk result calculated for the 50 mi population was 5 whole body person-rem. In general, the population dose risk values calculated for Oconee Station are relatively low in comparison to other plants (NRC 2023 – TN7802).

The CDF level from the Oconee Station license renewal Level 1 internal event PRA analyses is lower than the range of PWR internal event accident frequencies that was used to form the basis for the environmental impacts in the 1996 LR GEIS. The internal event CDF for Oconee Station has further decreased since the time of the Oconee Station LR SAMA analysis. These results demonstrate the conservatism in the 1996 LR GEIS values, both from the standpoint of reduced population dose risk from more recent estimates and the conservatism built into the 1996 LR GEIS methodology.

During the review of Oconee Station historical changes in CDF values during an audit for this EIS (NRC 2021 – TN9716), the staff noted that increases in the CDF as a result of PRA updates were sometimes due to changes in PRA modeling or methodology and not due to physical changes in plant design or operation. For example, after Duke Energy submitted the Oconee Station initial license renewal application ER in 1998 and after the NRC staff issued its corresponding SAMA review in its 1999 SEIS, several changes had been implemented at Oconee Station that are risk beneficial but may not be fully credited in the PRA. This includes safety improvements as a result of the Fukushima Near-Term Task Force recommendations and other plant-specific programs (Duke Energy 2021-TN8897).

A number of physical plant improvements that may benefit risk have been implemented at Oconee Station since the initial license renewal. The Oconee Station ER listed the following:

- upgraded Oconee Station Unit 1 Westinghouse Reactor Coolant Pump seals to a low leakage seal design
- replaced the station Auxiliary Service Water system (pump and power system) with the Protected Service Water System, which provides enhanced capability to restore steam generator cooling, Reactor Coolant System makeup, and Reactor Coolant Pump seal injection
- installed backup alternating current power connection for the Safe Shutdown Facility (SSF) from Protected Service Water switchgear
- upgraded the west penetration room masonry walls to withstand tornado wind and differential pressure
- added Borated Water Storage Tank tornado missile protection
- installed additional tornado missile protection for SSF cabling for portions of west penetration room and SSF cable trench
- installed reliable Spent Fuel Pool instrumentation in response to NRC Order EA-12-051
- implemented diverse and flexible coping strategies features and capabilities in response to NRC Order EA-12-049
- enhanced external flood protection for post-Fukushima response
- improved closure capability of valve HP-5 to isolate containment following a seismic event (Duke Energy 2021-TN8897)

Changes in PRA methodology (e.g., more conservative calculations for treatment of dependency between human actions) also have increased the value of CDF in a manner that could potentially diminish the impact and real benefits from demonstrable plant safety improvements (i.e., implemented diverse and flexible coping strategies features and capabilities in response to NRC Order EA-12-049) (Duke Energy 2021-TN8897). Considering plant improvements to reduce internal events risk and the conservative population dose risk values used in the 1996 LR GEIS (as discussed in uncertainties section below), the offsite consequences of severe accidents initiated by internal events at Oconee Station during the subsequent period of extended operation would not exceed the impacts predicted in the 1996 LR GEIS.

Therefore, considering the CDF reduction in Oconee Station's risk profile and the information evaluated in Table F-3, the NRC staff concludes that the offsite probability-weighted consequences of severe accidents initiated by internal events during the SLR term at Oconee Station would not exceed the impacts predicted in the 1996 or 2013 LR GEIS. The NRC staff identified no new and significant information regarding internal events during its review of Duke Energy's ER, during the SAMA audit, through the scoping process, or through the evaluation of other available information. Thus, the NRC staff concludes that no new and significant information exists for Oconee Station during the SLR term concerning offsite probability-weighted consequences of severe accidents initiated by internal events that would alter the conclusions reached in the 1996 or 2013 LR GEIS. For these issues, the LR GEIS predicted that the probability-weighted consequences of severe accidents would be SMALL for all nuclear power plants.

F.3.2 External Events Information (Section E.3.2 of the 2013 LR GEIS)

The 1996 LR GEIS included a qualitative assessment of the environmental impacts of accidents initiated by external events (see Section 5.3.3.1 of the 1996 LR GEIS [NRC 1996-TN288]). The purpose of this section is to consider updated information regarding the contribution to CDF from accidents initiated by external events and potential external event impacts. The sources of information used in this external events assessment are the 1998 Oconee Station SAMA analyses provided in the Oconee Station license renewal ER and the plant-specific supplemental EIS to NUREG-1437. The license renewal SAMA analyses submitted and reviewed by the NRC staff explicitly considers the impact of external events in the assessment of SAMAs.

The 2013 LR GEIS expanded the scope of the evaluation in the 1996 LR GEIS and used more recent technical information that included both internally and externally initiated event core damage frequencies. Section E.3.2.3 of the 2013 LR GEIS concluded that the CDFs from severe accidents initiated by external events, as quantified in NUREG-1150, "Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants" (NRC 1990-TN525), and other sources documented in the LR GEIS, are comparable to CDFs from accidents initiated by internal events, but lower than the CDFs that formed the basis for the 1996 LR GEIS.

As with the previous section that addressed updated information with regard to internal events risk, the evaluation contained in this section compares the CDFs that formed the basis for the 1996 LR GEIS, and population dose risk values directly from the 1996 LR GEIS, with the more recent Oconee Station values provided in the Oconee SLR ER.

The total plant CDF (referred to as the All Hazards CDF) from the SAMA analyses is the summation of the CDFs for internally initiated events, including internal flood events, and external events. Duke Energy provided the base case CDF values used to evaluate SAMAs in Table 4.15-2 of the Oconee Station SLR ER, as supplemented. The sum of the external events CDF (1×10^{-4} per reactor-year); fire, seismic, high winds, and external flooding CDFs (5.14×10^{-5} per reactor-year, 3.27×10^{-5} per reactor-year, 1.59×10^{-5} per reactor-year, and 2.47×10^{-7} per reactor-year, respectively), is greater than the current Oconee Station internal event CDF (2.41×10^{-5} per reactor-year), but lower than the range of PWR internal event CDFs (4.4×10^{-5} to 3.5×10^{-4} per reactor-year) that formed the basis of the 1996 LR GEIS to conservatively estimate probability-weighted, offsite consequences from airborne, surface water, and groundwater pathways, as well as the resulting economic impacts from such pathways. Because Oconee Station's fire, seismic, high winds, and external flood PRA models have been developed since the time of the initial license renewal, these models were considered new information by Duke Energy and were used in the quantitative PRA calculation to evaluate SAMAs' potential for significance, as demonstrated in Table 4.15-2 of the ER and reviewed in the SAMA section of this EIS below.

Data in Table F-4 and Table F-5 show that after accounting for the Oconee Station CDF contribution from all hazards, the total plant CDF is within the range of values used in the 1996 LR GEIS, which only considered internal events.

Table F-4 Pressurized Water Reactor All Hazards (Full Power) Core Damage Frequency Comparison

Nuclear Power Plant	1996 LR GEIS Estimated CDF[(a)]	SAMA All Hazards CDF[(b)]
Oconee Nuclear Station	N/A	8.90×10^{-5} /yr
Indian Point 2	3.5×10^{-4} /yr	6.7×10^{-5} /yr
Mean value	8.4×10^{-5} /yr	5.1×10^{-5} /yr
Median value	4.8×10^{-4} /yr	4.5×10^{-5} /yr

CDF = core damage frequency; LR GEIS = Generic Environmental Impact Statement for License Renewal of Nuclear Plants; PDR = population dose risk; SAMA = severe accident mitigation alternative.

(a) Data were obtained by summing individual atmospheric release sequences, including intact containment sequences.

(b) Data were obtained from the applicable plant-specific supplement to NUREG-1437. Where applicable, the SAMA PDR was adjusted using the external events multiplier.

Source: NRC 2022-TN7857, unless otherwise noted.

Regarding the current ER, as supplemented, Duke Energy provided the overall hazard contribution to CDF for Oconee Station, as shown in Table F-5.

Table F-5 Oconee Nuclear Station Hazard Contribution to Core Damage Frequency

Oconee Nuclear Station SLRA	CDF	Percent of Combined CDF
Int. Events CDF	2.41×10^{-5}/yr	19.12%
Int. Flood CDF	1.58×10^{-6}/yr	1.26%
High Winds CDF	1.59×10^{-5}/yr	12.60%
Ext. Flood CDF	2.47×10^{-7}/yr	0.20%
Fire CDF	5.14×10^{-5}/yr	40.83%
Seismic CDF	3.27×10^{-5}/yr	26.02%
Combined CDF	1.26×10^{-4}/yr	100.02%

CDF = core damage frequency; SLRA = subsequent license renewal application.

As provided in Table F-4, the Oconee Station All Hazards CDF is less than the highest estimated Internal Events CDF from the 1996 LR GEIS (Indian Point 2). Accordingly, the likelihood of an accident that leads to core damage, including accounting for the contribution from external events, is less for Oconee Station than the highest estimated Internal Events CDF used as the basis for the 1996 LR GEIS.

Although the Combined CDF (All Hazards) increased to 1.26×10^{-4} per reactor-year, the Oconee Station All Hazards CDF is still less than the highest estimated internal events CDF (Indian Point 2 is 3.5×10^{-4} per reactor-year) used in the 1996 LR GEIS. Accordingly, the likelihood of an accident that leads to core damage, including accounting for the contribution from external events, is less for Oconee Station than the highest estimated internal events CDF from the values which were used as the basis for the 1996 LR GEIS.

In the current Oconee Station ER, as supplemented, Duke Energy indicated that these PRA models reflected the most up-to-date understanding of plant risk at the time of analysis. The staff determined that this approach is sufficient to evaluate new and significant information related to SAMAs because use of the models reflected the most up-to-date understanding of plant risk at the time of the analysis, consistent with NEI 17-04, “Model SLR New and Significant Assessment Approach for SAMA.”

Additional comparisons can be made of the estimated total population dose risk from severe accidents initiated by internal and external events (as estimated in the license renewal SAMA analyses), with the estimated total population dose risk from severe accidents initiated by only internal events (as estimated in the 1996 LR GEIS). For this comparison, the NRC staff used the 95 percent UCB population dose risk estimates from the 1996 LR GEIS.

The Oconee Station SAMA analysis performed during initial license renewal used a full-scope, Level 3 PRA with analysis of both the internal and external events. This examination identified the most likely severe accident sequences, both internally and externally induced, with quantitative perspectives on their likelihood and fission product release potential. The Level 3 PRA provided an updated profile of the severe accident risk for Oconee Station compared to the 1996 LR GEIS characterized by (1) CDF (i.e., the risk of core damage severe accidents which could release substantial fission products) and (2) person-rem risk (or population dose risk) (i.e., the risk of release of significant fission products offsite given a core damage accident).

As provided in the 1998 ER, the Oconee Station annual person-rem risk result for the 50 mi population is 5 whole body person-rem. In general, the population dose risk measures calculated for Oconee Station show relatively low risk of environmental impacts compared to other nuclear power plants (NRC 2023-TN7802).

Data in Table F-6 show that the estimated population dose risk in the Oconee Station Level 3 analyses, accounting for the risk from all hazards, is significantly less than the 95 percent UCB estimate for Oconee Station in the 1996 LR GEIS. Specifically, as shown in Table F-6, the Oconee Station SAMA analyses is more than a factor of 266 less than the corresponding 95 percent UCB estimates for Oconee Station. As shown in Table F-6, the 1996 LR GEIS estimated Oconee Station population dose risk (1,311) was near half the mean PWR population dose risk values calculated for other plants (2,294), and near the median for PWR plants (1,222).

Table F-6 Oconee All Hazards (full power) Population Dose Risk Comparison

Nuclear Power Plant	1996 LR GEIS Estimated Predicted Total Population Dose – Non-normalized 95% UCB (person-rem/reactor-year)[(a)]	SAMA All Hazards PDR (person-rem/reactor-year)[(b)]
Oconee Nuclear Station	1,311	5
PWR Mean value	2,294	89.8
PWR Median value	1,222	34.0

LR GEIS = Generic Environmental Impact Statement for License Renewal of Nuclear Plants; PDR = population dose risk; SAMA = severe accident mitigation alternative; UCB = upper-confidence bound.

(a) Data were obtained from NRC 1996-TN288.

(b) Data were obtained from the applicable plant-specific supplement to NUREG-1437 and multiplied by the external events multiplier from the same plant-specific Supplemental EIS to NUREG-1437, if applicable (NRC 2022-TN7857).

Source: NRC 2022-TN7857, unless otherwise.

Accordingly, based on the Oconee Station license renewal Level 3 PRA analyses, the risk of severe accidents that result in core damage, considering accidents initiated by all hazards, is significantly less for Oconee Station than that used as the basis for the 1996 LR GEIS.

On March 12, 2012, the NRC issued a request under 10 CFR 50.54(f) (TN249), as part of implementing lessons learned from the accident at Fukushima, that, among other things, requested licensees to reevaluate the seismic hazards at their sites using present-day methodologies and guidance to develop a Ground Motion Response Spectrum (SNL 1982-TN7749). Duke Energy submitted its seismic PRA (SPRA) on December 21, 2018 (Duke Energy 2018-TN8992). The NRC staff reviewed Duke Energy's SPRA (NRC 2019-TN8994) and concluded:

> Based on the staff's review of the Oconee submittal against the endorsed SPID [Screening, Prioritization and Implementation Details] guidance, the NRC staff concludes that the licensee responded appropriately to Enclosure 1, Item (8) of the 50.54(f) letter. Additionally, the staff's review concluded that the SPRA is of sufficient technical adequacy to support Phase 2 regulatory decision-making in accordance with the intent of the 50.54(f) letter. Based on the results and risk insights of the SPRA submittal, the NRC staff also concludes that no further response or regulatory actions associated with NTTF [Near-Term Task Force] Recommendation 2.1 "Seismic" are required. The staff notes that this conclusion is dependent on the completion of the planned modifications, as described in the SPRA submittal.

A letter dated September 18, 2019, provides the regulatory commitments to specific actions which Oconee Station planned to implement. (Duke Energy 2020-TN9001).

In a November 17, 2020, letter regarding the assessment of Oconee Station's completion of required actions taken in response to the lessons learned from Fukushima, the NRC staff acknowledged and documented that the actions required by the NRC in orders issued following the accident at the Fukushima Nuclear Power Station had been completed for Oconee Station and stated that the NRC would continue to provide oversight of Oconee Station's safety enhancements through the NRC's reactor oversight process (NRC 2020-TN8995). In addition, the letter acknowledged and documented that Duke Energy had provided the information requested in the NRC's March 12, 2012, request for information under 10 CFR 50.54(f) (TN249), related to the lessons learned from that accident. Completing these actions and providing the requested information, implemented the safety enhancements mandated by the NRC based on the lessons learned from the accident.

In conclusion, there was an 8 percent decrease in the Oconee Station internal events CDF since its initial ER. Duke Energy provided commitments or implemented the safety enhancements mandated by the NRC based on the lessons learned from the Fukushima accident. Furthermore, the sum of the Oconee Station external events CDFs was within the range of PWR internal event CDFs that formed the basis for the 1996 LR GEIS. Therefore, the NRC staff concludes that the probability-weighted offsite consequences of severe accidents initiated by external events during the SLR term would not exceed the probability-weighted consequences predicted in the 1996 or 2013 LR GEIS. For these issues, the 1996 and 2013 LR GEIS predicted that the probability-weighted consequences of severe accidents would be SMALL for all nuclear plants. The NRC staff identified no new and significant information regarding external events during its review of Duke Energy's ER, during the SAMA audit, through the scoping process, or through the evaluation of other available information. Thus, the NRC staff finds Duke Energy's conclusion acceptable that no new and significant information exists for Oconee Station concerning offsite probability-weighted consequences of severe accidents initiated by external events that would alter the conclusions that for Oconee Station, the probability-weighted consequences of atmospheric releases, fallout onto open bodies of water, releases to groundwater, and societal and economic impacts from severe accidents remains SMALL for the SLR period. Further details regarding the Oconee fire and seismic PRA are described below.

F.3.2.1 Fire Events

Since publication of the 1996 LR GEIS, the NRC and nuclear industry have developed updated PRA standards and guidance (i.e., methods, tools, and data) for the development of quality fire PRA models. The updated guidance was published as NUREG/CR-6850 and Electric Power Research Institute (EPRI) Report 1011989, “EPRI/NRC-RES Fire PRA Methodology for Nuclear Power Facilities,” (EPRI/NRC 2005-TN7823, EPRI/NRC 2005-TN7824), and has subsequently been enhanced by numerous additional reports about specific fire PRAs and fire modeling topics. The documented methods are intended to support applications of fire PRAs in risk-informed regulatory applications. Subsequently, fire PRAs have been developed for most nuclear power plants using these updated guidance documents. Regulatory Guide 1.200, Revision 3 (NRC 2020-TN7806), describes one approach acceptable to the NRC staff for demonstrating the acceptability of PRA models for risk-informed activities.

In recent years, many nuclear plant licensees (including Duke Energy for Oconee Station) have submitted risk-informed license amendment requests for their plants to the NRC, in which risk results and risk insights from fire PRAs have been included. In addition, since about 2010, many of the SAMA analyses for license renewal applications have included risk results and insights from their newly developed fire PRAs. Table F-7 provides the mean and median for the plant-specific fire core damage frequency (FCDFs) obtained from fire PRAs (FPRAs) summarized in various risk-informed license amendment requests. Statistical results are calculated from approximately three-fourths of the current nuclear reactor operating fleet. The mean and median FPRA values reported are from NRC-approved NFPA 805, “Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants”, 2001 Edition (NRC 2022-TN7857). Probabilistic health consequences, such as population dose risk, are not available because this information is not used in the NRC staff assessment of risk-informed license amendment requests. Table F-7 also compares the Oconee Station FPRA FCDF to the FCDF used in the 1998 license renewal SAMA analyses.

Table F-7 Fire (Full Power) Core Damage Frequency Comparison

Nuclear Power Plant	SAMA FCDF(a)	FPRA FCDF(b)
Oconee Nuclear Station Units 1, 2	4.5×10^{-6}/yr	6.0×10^{-5}/yr
Oconee Nuclear Station 3	4.5×10^{-6}/yr	6.1×10^{-5}/yr
Mean value	1.8×10^{-5}/yr	4.5×10^{-5}/yr
Median value	9.4×10^{-5}/yr	4.6×10^{-5}/yr

FCDF = fire core damage frequency; FPRA = fire probabilistic risk assessment; SAMA = severe accident mitigation alternative.
(a) Data were obtained or compiled from applicable plant-specific supplement to NUREG-1437, unless otherwise noted.
(b) Data were obtained or compiled from risk-informed license amendment requests.
Source: NRC 2022-TN7857, unless otherwise noted.

The result in Table F-7 show that the Oconee Station FPRA FCDF value is higher by a factor of 14 than in the corresponding license renewal SAMA FCDF analyses. The NRC staff notes that this increase in CDF is consistent for approximately 80 percent of plants for which both values are available in the analysis completed and detailed in Table E.3-10 of the draft 2023 LR GEIS (NRC 2022-TN7857) (NRC 2023c).

The Oconee Station Level 3 PRA population dose risk calculated during initial license renewal included the contribution from severe accidents due to internally initiated events, which also generally included events initiated by internal flooding. Accounting for externally initiated events by using the best available information at the time, the Oconee Station external events multiplier was calculated explicitly based on the Individual Plant Examination – External Events (IPEEE). The use of external events multipliers was later included in the methodology provided in Nuclear Energy Institute (NEI) 05-01 (NEI 2005-TN1978), which was endorsed by the NRC staff (2013-TN4791). The external events multiplier is the ratio of the total plant core damage frequency (CDF) (both internally initiated and externally initiated) to the CDF for internally initiated events. This ratio then is multiplied by the estimated population dose risk for internally initiated events to develop the estimate of the total plant population dose risk that was used in the Oconee Station 1998 Level 3 PRA analysis. The external event multiplier for the Oconee Station was calculated to be 3.4 during initial license renewal. The NRC staff found that considering the substantial Oconee Station population dose risk reduction from the predicted 95 percent UCB population dose value from the 1996 LR GEIS population dose risk (reduction in population dose risk by a factor of 266), higher external event multipliers using the more recent higher Oconee Station external event PRA values would not change the conclusions in the 1996 LR GEIS. Thus, given the significant margin between the cumulative population dose risk results from the Oconee Station license renewal SAMA analyses and the cumulative 95th percentile UCB population dose risk results from the 1996 LR GEIS (factor of 266), the Oconee SLR ER FCDFs do not challenge the 95th percentile estimates used in the 1996 LR GEIS.

In February 2002, after the September 11, 2001, terrorist attacks, the NRC issued Order EA-02-026, “Order for Interim Safeguards and Security Compensatory Measures,” (NRC 2002-TN7864), which modified current operating licenses for commercial power reactor facilities to require compliance with specified interim safeguards and security compensatory measures. The Order required licensees to adopt mitigation strategies using readily available resources to maintain or restore core cooling, containment, and Spent Fuel Pool cooling capabilities to cope with the loss of large areas of the facility due to large fires and explosions from any cause, including from both design-basis and beyond-design-basis events. By August 2007, all operating power reactor licensees had implemented the guidance via commitments and in new conditions of their operating licenses. By December 2008, the NRC staff had completed licensing reviews and onsite inspections to verify implementation of the licensee actions as documented by NRC staff in “Chronological History: The Evolution of Mitigating Measures For Large Fire and Explosions” (NRC 2010-TN7760).

Additionally, licensees (including Duke Energy for Oconee Station) have submitted license amendment requests to transition the plant-specific fire protection programs from 10 CFR 50.48(a) and (b) to 10 CFR 50.48(c) (TN249), NFPA 805, “Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants”, 2001 Edition (NFPA 2022-TN7849). In addition to developing FPRAs that were necessary to support this transition, which are all represented in the mean and median values in Table F-7 (NRC 2022-TN7857), many of these licensees committed to making plant modifications to reduce the risk of fires. For Oconee Station, impacts of plant changes that are included in the plant risk models are reflected in the model results (Duke Energy 2021-TN8897).

Given the significant margin between the cumulative population dose risk results from the license renewal SAMA analyses and the cumulative 95th percentile UCB population dose risk results (factor of 266) from the 1996 LR GEIS, the reevaluated Oconee Station FCDF does not challenge the 95th percentile estimates used in the 1996 LR GEIS. Furthermore, plant modifications have been made to reduce fire risk and to cope with the loss of large areas of the plant due to large fires and explosions at Oconee Station. Thus, the NRC staff concludes that the new information from the Oconee Station FPRAs is not significant for the purposes of the probability-weighted consequences to the environment.

F.3.2.2 Seismic Events

In response to the March 11, 2011, Great Tohoku Earthquake and subsequent tsunami that initiated severe reactor accidents at three units of the Fukushima nuclear power plant that resulted in major fuel melting, the NRC issued information requests under 10 CFR 50.54(f) (NRC 2012-TN7762). With respect to seismic design, licensees were requested to reevaluate the seismic hazards at their sites relative to present-day NRC requirements and guidance (NRC 2012-TN7762).

As further background, prior to the Fukushima accident, the results of NRC staff analyses had determined that the probability of exceeding the safe shutdown earthquake at some currently operating sites in the Central and Eastern United States is higher than previously understood and that, therefore, further study was warranted. As a result, NRC staff concluded that the issue of increased seismic hazard estimates in the Central and Eastern United States should be examined under the NRC’s Generic Issues Program. Generic Issue (GI)-199 was established on June 9, 2005 (NRC 2005-TN7786). The initial screening analysis for GI-199 suggested that estimates of the seismic hazard for some currently operating plants in the Central and Eastern United States have increased. The NRC staff completed the initial screening analysis of GI-199 and concluded that GI-199 should proceed to the safety/risk assessment stage of the Generic Issues Program. For the GI-199 safety/risk assessment, the NRC staff evaluated the potential risk significance of the updated seismic hazards on seismic core damage frequency (SCDF) estimates. The changes in the SCDF estimate in the safety/risk assessment for some plants lie in the range of 10×10^{-4} per year to 10×10^{-4} per year, which met the numerical risk criterion for an issue to continue to the regulatory assessment stage of the Generic Issues Program. After the Fukushima accident, resolution of GI-199 was subsumed into NTTF Recommendation 2.1.

To implement NTTF Recommendation 2.1, the NRC staff used the general process developed for GI-199. This process asked each licensee (including Duke Energy for Oconee Station) to provide information about the current hazard and potential risk posed by seismic events using a progressive screening approach. This screening approach is defined in EPRI Report 1025287 (EPRI 2012-TN7751), which is endorsed by the NRC staff (2013-TN7765). In the first phase of this screening approach, a seismic hazard reevaluation was performed for each nuclear power plant site, which included development of new plant-specific seismic hazard curves using up-to-date models representing seismic sources, ground motion equations, and site amplification. For screening purposes, a Ground Motion Response Spectrum was developed. This spectrum provides an estimate of the structural response of plant structures (i.e., the magnitude of building shaking or movement) to ground motion caused by plant-specific postulated earthquakes. The Ground Motion Response Spectrum estimate was then compared to the plant design-basis safe shutdown earthquake. If the amount by which the Ground Motion Response Spectrum exceeds the safe shutdown earthquake in the 1 to 10 hertz[3] frequency range of the response spectrum and/or peak spectral acceleration was considered significant by the NRC staff, then performance of a detailed seismic risk evaluation was necessary. Furthermore, if these considerations were determined to not be significant, additional consideration was given to a general estimate of the plant’s SCDF and on insights related to the conditional containment failure probability for the plant’s specific type of containment. If either of these considerations

[3] This response spectrum frequency range has the greatest potential effect on the performance of equipment and structures important to safety.

was considered significant by the NRC staff, then performance of a detailed seismic risk evaluation was necessary. Based on the licensee seismic hazard reevaluation submittals provided in response to NTTF Recommendation 2.1 that addressed each of these considerations, the NRC issued a final determination of which nuclear power plants were required to perform a full power seismic PRA (NRC 2015-TN7856).

On March 12, 2012, the NRC issued a request under 10 CFR 50.54(f), as part of implementing lessons learned from the accident at Fukushima, that, among other things, requested licensees to reevaluate the seismic hazards at their sites using present-day methodologies and guidance to develop a Ground Motion Response Spectrum (SNL 1982-TN7749). Duke Energy submitted its SPRA on December 21, 2018 (Duke Energy 2018-TN8992). The NRC staff reviewed Duke Energy's SPRA (NRC 2019-TN8994) and concluded the following:

> "Based on the staff's review of the Oconee submittal against the endorsed SPID guidance, the NRC staff concludes that the licensee responded appropriately to Enclosure 1, Item (8) of the 50.54(f) letter. Additionally, the staff's review concluded that the SPRA is of sufficient technical adequacy to support Phase 2 regulatory decision-making in accordance with the intent of the 50.54(f) letter. Based on the results and risk insights of the SPRA submittal, the NRC staff also concludes that no further response or regulatory actions associated with NTTF Recommendation 2.1 "Seismic" are required. The staff notes that this conclusion is dependent on the completion of the planned modifications, as described in the SPRA submittal."

A letter dated September 18, 2019, provides the regulatory commitments to specific actions which Oconee Station plans to implement (Duke Energy 2020-TN9001).

Table E.3-11 of the 2023 draft LR GEIS (NRC 2023) provides the updated plant-specific SCDFs obtained predominantly from these SPRAs. Each of the SPRAs reported in the table of the 2023 draft LR GEIS was independently peer reviewed in accordance with NRC guidance (see, for example, NRC 2020-TN7806). Probabilistic health consequences, such as population dose risk, are not available because this information was not requested in the response to NTTF Recommendation 2.1. Table E.3-11 of the 2023 draft LR GEIS also compares these updated SCDFs (including Oconee Station) to those used in the license renewal SAMA analyses where available. The results in Table E.3-11 show that the SCDF values are higher for the SPRAs (including Oconee Station) than in the corresponding license renewal SAMA analyses for about two-thirds of the plants for which both values are available (NRC 2023-TN9172).

The results in Table F-8 show that the Oconee Station SPRA SCDF value is higher (less than a factor of 2) than in the corresponding SAMA SCDF. This increase in CDF is consistent with the 2023 draft LR GEIS that a higher SCDF value was identified in about 80 percent of the plants for which both values are available (Table E.3-10). The Oconee Station SPRA SCDF was near double the mean of the other plants' SPRA SCDF but within the range of all plants (NRC 2022-TN7857). Given the significant margin between the cumulative population dose risk results from the Oconee Station SAMA and the cumulative 95th percentile UCB population dose risk results (factor of 266) from the 1996 LR GEIS, the reevaluated Oconee Station SCDF does not challenge the 95th percentile estimates used in the 1996 LR GEIS.

Based on its review of each of the SPRA reports submitted in response to the Fukushima NTTF Recommendation 2.1, the NRC staff determined in each case that no further response or regulatory actions, including the need for additional strategies to mitigate seismic events, were necessary with regard to seismic risk.

Table F-8 Seismic (Full Power) Core Damage Frequency Comparison

Nuclear Power Plant	SAMA SCDF[(a)]	SPRA SCDF[(b)]
Oconee Nuclear Station Units 1, 2, 3	3.9×10^{-5}/yr	5.7×10^{-5}/yr
Mean value	1.7×10^{-5}/yr	3.0×10^{-5}/yr
Median value	7.35×10^{-5}/yr	1.7×10^{-5}/yr

SAMA = severe accident mitigation alternative; SCDF = seismic core damage frequency; SPRA = seismic probabilistic risk assessment.
(a) Data were obtained from the applicable plant-specific supplement to NUREG-1437, unless otherwise noted.
(b) Data were obtained from the applicable licensee-submitted seismic PRA report and NRC staff evaluation, unless otherwise noted.
Source: NRC 2022-TN7857, unless otherwise noted.

The recent SOARCA studies (published 2012–2022) add to the NRC staff's updated understanding of the consequences that may result from seismic initiators. These studies provided no new analysis of quantifying CDFs but did analyze the conditional consequences. In other words, the studies modeled the consequences if a challenging seismic initiating event were to occur. SOARCA analyzed three operating U.S. nuclear plants: (1) Peach Bottom Atomic Power Station in Pennsylvania, (2) Surry Power Station in Virginia, and (3) Sequoyah Nuclear Power Plant in Tennessee. Peach Bottom is a General Electric-designed boiling water reactor with Mark I containment, Surry is a Westinghouse-designed PWR with large dry containment, and Sequoyah is a Westinghouse-designed PWR with ice condenser containment. For Peach Bottom, Surry, and Sequoyah, the team modeled loss of all alternating current electrical power or "station blackout" scenarios caused by earthquakes more severe than anticipated in the plant's design—in other words, beyond-design-basis earthquakes. The SOARCA reports present results of an earthquake and station blackout in terms of individual latent cancer fatality risk and early (or prompt) fatality risk. In summary, the mitigated scenarios show essentially zero risk of early fatalities from radiation exposure and result in very small risk of a long-term cancer fatality (NRC 2012-TN3092). As indicated in the SOARCA report:

> The individual early fatality risk from SOARCA scenarios is essentially zero. Individual LCF [latent cancer fatality] risk from the selected specific, important scenarios is thousands of times lower than the NRC Safety Goal and millions of times lower than the general cancer fatality risk in the United States from all causes, even assuming the LNT [linear no-threshold] dose-response model. Using a dose-response model that truncates annual doses below normal background levels (including medical exposures) results in a further reduction to the LCF [latent cancer fatality] risk (by a factor of 100 for smaller releases and a factor of 3 for larger releases). LCF [latent cancer fatality] risk calculations are generally dominated by long-term exposure to small annual doses (about 500 mrem per year) corresponding to evacuees returning to their homes after the accident and being exposed to residual radiation over a long period of time. (NRC 2012-TN3092)

The unmitigated scenarios from SOARCA result in essentially zero risk (1E-14) of early fatality for an individual. Although these unmitigated scenarios result in core damage and release of radioactive material to the environment, the release is often delayed, which allows the population to take protective actions (including evacuation and sheltering). Therefore, the public would not be exposed to concentrations of radioactive material in excess of NRC regulatory limits. This result holds even when uncertainties are considered—all three uncertainty analyses continued to show extremely low risk of early fatalities. For the unmitigated scenarios, the individual risk of a long-term cancer fatality is calculated to be very small, regardless of which distance interval (e.g., 0–10 mi, 0–20 mi, 0–50 mi) is considered. This result holds even when uncertainties are considered (NRC 2022-TN7922).

Even though the reevaluated Oconee Station SPRA SCDF for SLR is higher than the Oconee Station SPRA SCDF value during initial license renewal, this increase does not challenge the 95th percentile UCB for population dose estimates used in the 1996 LR GEIS. Given the significant margin between the cumulative population dose risk results from the Oconee Station Level 3 PRA analysis and the cumulative 95th percentile Oconee Station UCB population dose risk results (factor of 266) from the 1996 LR GEIS, the reevaluated Oconee Station SCDF does not challenge the 95th percentile estimates used in the 1996 LR GEIS. Thus, the NRC staff concludes that the new information from the Oconee Station SPRA is not significant for the purposes of the probability-weighted consequences to the environment.

F.3.3 New Source Term Information (Section E.3.3 of the 2013 LR GEIS)

The source term, as defined in 10 CFR 50.2, refers to the magnitude and mix of the radionuclides released from the fuel (expressed as fractions of the fission product inventory in the fuel), as well as their physical and chemical form, and the timing of their release following an accident. The 2013 LR GEIS concludes that, in most cases, more recent estimates give significantly lower release frequencies and release fractions than was assumed in the 1996 LR GEIS. Thus, the probability weighted consequences of radioactive materials released during severe accidents, used as the basis for the 1996 LR GEIS (i.e., the frequency-weighted release consequences), are higher than the environmental impacts using more recent source term information.

The predicted early and latent fatalities and dose estimates per reactor-year for Oconee Station are provided in Table 5.6 of the 1996 LR GEIS. The very conservatively predicted latent total fatalities/RY (95 percent UCB) were determined to be 1.00×10^{-1} in the 1996 LR GEIS. In the Oconee Station initial license renewal ER, the total CDF (a surrogate for the individual latent cancer fatality risk) was calculated to be 8.90×10^{-5} (over a factor of 1,000 improvement). Similarly, for consequences the very conservatively predicted population dose/RY (95 percent UCB) was determined to be 1311 person-rem/RY (95 percent UCB) in the 1996 LR GEIS. In the Oconee Station initial license renewal ER, Duke Energy calculated the population dose risk to be 5 person-rem/RY (a factor of 266 improvement).

Although not a physical change to Oconee Station or to the explicit Oconee Station PRA modeling, Volume 2 of NUREG-7110, SOARCA, was published in August 2013 (NRC 2013c). This analysis updated the NRC staff’s severe accident studies of the Surry Power Station (e.g., NUREG-1150, NRC 1990-TN525), incorporating state-of-the-art analyses to evaluate offsite risk. The conclusions of the SOARCA analysis were that the calculated risks of public health consequences from severe accidents modeled in SOARCA are “very small” and “[t]he unmitigated versions of the scenarios analyzed in SOARCA have lower risk of early fatalities than calculated in the 1982 Siting Study SST1 [siting source term] case.” SOARCA’s analyses show essentially zero risk of early fatalities. As stated in SOARCA, “[t]he actual risk of a prompt fatality (cf., Table 7-13), using current best-estimate practices for calculating source terms, is about five orders of magnitude lower than using the SST1 source term would imply (cf., Table 7-13 and Table 7-18).” Included in the SOARCA state-of-the-art analyses are evaluations of steam generator tube ruptures, demonstrating that their offsite consequences are less than previously modeled. The SOARCA analysis was not a complete analysis of all scenarios in the PRA, but it is sufficient to support the conclusion that the probability-weighted consequences from a severe accident would be very small. While Oconee Station is not an identical design as Surry, both are PWRs with large, dry containments, and the general conclusions of lower offsite consequences from the SOARCA apply to Oconee Station as well.

More recent source term information indicates that the timing from dominant severe accident sequences, as quantified in the state-of-the-art reactor consequence analysis (NRC 2012-TN3092), is much later than the analysis forming the basis of the 1996 LR GEIS. In most cases, the release frequencies and release fractions are significantly lower for the more recent estimate. Furthermore, while the SOARCAs were focused on the most risk-significant accident scenarios and did not evaluate all scenarios, the SOARCA offsite consequence calculations for the three sites evaluated are generally smaller than reported in earlier studies. Specifically, the SOARCA results show essentially zero early fatality risk for the three sites and show a very low individual risk of cancer fatalities for the populations close to the nuclear power plants (i.e., well below the NRC Safety Goal of two long-term cancer fatalities annually in a population of one million individuals) (NRC 2012-TN3092). Thus, the environmental impacts estimated using the more recent and realistic source term information are expected to be much lower than the impacts used as the basis for the 1996 LR GEIS (i.e., the frequency-weighted consequences).

For the reasons described above, more recent source term (timing and magnitude) at Oconee Station has significantly smaller effects than had been quantified in the 1996 LR GEIS and would be expected to be smaller than that calculated during the initial license renewal Oconee Station SAMA analysis in 1998. For the Oconee Station SAMA new and significant evaluation (described in ER Section 4.15.3 and evaluated in Section F.5 below), SAMAs were evaluated for impact on CDF and source term category group frequencies if they were implemented. None of the SAMAs evaluated in the Oconee Station ER were found to reduce source term category group frequency by at least 50 percent. Therefore, the offsite consequences of severe accidents initiated by the new source term during the SLR term would not exceed the impacts predicted in the LR GEIS. For these issues, the LR GEIS predicts that the offsite probability-weighted consequences of severe accidents would be SMALL for all nuclear power plants. The NRC staff identified no new and significant information regarding the source term during its review of Duke Energy's ER, through the SAMA audit, during the scoping process, or through the evaluation of other available information. Thus, the NRC staff concludes that no new and significant information exists for Oconee Station concerning the source term that would alter the conclusions reached in the 1996 or 2013 LR GEIS.

F.3.4 Power Uprate Information (Section E.3.4 of the 2013 LR GEIS)

Operating at a higher reactor power level results in a larger fission product radionuclide inventory in the core than if the reactor were operating at a lower power level. In the event of an accident, the larger radionuclide inventory in the core would result in a larger source term. If the accident is severe, the release of radioactive materials from this larger source term could result in higher doses to offsite populations.

LERF represents the frequency of event sequences that could result in early fatalities. The impact of a power uprate on early fatalities can be measured by considering the impact of the uprate on the LERF calculated value. To this end, Table E-14 of the 2013 LR GEIS presents the change in LERF calculated by each licensee that has been granted a power uprate of greater than 10 percent. Table E-14 shows that the increase in LERF ranges from a minimal impact to an increase of about 30 percent (with a mean of 10.5 percent). The 2013 LR GEIS, Section E.3.4.3, "Conclusion," determined that a power uprate will result in a small to (in some cases) moderate increase in the environmental impacts from a postulated accident. However, taken in combination with the other information presented in the 2013 LR GEIS, the increases would be bounded by the 95-percent UCB values in Table 5.10 and Table 5.11 of the 1996 LR GEIS. Combined with the other information presented in the 2013 LR GEIS, the NRC staff concluded that effects of such increases on risk and environmental impacts of severe accidents would be bounded by the 1996 LR GEIS, which used the 95 percent UCB values as the basis for estimating offsite consequences.

Duke Energy indicated that at the time of the Oconee Station SLR submittal, no power uprate has been implemented at Oconee Station. Therefore, there is no new information affecting the probability-weighted consequences related to power uprates.

Therefore, the NRC staff finds that the offsite consequences from the power uprate would not exceed the consequences predicted in the 1996 or 2013 LR GEIS. The NRC staff has identified no new and significant information regarding power uprates during its review of Duke Energy's ER, through the SAMA audit, during the scoping process, or through the evaluation of other available information. Thus, the staff concludes using plant-specific information that no new and significant information exists for Oconee Station concerning offsite probability-weighted consequences due to power uprates during the SLR term that would alter the conclusions reached in the 1996 or 2013 LR GEIS.

F.3.5 Higher Fuel Burnup Information (Section E.3.5 of the 2013 LR GEIS)

According to the 2013 LR GEIS, increased peak fuel burnup from 42 to 75 gigawatt days per metric ton uranium (GWd/MTU) for PWRs, and 60 to 75 GWd/MTU for boiling water reactors, results in small-to-moderate increases (up to 38 percent) in population dose in the event of a severe accident. However, taken in combination with the other information presented in the 2013 LR GEIS, the increases would be bounded by the 95-percent UCB values in Table 5.10 and Table 5.11 of the 1996 LR GEIS.

To allow for more efficient use of the fuel and longer operating cycles, there has been continued movement toward higher fuel burnup. The purpose of Section E.3.5 of the 2013 LR GEIS was to account for the effect of current and possible future increased fuel burnup on postulated accidents. Future peak burnups considered were 62 GWd/MTU for PWRs and 70 GWd/MTU for boiling water reactors.

In the ER, Duke Energy indicated that the average burnup level of the peak rod is not planned to exceed 62 GWd/MTU during the proposed SLR operating term. Therefore, the offsite consequences from higher fuel burnup would not exceed the consequences predicted in the 2013 LR GEIS. For these issues, the 2013 LR GEIS predicted that the probability-weighted consequences would be small for all nuclear power plants. The NRC staff identified no new and significant information regarding higher fuel burnup during its review of Duke Energy's ER, through the SAMA audit, during the scoping process, or through the evaluation of other available information. Thus, the NRC staff concludes that no new and significant information exists for Oconee Station concerning offsite consequences due to higher fuel burnup that would alter the conclusions reached in the 2013 LR GEIS. Thus, the staff concludes, using plant-specific information, that no new and significant information exists for Oconee Station concerning offsite probability-weighted consequences due to higher fuel burnup that would alter the conclusions reached in the 1996 or 2013 LR GEIS.

F.3.6 Low Power and Reactor Shutdown Event Information (Section E.3.6 of the 2013 LR GEIS)

The 2013 LR GEIS states the environmental impacts from accidents at low power and shutdown conditions are generally comparable to those from accidents at full power when comparing the values in NUREG/CR-6143, *Evaluation of Potential Severe Accidents During Low Power and Shutdown Operations at Grand Gulf, Unit 1* (NRC 1995-TN8976), and NUREG/CR-6144, *Evaluation of Potential Severe Accidents During Low Power and Shutdown Operations at Surry, Unit 1* (BNL 1995-TN7776), with the values in NUREG-1150, *Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants* (NRC 1990-TN525). The 2013 LR GEIS further indicates that although the impacts for low power and shutdown conditions could be somewhat greater than for full power (for certain metrics), the 1996 LR GEIS's very conservative estimates of the environmental impact of severe accidents (using 95th percentile UCBs) bound the potential impacts from accidents at low power and shutdown with margin.

In NUREG-1150 and NUREG/CR-6144, Surry was evaluated for low power and reactor shutdown event information, but Oconee Station is a similarly designed nuclear power plant (i.e., they are Westinghouse PWRs with large containments); thus, the NRC staff concludes that there are likely to be no significant nuclear power plant configurations in low power and shutdown conditions likely to distinguish Oconee Station from the evaluated nuclear power plants. Thus, the staff assumed that the environmental impact of Oconee Station from accidents at low power and shutdown conditions are generally comparable to those from accidents at full power, which is consistent with the assumptions made in the 2013 and 1996 LR GEISs.

Additionally, as discussed in SECY-97-168, "Issuance for Public Comment of Proposed Rulemaking Package for Shutdown and Fuel Storage Pool Operation" (NRC 1997-TN7621), industry initiatives taken during the early 1990s also have contributed to the improved safety of low power and shutdown operations for all nuclear power plants. Promulgation of 10 CFR 50.65(a)(4) to require licensees to assess and manage the increase in risk that may result from the proposed maintenance activities, and industry's implementation of NUMARC 93-01 "Industry Guideline for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants" (NRC endorsed in RG 1.160) have further enhanced the NRC staff's ability to oversee licensee activities related to shutdown risk. The NRC staff concludes that the information from an Oconee Station low power and shutdown PRA is not significant for the purpose of the determination of this environmental impact, that low power and shutdown risk is effectively managed by NRC required maintenance rule programs, and that, therefore, low power and shutdown risk is not expected to challenge the 1996 LR GEIS 95 percent UCB risk metrics during the SLR time period.

Therefore, the offsite probability-weighted consequences of severe accidents, considering low power and reactor shutdown events, are consistent with the conclusions in the 1996 and 2013 LR GEISs. For these issues, the 1996 and 2013 LR GEISs predict that the probability-weighted consequences of severe accidents would be SMALL for all nuclear power plants. The NRC staff identified no new and significant information regarding low power and reactor shutdown events during its review of the Duke Energy ER, through the NRC staff's SAMA audit, during the scoping process, or through the evaluation of other available information. Thus, the staff concludes that no new and significant information exists for Oconee Station concerning low power and reactor shutdown events that would alter the conclusions reached in the 2013 LR GEIS or the 1996 LR GEIS.

F.3.7 Spent Fuel Pool Accident Information (Section E.3.7 of the 2013 LR GEIS)

The 2013 LR GEIS concludes that the environmental impacts from accidents involving spent fuel pools, as quantified in NUREG-1738, *Technical Study of Spent Fuel Pool Accident Risk at Decommissioning Nuclear Power Plants* (NRC 2001-TN5235), can be comparable to those from reactor accidents at full power (as estimated in NUREG-1150 (NRC 1990-TN525)). The 2013 LR GEIS further indicates that subsequent analyses performed, and mitigative measures employed since 2001, have further lowered the risk of accidents involving spent fuel pools. In addition, the LR GEIS notes that even the conservative estimates from NUREG-1738 (published in 2001) are much lower than the impacts from full power reactor accidents estimated in the 1996 LR GEIS. Therefore, the 2013 LR GEIS concludes, the environmental impacts stated in the 1996 LR GEIS bound the impact from spent fuel pool accidents for all nuclear power plants. For these issues, the LR GEIS predicts that the impacts would be SMALL for all nuclear power plants. There are no spent fuel configurations that would distinguish Oconee Station from the evaluated nuclear power plants such that the assumptions in the 2013 and 1996 LR GEISs would not apply. Consistent with NUREG-1738, the impacts of accidents in Spent Fuel Pools at Oconee Station is comparable to or lower than those from reactor accidents and are bounded by the 1996 LR GEIS.

In addition, two orders were issued by the NRC in March 2012, Mitigating Strategies (EA-12-049) and Spent Fuel Pool Instrumentation (EA-12-051). Duke Energy implemented both of these orders at Oconee Station in 2016 and 2017, respectively (NRC 2017-TN8996). Mitigation strategies implemented after September 11, 2001, and diverse and flexible coping strategies, provide additional resources to maintain Spent Fuel Pool water inventory and risk reduction.

The NRC staff identified no new and significant information regarding Spent Fuel Pool accidents during its review of Duke Energy's ER, through the SAMA audit, during the scoping process, or through the evaluation of other available information. Thus, the NRC staff concludes that no new and significant information exists for Oconee Station during the SLR term concerning the probability-weighted consequences of Spent Fuel Pool accidents that would alter the conclusions reached in the 1996 and 2013 LR GEISs.

F.3.8 Use of Biological Effects of Ionizing Radiation VII Risk Coefficients (Section E.3.8 of the 2013 LR GEIS)

In 2005, the NRC staff completed a review of the National Academy of Sciences report, "Health Risks from Exposure to Low Levels of Ionizing Radiation: BEIR VII" The NRC staff documented its findings in SECY-05-0202, "Staff Review of the National Academies Study of the Health Risks from Exposure to Low Levels of Ionizing Radiation (BEIR VII)" (NRC 2005-TN4513). The SECY paper states that the NRC staff agrees with the BEIR VII report's major conclusion—namely, the current scientific evidence is consistent with the hypothesis that there is a linear, no-threshold, dose-response relationship between exposure to ionizing radiation and the development of cancer in humans. The BEIR VII conclusion is consistent with the hypothesis on radiation exposure and human cancer that the NRC uses to develop its standards of radiological protection. Therefore, the NRC staff has determined that the conclusions of the BEIR VII report do not warrant any change in the NRC's radiation protection standards and regulations because the NRC's standards are adequately protective of public health and safety and will continue to apply during Oconee Station's SLR term. This general topic is discussed further in the NRC's 2007 denial of Petition for Rulemaking (PRM)-51-11 (72 FR 71083-TN7789), in which the NRC stated that it finds no need to modify the 1996 LR GEIS considering the BEIR VII report. For these issues, the LR GEIS predicts that the impacts of using the BEIR VII risk coefficients would be SMALL for all nuclear power plants.

The NRC staff identified no new and significant information regarding the risk coefficient used in the BEIR VII report during its review of Duke Energy's ER, through the SAMA audit, during the scoping process, or through the evaluation of other available information. Thus, the staff concludes that no new and significant information exists for Oconee Station concerning the biological effects of ionizing radiation that would alter the conclusions reached in the 1996 or 2013 LR GEIS.

F.3.9 Uncertainties (Section E.3.9 of the 2013 LR GEIS)

Section 5.3.3 in the 1996 LR GEIS provides a discussion of the uncertainties associated with the analysis in the LR GEIS and in the individual nuclear power plant EISs used to estimate the environmental impacts of severe accidents. The 1996 LR GEIS used 95th percentile UCB estimates when available for its estimates of the environmental impacts of severe accidents. This approach provides conservatism to cover uncertainties, as described in Section 5.3.3.2.2 of the 1996 LR GEIS. Many of these same uncertainties also apply to the analysis used in the 2013 LR GEIS update. As discussed in Sections E.3.1 through E.3.8 of the 2013 LR GEIS, the LR GEIS update used more recent information to supplement the estimate of environmental impacts contained in the 1996 LR GEIS. In effect, the assessments contained in Sections E.3.1 through E.3.8 of the 2013 LR GEIS provided additional information and insights into certain areas of uncertainty associated with the 1996 LR GEIS. However, as provided in the 2013 LR GEIS, the impact and magnitude of uncertainties, as estimated in the 1996 LR GEIS, bound the uncertainties introduced by the new information and considerations addressed in the 2013 LR GEIS. Accordingly, in the 2013 LR GEIS, the NRC staff concluded that the reduction in environmental impacts resulting from the use of new information (because the 1996 GEIS analysis) outweighs any increases in impact resulting from the new information. As a result, the findings in the 1996 LR GEIS remained valid. The NRC staff identified no new and significant information regarding uncertainties during its review of Duke Energy's ER, the SAMA audit, the scoping process, or the evaluation of other available information. Accordingly, the NRC staff concludes that no new and significant information exists for Oconee Station concerning uncertainties that would alter the conclusions reached in the 2013 or 1996 LR GEIS.

F.4 Sensitivity Regarding Population

A sensitivity analysis is performed to determine the influence of the factor on the probability-weighted consequences. Section E.3.9.2 of Appendix E to the 2013 LR GEIS provides a sensitivity analysis regarding the impact of population increases on offsite dose and economic consequences. In Section E.3.9.2, the 2013 LR GEIS states the following:

> The 1996 GEIS estimated impacts at the mid-year of each plant's license renewal period (i.e., 2030 to 2050). To adjust the impacts estimated in the NUREGs and NUREG/CRs to the mid-year of the assessed plant's license renewal period, the information (i.e., exposure indexes [EIs]) in the 1996 GEIS can be used. The Els adjust a plant's airborne and economic impacts from the year 2001 to its mid-year license renewal period based on population increases. These adjustments result in anywhere from a 5 to a 30 percent increase in impacts, depending upon the plant being assessed. Given the range of uncertainty in these types of analyses, a 5 to 30 percent change is not considered significant. Therefore, the effect of increased population around the plant does not generally result in significant increases in impacts.

In the SLR ER, Duke Energy extrapolated the population within the 50-mile radius to the year 2054. Duke Energy projected the total population for the year 2054 to be 3,454,092. Based on 2010–2054 population projections, an annual growth rate of approximately 0.92 percent is anticipated for the combined permanent population in the 29 counties entirely or partially within a 50-mile radius of Oconee Station. A 20-year population increase based on this annual growth rate is approximately 19 percent, which is within the 1996 and 2013 LR GEIS range of 5 to 30 percent change which the LR GEIS concludes does not generally result in significant increases in impacts.

As can be seen from the data in Tables 5.10 and 5.11 of the 1996 LR GEIS, the estimated risk of early and latent fatalities from individual postulated nuclear power plant accidents is SMALL, using very conservative 95th-percentile, UCB estimates for environmental impact. Furthermore, as discussed in Section E.3.3 of the 2013 LR GEIS and in Section F.3.3 of this EIS, more recent estimates give significantly lower release frequencies and release fractions for the source term than was assumed in the 1996 LR GEIS. The Oconee Station-specific analyses performed in the initial Oconee Station LR ER estimated the total population dose within the 50-mile boundary to be only 5 person-rem per reactor-year. The 2013 LR GEIS states that "a comparison of population dose from newer assessments illustrates a reduction in impact by a factor of 5 to 100 when compared to older assessments, and an additional factor of 2 to 4 due to the conservatism built into the 1996 LR GEIS values." Similarly, for Oconee Station consequences, the very conservatively predicted population dose per reactor-year (95 percent UCB) was determined to be 1311 person-rem per reactor-year (95 percent UCB) in the 1996 LR GEIS. In the Oconee Station initial license renewal ER, the population dose was calculated to be only 5 person-rem per reactor-year. The effect of this reduction in total dose impact (over three orders of magnitude improvement) far exceeds the effect of a population increase. The NRC staff concludes that the overall effect of projected increased population around Oconee Station during the SLR period of extended operation does not result in significant increases in impacts. Thus, the staff concludes, using plant-specific information, that no new and significant information exists for Oconee Station concerning population increases that would alter the conclusions reached in the 1996 or 2013 LR GEIS.

F.4.1 Additional Sensitivity as it Relates to Population Dose Risk and the Jocassee Dam SAMA

On February 3, 2023, the staff received a comment regarding Federal Register Notice: 87 FR 77643 [TN8903] (NRC 2024-TN9478). One of the comments stated that:

> "…the likelihood of a core melt accident caused by a random failure of the Jocassee Dam, which lies twelve miles above Oconee [Station], is 2E-4 per year which is 30 times higher than presented in Duke's Environmental Report. [See "Technical Basis for Allowing Oconee to Remain in Operation through November 2010," August 12, 2009 (NRC 2009-TN9173)]. This new and significant information demonstrates that Duke [Energy] erred by concluding that operation of Oconee [Station] for an additional license term will have no significant environmental impacts." (NRC 2024-TN9478)

The scoping comment further requested that:

> "…if the NRC revises its accident risk analysis to take into account all current and relevant information, the estimated risk of an accident will substantially increase, thereby changing the cost-benefit analysis for mitigation measures to make mitigation more cost-effective. In light of this new information, the EIS should address the cost-effectiveness of mitigation measures for reduction of accident risk. For instance, the EIS should address the costs and benefits of safety upgrades..." (NRC 2024-TN9478)

The following sensitivity is performed by NRC staff to address this scoping comment. This sensitivity also addresses issues of uncertainty in the Oconee Station and staff analysis.

The Oconee Station SAMA evaluated a SAMA potential improvement to increase the height of the Safe Shutdown Facility flood barrier to address the PRA sequence relating to a random failure of Jocassee Dam exceeding the 5 ft (1.5 m) Safe Shutdown Facility (SSF) flood barrier. The contribution of this sequence to the annual total population dose risk is 0.08 person-rem per reactor-year. The population dose risk calculated in the Oconee Station Level 3 PRA analysis considers many more PRA sequences than the single sequence relating to the Jocassee Dam. Thus, increasing the annual total population dose risk by 30 is conservative and considers multiple sequences and Oconee Station-specific PRAs being in error. With this conservative sensitivity multiplier of 30, the total population dose risk calculated would only increase by 2.4 (0.08 × 30). The Oconee Station SAMA total population dose risk was calculated to be 5 in the 1998 Oconee Station SAMA, and this conservative sensitivity would only bring the Oconee Station total population dose risk to approximately 7.4; thus, there is substantial margin to the 1996 Oconee predicted value for the total population dose risk of 1,311. A similar calculation was performed by the NRC staff for all of the 1998 SAMAs and all had substantial margin to the 1996 GEIS predicted values. This sensitivity also bounds other questions of increases in individual Oconee Station hazard CDFs mentioned earlier.

Regarding cost and SAMA benefit (worth) of a potential improvement, the 1998 worth of the averted risk of the increase in height of the Jocassee dam is only $1,800 dollars. Eighteen hundred dollars multiplied by 30 brings the 1998 Averted Risk value up to $54,000. The 1998 cost of increasing the height of the SSF flood barrier is $500,000. Thus, the staff continues to find that the SAMA to increase the height of the SSF flood level is not cost effective. Table F-9 summarizes the results of the NRC staff's sensitivity and analysis.

The staff concludes that the overall effect of an increase by 30 times of the total population dose risk during the SLR period of extended operation does not result in significant environmental impacts. Thus, the staff concludes that no new and significant information exists for Oconee Station concerning uncertainty that would alter the conclusions reached in the 1996 or 2013 LR GEIS.

Table F-9 Sensitivity Regarding Jocassee Dam Failure Sequence

SAMA Analysis	Sequence	Potential Improvement	Annual Total PDR	1998 Worth of Averted Risk	1998 Cost of Alternative
Original	Random failure of Jocassee Dam exceeds 5 ft (1.5 m) SSF flood barrier	Increase the height of the SSF flood barrier	0.08	1,800	500,000
Original with Sensitivity: 30 times increase in total PDR and worth of averted risk	-	-	2.4	54,000	500,000

PDR = population dose risk; SSF = Safe Shutdown Facility.
No table entry has been denoted by "-"

F.4.2 Summary and Conclusion (Section E.5 of the 2013 LR GEIS)

The 2013 LR GEIS categorizes "sources of new information" by their potential effect on the best-estimate environmental impacts associated with postulated severe accidents. These effects can: (1) decrease the environmental impact associated with severe accidents; (2) not affect the environmental impact associated with severe accidents; or (3) increase the environmental impact associated with severe accidents.

New information regarding Oconee Station was evaluated in the above sections. No new and significant information regarding Oconee Station was identified that was above the values previously evaluated in the 1996 LR GEIS. Thus, there was no new and significant information that would significantly increase the environmental impact associated with severe accidents. The reduction in risk due to a better understanding of the Oconee Station source term alone provided a substantial decrease in the calculated environmental impact (consequences) by several orders of magnitude than was calculated in the 1996 LR GEIS. Given the new and updated information, the reduction in estimated environmental impacts from the use of new internal event and source term information outweighs any increases from the consideration of external events, future power uprates, higher fuel burnup, low power and shutdown risk, and Spent Fuel Pool risk. Therefore, the NRC staff finds that the probability-weighted consequences of atmospheric releases, fallout onto open bodies of water, releases to groundwater, and societal and economic impacts from severe accidents are SMALL.

The Commission considers ways to mitigate severe accidents at a given site more than just in the one-time SAMA analysis associated with a license renewal application. Other areas of new information relating to the Oconee Station severe accident risk, severe accident environmental impact assessment, and cost-beneficial SAMAs are described below. These areas of new information demonstrate additional conservatism in the evaluations in the LR GEIS and Duke Energy's ER, because they result in further reductions in the impact of a severe accident.

F.5 Other New Information Related to NRC Efforts to Reduce Severe Accident Risk Following Publication of the 1996 LR GEIS

The Commission has considered and adopted various regulatory requirements for mitigating severe accident risks at reactor sites through a variety of NRC programs. For example, in 1996, when it promulgated Table B-1, "Summary of Findings on NEPA Issues for License Renewal of Nuclear Power Plants," in Appendix B to Subpart A of 10 CFR Part 51 (TN250), "Environmental Effect of Renewing the Operating License of a Nuclear Power Plant," the Commission explained in a *Federal Register* notice:

> The Commission has considered containment improvements for all plants pursuant to its Containment Performance Improvement program…and the Commission has additional ongoing regulatory programs whereby licensees search for individual plant vulnerabilities to severe accidents and consider cost-beneficial improvements (Final rule, "Environmental Review for Renewal of Nuclear Power Plant Operating Licenses," 61 FR 28467-TN4491 (June 5, 1996)).

These "additional ongoing regulatory programs" that the Commission mentioned include the Individual Plant Examination (IPE) and the IPEEE program, which consider "potential improvements to reduce the frequency or consequences of severe accidents on a nuclear power plant-specific basis and essentially constitute a broad search for severe accident mitigation alternatives." Further, in the same rule, the Commission observed that the IPEs "resulted in a number of plant procedural or programmatic improvements and some plant modifications that will further reduce the risk of severe accidents" (61 FR 28481-TN8474) (*Federal Register* notices are accessible and searchable at https://www.federalregister.gov). Based on these and other considerations, the Commission stated its belief that it is "unlikely that any site-specific consideration of SAMAs for license renewal will identify major plant design changes or modifications that will prove to be cost-beneficial for reducing severe accident frequency or consequences." The Commission noted that it may review and possibly reclassify the issue of severe accident mitigation as a Category 1 issue upon the conclusion of its IPE/IPEEE program but deemed it appropriate to consider SAMAs for nuclear power plants for which it had not done so previously, pending further rulemaking on this issue.

The Commission reaffirmed its SAMA-related conclusions in Table B-1 of Appendix B to Subpart A of 10 CFR Part 51-TN250) and 10 CFR 51.53(c)(3)(ii)(L), "Postconstruction environmental reports," in *Exelon Generation Co., LLC* (Limerick Generating Station, Units 1 and 2), CLI-13-07, (October 31, 2013). In addition, the Commission observed that it had promulgated those regulations because it had "determined that one SAMA analysis would uncover most cost-beneficial measures to mitigate both the risk and the effects of severe accidents, thus satisfying our obligations under NEPA" (NRC 2013-TN7766).

The NRC has continued to address severe accident-related issues since the agency published the LR GEIS in 1996. Combined NRC and licensee efforts have reduced risks from accidents beyond those accidents that were considered in the 1996 LR GEIS. The 2013 LR GEIS describes many of those efforts (NRC 2013-TN2654).

The NRC staff describes several efforts to reduce severe accident risk (i.e., CDF and LERF) following publication of the 1996 LR GEIS, in the following sections. Each of these initiatives applies to all reactors, including Oconee Station. These are areas of new information that reinforce the conclusion that the probability-weighted consequences of severe accidents are SMALL for all nuclear power plants, as stated in the 2013 LR GEIS, and further reduce the likelihood of finding a cost-beneficial SAMA that would substantially reduce the severe accident risk at Oconee Station during the SLR term.

F.5.1 Requirements Regarding Loss of Large Areas of the Nuclear Power Plant Caused by Fire or Explosions

As discussed on page E-7 of the 2013 LR GEIS, following the terrorist attacks of September 11, 2001, the NRC conducted a comprehensive review of the agency's security program and made further enhancements to security at a wide range of NRC-regulated facilities. These enhancements included significant reinforcement of the defense capabilities for nuclear facilities, better control of sensitive information, enhancements in emergency preparedness, and implementation of mitigating strategies to deal with postulated events potentially causing loss of large areas of the nuclear power plant due to explosions or fires, including those that an aircraft impact might create.

For example, the Commission issued Order EA-02-026, "Order for Interim Safeguards and Security Compensatory Measures" (NRC 2002-TN7825) to provide interim safeguards and security compensatory measures, which ultimately led to the promulgation of a new regulation in 10 CFR Part 50.54(hh) (TN249). This regulation requires commercial power reactor licensees to prepare for a loss of large areas of the facility due to large fires and explosions from any cause, including beyond-design-basis aircraft impacts. The regulation in 10 CFR 50.54(hh)(2) provided that licensees must adopt guidance and strategies to maintain or restore core cooling, containment, and Spent Fuel Pool cooling capabilities under circumstances associated with the loss of large areas of the nuclear power plant due to explosion or fire (NRC 2013-TN2654). The requirements formerly in 10 CFR 50.54(hh)(2) have been moved to 10 CFR 50.155, "Mitigation of beyond-design-basis events".

The NRC requirements pertaining to nuclear power plant security are subject to NRC oversight on an ongoing basis under a nuclear power plant's current operating license and are beyond the scope of license renewal. As discussed in Section 5.3.3.1 of the 1996 LR GEIS, the NRC addresses security-related events using deterministic criteria in 10 CFR Part 73, "Physical Protection of Plants and Materials," rather than by risk assessments or SAMAs (TN423).

Accordingly, actions taken by Duke Energy to comply with those regulatory requirements have further contributed to the mitigation of severe accidents at Oconee Station.

In sum, the new information regarding actions that Duke Energy has taken as a result of regulatory actions to prepare for potential loss of large areas of the nuclear power plant due to fire or explosions has further contributed to the mitigation of severe accidents at Oconee Station. Thus, this information does not alter the conclusions reached in the 2013 LR GEIS regarding the probability-weighted consequences of severe accidents for Oconee Station SLR.

F.5.2 State-of-the-Art Reactor Consequence Analysis

The NRC has completed a SOARCA study for Surry. Surry, like Oconee Station, is a PWR with large dry containment. (NRC 2013-TN4593). The Surry SOARCA analyses indicate that successful implementation of existing mitigation measures can prevent reactor core damage or delay or reduce offsite releases of radioactive material. All SOARCA scenarios, even when unmitigated, progress more slowly and release much less radioactive material than the potential releases cited in the 1982 Siting Study, NUREG/CR-2239, *Technical Guidance for Siting Criteria Development* (SNL 1982-TN7749). As a result, the calculated risks of public health consequences of severe accidents modeled in SOARCA are very small.

This new independent information regarding the SOARCA project's findings supports the staff's findings that the probability-weighted consequences of a severe accident for Oconee Station SLR is SMALL.

F.5.3 Fukushima-Related Activities

As discussed in Section E.2.1 of the 2013 LR GEIS, on March 11, 2011, a massive earthquake off the east coast of the main island of Honshu, Japan, produced a tsunami that struck the coastal town of Okuma in Fukushima Prefecture. The resulting flooding damaged the six-unit Fukushima nuclear power plant, causing the failure of safety systems needed to maintain cooling water flow to the reactors. Because of the loss of cooling, the fuel overheated, and there was a partial meltdown of fuel in three of the reactors. Damage to the systems and structures containing reactor fuel resulted in the release of radioactive material to the surrounding environment (NRC 2013-TN2654).

Additional discussion specific to Duke Energy's response to earthquakes, including Duke Energy's performance of a seismic PRA at Oconee Station, is available above in Section F.3.2 and Section 3.4.4 of this EIS.

In summary, the Commission has imposed additional safety requirements on operating reactors, including Oconee Station, following the Fukushima accident. The new regulatory actions contributed to mitigations of severe accident risk at Oconee Station. These regulatory actions with resulting mitigations further support the NRC staff determination above that the probability weighted consequences of a severe accident are SMALL at Oconee Station during the SLR term. The NRC staff further concludes that there is no new and significant information related to the regulatory actions described above that would alter the conclusions reached in the 2013 LR GEIS or Duke Energy's previous SAMA analysis for Oconee Station during the SLR term.

F.5.4 Probability-Weighted Consequences Conclusion

In sum, the new information related to NRC efforts to reduce severe accident risk described above contribute to safety, as do safety improvements not related to license renewal, including the NRC and industry response to generic safety issues (NRC 2011-TN7816). Thus, the performance and safety record of nuclear power plants operating in the United States, including Oconee Station, would continue to be maintained in the SLR period. (NRC 2013-TN2654).

As discussed above, the NRC and the nuclear industry have addressed and continue to address numerous severe accident-related issues since publication of the 1996 LR GEIS and the 1998 Oconee Station SAMA analysis. These actions reinforce the conclusion that the probability-weighted consequences of atmospheric releases, fallout onto open bodies of water, releases to groundwater, and societal and economic impacts from severe accidents are SMALL for all nuclear power plants, as stated in the 2013 LR GEIS, and further reduce the likelihood of finding a cost-beneficial SAMA that would substantially reduce the severe accident risk at Oconee Station during the SLR term.

F.6 Evaluation of New and Significant Information Pertaining to SAMAs Using NEI 17-04, "Model SLR New and Significant Assessment Approach for SAMA"

In its assessment of new and significant information related to SAMAs in its Oconee Station SLR application, Duke Energy used the Nuclear Energy Institute (NEI) guidance document, NEI 17-04, Revision 1, "Model SLR [Subsequent License Renewal] New and Significant Assessment Approach for SAMA" (NEI 2019-TN6815). On December 11, 2019, the NRC staff endorsed NEI 17-04, Revision 1, for use by license renewal applicants (NRC 2019-TN7805). The NEI developed a model approach for license renewal applicants to use in assessing the significance of new information, of which the applicant is aware, that relates to a prior SAMA analysis that was performed in support of the issuance of an initial license, renewed license, or combined license. NEI 17-04 provides a tiered approach that entails a three-stage screening process for the evaluation of new information.

In its evaluation of the significance of new information, the NRC staff considers that new information is significant if it provides a seriously different picture of the impacts of the Federal action under consideration. Thus, for mitigation alternatives such as SAMAs, new information is significant if it indicates that a mitigation alternative would substantially reduce an impact of the Federal action on the environment. Consequently, with respect to SAMAs, new information may be significant if it indicates a given potentially cost-beneficial SAMA would substantially reduce the impacts of a severe accident or the probability or risk of a severe accident occurring (NRC 2013-TN2654).

In general, the NEI 17-04 methodology (NEI 2017-TN8338) does not consider a potential SAMA to be significant unless it reduces by at least 50 percent the maximum benefit as defined in Section 4.5, "Total Cost of Severe Accident Risk/Maximum Benefit," of NEI 05-01, Revision A, "Severe Accident Mitigation Alternatives (SAMA) Analysis Guidance Document." NEI 05-01 is endorsed in NRC Regulatory Guide 4.2, Supplement 1 (NRC 2013-TN2654).

NEI 17-04, "Model SLR New and Significant Assessment Approach for SAMA," describes a three-stage process for determining whether there is any new and significant information relevant to a previous SAMA analysis.

- **Stage 1**: The SLR applicant uses PRA risk insights and/or risk model quantifications to estimate the percent reduction in the maximum benefit associated with (1) all unimplemented “Phase 2” SAMAs for the analyzed nuclear power plant and (2) those SAMAs identified as potentially cost beneficial for other U.S. nuclear power plants and that are applicable to the analyzed nuclear power plant. If one or more of those SAMAs are shown to reduce the maximum benefit by 50 percent or more, the applicant must complete Stage 2. Applicants that demonstrate through the Stage 1 screening process that there is no potentially significant new information are not required to perform the Stage 2 or Stage 3 assessments.
- **Stage 2**: The SLR applicant develops updated averted cost-risk estimates for implementing those SAMAs. If the Stage 2 assessment confirms that one or more SAMAs reduce the maximum benefit by 50 percent or more, then the applicant must complete Stage 3.
- **Stage 3**: The SLR applicant performs a cost-benefit analysis for the “potentially significant” SAMAs identified in Stage 2.

Upon completion of the Stage 1 screening process, Duke Energy determined that there is no potentially significant new information affecting the Oconee Station SAMA analysis; thus, it did not perform the Stage 2 or Stage 3 assessments. The following sections summarize Duke Energy’s application of the NEI 17-04 methodology to Oconee Station SAMAs.

F.6.1 Data Collection

NEI 17-04 Section 3.1, “Data Collection,” explains that the initial step of the assessment process is to identify the “new information” relevant to the SAMA analysis and to collect and develop those elements of information that will be used to support the assessment. The guidance document states that each applicant should collect, develop, and document the information elements corresponding to the stage or stages of the SAMA analysis performed for the site. For the Oconee Station SLR, the NRC staff reviewed the onsite information during an audit at NRC headquarters and concluded that Duke Energy considered appropriate information (NRC 2021-TN9716).

F.6.2 Stage 1 Assessment

Section E4.15.3, “Methodology for Evaluation of New and Significant SAMAs,” of Duke Energy’s SLR ER describes the process used to identify any potentially new and significant SAMAs from the 1998 SAMA analysis (Duke Energy 2021-TN8897). In Stage 1 of the process, Duke Energy used PRA risk insights and/or risk model quantifications to estimate the percent reduction in the maximum benefit associated with the following two types of SAMAs:

1. all unimplemented “Phase 2” SAMAs for Oconee Station
2. those SAMAs identified as potentially cost-beneficial for other U.S. nuclear power plants and that are applicable to Oconee Station (Duke Energy 2021-TN8897)

F.6.3 Duke Energy’s Evaluation of Unimplemented Oconee “Phase 2” SAMAs

In 1998, Duke Energy submitted an application for initial operating license renewal (NRC 1998-TN8991), which the NRC approved in 2000. Duke Energy re-examined its initial license renewal SAMA analysis and the Oconee Station PRA in the Oconee Station SLR ER. The purpose was to determine if there was any new and significant information regarding the SAMA analyses that were performed to support issuance of the initial renewed operating licenses for

Oconee Station. Duke Energy re-evaluated the 16 SAMAs that were considered “Phase 2” in connection with initial license renewal, using the NEI 17-04 process.

The list of SAMAs collected was evaluated qualitatively to screen any that are not applicable to Oconee Station or already exist at Oconee Station. The remaining SAMAs then were grouped (if similar) based on similarities in mitigation equipment or risk reduction benefits, and all were evaluated for the impact they have on the Oconee Station CDF and source-term category frequencies if implemented. In addition, Duke Energy applied two other screening criteria to eliminate SAMAs that have excessive cost. First, SAMAs were screened if they were found to reduce the Oconee Station maximum benefit by greater than 50 percent in the initial Oconee Station license renewal but also if they were found not to be cost effective because of high cost in the first license renewal. Second, SAMAs related to creating a containment vent were screened because this nuclear power plant modification has been evaluated industrywide and explicitly found to be ineffective in terms of cost in Westinghouse large/dry containments. If any of the SAMAs were found to reduce the total CDF or at least one consequential source term category frequency by at least 50 percent, then the SAMA was retained for a Stage 2 assessment (Level 3 PRA evaluation of the reduction in maximum benefit). As discussed below, all SAMAs were screened as not significant without the need to proceed to the Stage 2 assessment or Level 3 PRA evaluation.

F.6.4 Duke Energy’s Evaluation of SAMAs Identified as Potentially Cost-Beneficial at Other U.S. Nuclear Power Plants and Which Are Applicable to Oconee Station

Duke Energy reviewed the supplemental EISs of nuclear power plants with a similar design to Oconee Station (PWRs with large/dry containments), to identify 283 potentially cost-beneficial SAMAs from other nuclear power plants. This large list of industry SAMAs was qualitatively screened by Duke Energy using criteria that a potential SAMA is either not applicable to the Oconee Station design or the SAMA has already been implemented at Oconee Station. Duke Energy grouped the remaining SAMAs based on similarities in mitigation equipment or risk reduction benefits. Thus, Duke Energy evaluated 16 Oconee Station-specific SAMAs and 283 potentially cost-beneficial SAMAs identified at similarly designed nuclear power plants (industry SAMAs) for a total of 299 SAMAs.

Section E4.15.4 of Duke Energy’s SLR ER provides the Oconee Station evaluation using the methodology in NEI 17-04, “Model SLR New and Significant Assessment Approach for SAMA.” The industry SAMAs that were not qualitatively screened were then merged with the Oconee Station-specific SAMAs collected from initial license renewal, with similar SAMAs grouped for further analysis. The combined SAMA list was then quantitatively screened to determine if the CDF or any source term category frequency would be reduced at least 50 percent if the SAMA was implemented. Table E4.15-1 of the ER presents the 45 industry SAMAs that were not qualitatively screened out, combined with the 10 Oconee Station-specific SAMAs selected for further evaluation. Table E4.15-2 presents the quantitative screening results from the bounding SAMA evaluations. As seen in Table E4.15-2, none of the bounding quantitative screening evaluations resulted in a reduction of total CDF, total LERF, or total large release frequency greater than 50 percent. Because Duke Energy’s Stage 1 analysis demonstrated that none of the SAMAs considered for quantitative evaluation would reduce the Oconee Station maximum benefit by 50 percent or greater, Duke Energy concluded that no new and significant information relevant to the original SAMA analysis for Oconee Station exists, and no further analysis is needed.

The NRC staff reviewed Oconee Station’s plant-specific information and its SAMA Stage 1 process during an in-office audit at NRC headquarters (NRC 2020-TN8995). The staff found that Duke Energy had used a methodical and reasonable approach to identify any SAMAs that might reduce the maximum benefit by at least 50 percent and therefore could be considered potentially significant. Therefore, the NRC staff finds that Duke Energy properly concluded, in accordance with the NEI 17-04 guidance, that it did not need to conduct a Stage 2 assessment.

F.6.5 Other New Information

As discussed in Duke Energy's SLR application ER and in NEI 17-04, there are some inputs to the SAMA analysis that are expected to change or to potentially change for all nuclear power plants. Examples of these inputs are described below:

- updated Level 3 PRA model consequence results, which may be impacted by multiple inputs, including, but not limited to, the following:
  - population, as projected within a 50 mi (80 km) radius of the nuclear power plant
  - value of farm and nonfarm wealth
  - core inventory (e.g., due to power uprate)
  - evacuation timing and speed
  - Level 3 PRA methodology updates
  - cost-benefit methodology updates

In addition, other changes that could be considered new information may be dependent on nuclear power plant activities or site-specific changes. These types of changes (listed in NEI 17-04) include the following:

- identification of a new hazard (e.g., a fault that was not previously analyzed in the seismic analysis)
  - updated nuclear power plant risk model (e.g., a fire PRA that replaces the IPEEE analysis)
- impacts of nuclear power plant changes that are included in the nuclear power plant risk models will be reflected in the model results and do not need to be assessed separately
- nonmodeled modifications to the nuclear power plant
  - modifications determined to have no risk impact need not be included (e.g., replacement of the condenser vacuum pumps), unless they impact specific input to SAMA (e.g., new low-pressure turbine in the power conversion system that results in a greater net electrical output)

The NRC-endorsed NEI methodology described in NEI 17-04 (NRC 2019-TN7805) uses "maximum benefit" to determine if SAMA-related information is new and significant. Maximum benefit is defined in Section 4.5 of NEI 05-01, Revision A, "Severe Accident Mitigation Alternatives (SAMA) Analysis Guidance Document" (NEI 2005-TN1978), as the benefit a SAMA could achieve if it eliminated all risk. The total offsite dose and total economic impact are the baseline risk measures from which the maximum benefit is calculated. The methodology in NEI 17-04 considers a cost-beneficial SAMA to be potentially significant if it reduces the maximum benefit by at least 50 percent. The criterion of exceeding a 50 percent reduction in the maximum benefit correlates with significance determinations in the American Society of Mechanical Engineers and American Nuclear Society PRA standard (cited in RG 1.200) (ASME/ANS 2009-TN6220; NRC 2009-TN6211), NUMARC 93-01, "Industry Guideline for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants" (NRC endorsed in RG 1.160) (NEI 2018-TN7758; NRC 2018-TN7799) and NEI 00-04, "10 CFR 50.69 SSC

Categorization Guideline" (endorsed in RG 1.201) (NEI 2005-TN8340; NRC 2006-TN6279), which the NRC has cited or endorsed. It is also a reasonable quantification of the qualitative criteria that new information is significant if it presents a seriously different picture of the impacts of the Federal action under consideration, requiring a supplement (NUREG-0386, United States Nuclear Regulatory Commission Staff Practice and Procedure Digest: Commission, Appeal Board, and Licensing Board Decisions [NRC 2009-TN8377]). Furthermore, it is consistent with the criteria that the NRC staff accepted in the Limerick Generating Station license renewal final supplemental EIS (NRC 2014-TN7328). The NRC-endorsed approach in NEI 17-04 was used by Duke Energy for SAMAs to determine whether new information related to SAMAs could be significant (i.e., a potentially cost-beneficial SAMA could substantially reduce the probability or consequences (risk) of a severe accident occurring. The implication of this statement is that "significance" is not solely related to whether a SAMA is cost-beneficial (which may be affected by economic factors, increases in population, etc.), but it also depends on a SAMA's potential to significantly reduce risk to the public.

F.6.6 Conclusion

The NRC staff reviewed Duke Energy's new and significant information regarding severe accidents and SAMAs at Oconee Station during the SLR period and finds Duke Energy's analysis and methods to be reasonable. As described above, Duke Energy evaluated a total of 299 SAMAs for Oconee Station SLR and did not find any SAMAs that would reduce the maximum benefit by 50 percent or more. Based on its review of Duke Energy's evaluation, the NRC staff concludes that the methods and results used were reasonable. Based on Oconee Station's Stage 1 qualitative and quantitative screening results, Duke Energy demonstrated that none of the nuclear power plant-specific and industry SAMAs that it considered constitute new and significant information in that none changed the conclusion of Oconee Station's previous SAMA analysis. Further, the NRC staff did not otherwise identify any new and significant information that would alter the conclusions reached in the previous SAMA analysis for Oconee Station. Therefore, the NRC staff concludes that there is no new and significant information that would alter the conclusions of the SAMA analysis performed for Oconee Station's initial license renewal.

In addition, given the relatively low residual risk at Oconee Station, the decrease in internal-event CDF from the previous SAMA analysis, and the fact that no potentially cost-beneficial SAMAs were identified during Oconee Station's initial license renewal review, the NRC staff considers it unlikely that Duke Energy would have found any potentially cost-beneficial SAMAs for SLR. Further, Duke Energy's implementation of actions to satisfy the NRC's orders and regulatory requirements regarding beyond-design-basis events after the September 2001, terrorist attacks and the March 2011 Fukushima events, including Duke Energy's performance of a seismic PRA, as well as the conservative assumptions used in earlier severe accident studies and SAMA analyses, also make it unlikely that Duke Energy would have found any potentially significant cost-beneficial SAMAs during its SLR review. For all the reasons stated above, the NRC staff concludes that Duke Energy reached reasonable SAMA conclusions in its SLR ER and that there is no new and significant information regarding any potentially cost-beneficial SAMA that would substantially reduce the risks of a severe accident at Oconee Station.

F.7 <u>References</u>

Note: All NUREG reports listed in Appendix F are available electronically from the NRC's public website found at https://www.nrc.gov/reading-rm/doc-collections/nuregs/index.html. From this

site, the public can gain access to NRC's collection of technical reports by using the technical report numbers (e.g., NUREG-xxxx or NUREG/CR-xxxx).

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APPENDIX G

ENVIRONMENTAL ISSUES AND IMPACT FINDINGS CONTAINED IN THE PROPOSED RULE, 10 CFR PART 51, "ENVIRONMENTAL PROTECTION REGULATIONS FOR DOMESTIC LICENSING AND RELATED REGULATORY FUNCTIONS"

The U.S. Nuclear Regulatory Commission (NRC, the Commission) staff prepared this site-specific environmental impact statement (EIS) to evaluate the environmental impacts of subsequent license renewal (SLR) for Oconee Nuclear Station, Units 1, 2, and 3 (Oconee) by Duke Energy Carolinas, LLC (Duke Energy). The NRC staff prepared this site-specific EIS in accordance with the Commission's decisions in Commission Legal Issuance (CLI)- CLI-22-03 (TN8272), that references CLI-22-02 (TN8182), both dated February 24, 2022.

On March 3, 2023, the NRC published a draft rule (88 FR 13329-TN8601) proposing to amend its environmental protection regulations in Title 10 of the *Code of Federal Regulations* Part 51 (10 CFR Part 51) (TN250). Specifically, the proposed rule would update the NRC's 2013 findings concerning the environmental impacts of renewing the operating license of a nuclear power plant. The technical basis for the proposed rule would be provided by Revision 2 to NUREG–1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (the 2023 LR GEIS; NRC 2023-TN7802), which would update NUREG–1437, Revision 1 (the 2013 LR GEIS NRC 2013-TN2654), which, in turn, was an update of NUREG–1437, Revision 0 (the 1996 LR GEIS; NRC 1996-TN288). The 2023 LR GEIS (NRC 2023-TN7802) would support the proposed revised list of National Environmental Policy Act of 1969, as amended (NEPA), issues and associated environmental impact findings for license renewal to be contained in Table B-1 in Appendix B to Subpart A of 10 CFR Part 51 (TN250). The 2023 LR GEIS and proposed rule (NRC 2023-TN7802) reflect lessons learned and knowledge gained from the NRC's conducting of environmental reviews for initial license renewal and subsequent license renewal (SLR) since 2013.

The 2023 proposed rule would redefine the number and scope of the environmental issues that must be addressed by the NRC during license renewal environmental reviews. The proposed rule identifies 80 environmental impact issues, 20 of which would require plant-specific analysis. The proposed rule would reclassify some previously site-specific (Category 2) issues as generic (Category 1) issues and would consolidate other issues. It would also add new Category 1 and Category 2 issues to Table B-1. These proposed changes are summarized as follows.

- One Category 2 issue, "Groundwater quality degradation (cooling ponds at inland sites)," and a related Category 1 issue, "Groundwater quality degradation (cooling ponds in salt marshes)," would be consolidated into a single Category 2 issue, "Groundwater quality degradation (plants with cooling ponds)."

- Two related Category 1 issues, "Infrequently reported thermal impacts (all plants)" and "Effects of cooling water discharge on dissolved oxygen, gas supersaturation, and eutrophication," and the thermal effluent component of the Category 1 issue, "Losses from predation, parasitism, and disease among organisms exposed to sublethal stresses," would be consolidated into a single Category 1 issue, "Infrequently reported effects of thermal effluents."

- One Category 2 issue, "Impingement and entrainment of aquatic organisms (plants with once-through cooling systems or cooling ponds)," and the impingement component of the Category 1 issue, "Losses from predation, parasitism, and disease among organisms exposed to sublethal stresses," would be consolidated into a single Category 2 issue, "Impingement mortality and entrainment of aquatic organisms (plants with once-through cooling systems or cooling ponds)."
- One Category 1 issue, "Impingement and entrainment of aquatic organisms (plants with cooling towers)," and the impingement component of the Category 1 issue, "Losses from predation, parasitism, and disease among organisms exposed to sublethal stresses," would be consolidated into a single Category 1 issue, "Impingement mortality and entrainment of aquatic organisms (plants with cooling towers)."
- One Category 2 issue, "Threatened, endangered, and protected species and essential fish habitat," would be divided into three Category 2 issues: (1) "Endangered Species Act: federally listed species and critical habitats under U.S. Fish and Wildlife jurisdiction;" (2) "Endangered Species Act: federally listed species and critical habitats under National Marine Fisheries Service jurisdiction;" and (3) "Magnuson-Stevens Act: essential fish habitat."
- Two new Category 2 issues, "National Marine Sanctuaries Act: sanctuary resources" and "Climate change impacts on environmental resources," would be added.
- One Category 2 issue, "Severe accidents," would be changed to a Category 1 issue.
- One new Category 1 issue, "Greenhouse gas impacts on climate change," would be added.
- Several issue titles and findings would be revised to clarify their intended meanings.

Finalization and publication of the 2023 LR GEIS and the proposed rule (NRC 2023-TN7802) is expected to occur in or about August 2024. Upon being finalized, under the NRC's environmental protection regulations, the NRC staff would have to consider and analyze in its license renewal environmental reviews the potential significant impacts associated with the new Category 2 issues and, to the extent that there is any new and significant information, the potential significant impacts associated with the new Category 1 issues. To account for the proposed rule and 2023 LR GEIS and the possibility of their finalization in 2024, the NRC staff analyzes in this appendix, on a site-specific basis, their new and revised environmental issues as they may apply to the SLR for Oconee. Table G-1 lists the new and revised environmental issues that would apply to Oconee SLR. The sections that follow discuss how the NRC staff addressed each of these new and revised issues in this site-specific EIS and explains how this site-specific EIS covers the issues in the proposed rule and 2023 LR GEIS.

Table G-1 New and Revised 10 CFR Part 51 License Renewal Environmental Issues

Issue	2023 LR GEIS Section	Category
Infrequently reported effects of thermal effluents	4.6.1.2	1
Impingement mortality and entrainment of aquatic organisms (plants with once-through cooling systems or cooling ponds)	4.6.1.2	2
Endangered Species Act: federally listed species and critical habitats under U.S. Fish and Wildlife jurisdiction	4.6.1.3.1	2
Endangered Species Act: federally listed species and critical habitats under National Marine Fisheries Service jurisdiction	4.6.1.3.2	2

Table G-1 New and Revised 10 CFR Part 51 License Renewal Environmental Issues (Continued)

Issue	2023 LR GEIS Section	Category
Magnuson-Stevens Act: essential fish habitat	4.6.1.3.3	2
National Marine Sanctuaries Act: sanctuary resources	4.6.1.3.4	2
Severe accidents	4.9.1.2.1	1
Greenhouse gas impacts on climate change	4.12.1	1
Climate change impacts on environmental resources	4.12.3	2

CFR = *Code of Federal Regulations*; LR GEIS = License Renewal Generic Environmental Impact Statement.
Source: 10 CFR Part 51-TN250; 2023 LR GEIS (NRC 2023-TN7802).

G.1 Infrequently Reported Effects of Thermal Effluents

The draft rule proposes to combine two Category 1 issues, "Infrequently reported thermal impacts (all plants)" and "Effects of cooling water discharge on dissolved oxygen, gas supersaturation, and eutrophication," and the thermal effluent component of the Category 1 issue, "Losses from predation, parasitism, and disease among organisms exposed to sublethal stresses," into one Category 1 issue, "Infrequently reported effects of thermal effluents." This issue pertains to interrelated and infrequently reported effects of thermal effluents, including cold shock, thermal migration barriers, accelerated maturation of aquatic insects, and proliferated growth of aquatic nuisance species, as well as the effects of thermal effluents on dissolved oxygen, gas supersaturation, and eutrophication. This issue also considers sublethal stresses associated with thermal effluents that can increase the susceptibility of exposed organisms to predation, parasitism, or disease. These changes do not introduce any new environmental issues; rather, the proposed rule would reorganize existing issues. The changes are fully summarized and explained in Section 4.6.1.2 of the 2023 LR GEIS and in the proposed rule (NRC 2023-TN7802).

Sections 3.7.4.4, 3.7.4.5, and 3.7.4.11 of this site-specific EIS analyze infrequently reported effects of thermal effluents for Oconee SLR and conclude that the impacts would be SMALL. Therefore, the environmental issue of infrequently reported effects of thermal effluents is addressed in this site-specific EIS.

G.2 Impingement Mortality and Entrainment of Aquatic Organisms (Plants with Once-Through Cooling Systems or Cooling Ponds)

The draft rule proposes to combine the Category 2 issue, "Impingement and entrainment of aquatic organisms (plants with once-through cooling systems or cooling ponds)," and the impingement component of the Category 1 issue, "Losses from predation, parasitism, and disease among organisms exposed to sublethal stresses," into one Category 2 issue, "Impingement mortality and entrainment of aquatic organisms (plants with once-through cooling systems or cooling ponds)." This issue pertains to impingement mortality and entrainment of finfish and shellfish at nuclear power plants with once-through cooling systems and cooling ponds during the license renewal term (either initial license renewal or SLR). This includes plants with helper cooling towers that are seasonally operated to reduce thermal load to the receiving water body, reduce entrainment during peak spawning periods, or reduce consumptive water use during periods of low river flow.

In the 2023 LR GEIS (NRC 2023-TN7802), the NRC renamed this issue to specify impingement mortality, rather than simply impingement. This change is consistent with the U.S. Environmental Protection Agency (EPA) 2014 Clean Water Act Section 316(b) (TN662) regulations and the EPA's assessment that impingement reduction technology is available, feasible, and has been demonstrated to be effective. Additionally, the EPA 2014 Clean Water Act Section 316(b) regulations establish best technology available standards for impingement mortality based on the fact that survival is a more appropriate metric for determining environmental impact rather than simply looking at total impingement. Therefore, the 2023 LR GEIS (NRC 2023-TN7802) also consolidates the impingement component of the "Losses from predation, parasitism, and disease among organisms exposed to sublethal stresses" issue for plants with once-through cooling systems or cooling ponds into this issue.

Section 3.7.4.1 of this site-specific EIS analyzes the impacts of impingement and entrainment for Oconee SLR. The analysis considers the components of the proposed revision to this issue, impingement mortality, and the impingement component of losses from predation, parasitism, and disease among organisms exposed to sublethal stresses. In this section, the NRC staff concludes that impingement and entrainment during the SLR term would be of SMALL significance on the aquatic organisms in Lake Keowee. Therefore, the environmental issue of impingement mortality and entrainment of aquatic organisms (plants with once-through cooling systems or cooling ponds) is addressed in this site-specific EIS.

G.3 Endangered Species Act: Federally Listed Species and Critical Habitats Under U.S. Fish and Wildlife Jurisdiction

The draft rule proposes to divide the Category 2 issue, "Threatened, endangered, and protected species and essential fish habitat," into three separate Category 2 issues for clarity and consistency with the separate Federal statues and interagency consultation requirements that the NRC must consider with respect to federally protected ecological resources. When combined, however, the scope of the three issues is the same as the scope of the former "Threatened, endangered, and protected species and essential fish habitat" issue discussed in the 2013 LR GEIS (NRC 2013-TN2654).

The first of the three issues, "Endangered Species Act: federally listed species and critical habitats under U.S. Fish and Wildlife jurisdiction," concerns the potential effects of continued nuclear power plant operation and any refurbishment during the license renewal term on federally listed species and critical habitats protected under the Endangered Species Act (ESA, TN1010) and under the jurisdiction of the U.S. Fish and Wildlife Service (FWS).

Sections 3.8.1 and 3.8.4 of this site-specific EIS addresses the impacts of Oconee SLR on federally listed species and critical habitats under FWS jurisdiction. The NRC staff determined that Oconee SLR may affect but is not likely to adversely affect the tricolored bat, a species proposed for listing, and the monarch butterfly, a candidate species. Appendix C.1 describes the staff's ESA consultation with the FWS. Therefore, the environmental issue of Endangered Species Act: federally listed species and critical habitats under U.S. Fish and Wildlife Service jurisdiction is addressed in this site-specific EIS.

G.4 Endangered Species Act: Federally Listed Species and Critical Habitats Under National Marine Fisheries Service Jurisdiction

As explained in the previous section, the draft rule proposes to divide the Category 2 issue, "Threatened, endangered, and protected species and essential fish habitat," into three separate

Category 2 issues. The second of the three issues, “Endangered Species Act: federally listed species and critical habitats under National Marine Fisheries Service jurisdiction,” concerns the potential effects of continued nuclear power plant operation and any refurbishment during the license renewal term on federally listed species and critical habitats protected under the ESA and under the jurisdiction of the National Marine Fisheries Service.

Section 3.8.1 and 3.8.4 of this site-specific EIS find that no federally listed species or critical habitats under National Marine Fisheries Service jurisdiction occur within the action area. Accordingly, the NRC staff concluded that the proposed action would have no effect on federally listed species or habitats under this agency’s jurisdiction. Therefore, the environmental issue of Endangered Species Act: federally listed species and critical habitats under National Marine Fisheries Service jurisdiction is addressed in this site-specific EIS.

G.5 Magnuson-Stevens Act: Essential Fish Habitat

As explained above, the draft rule proposes to divide the Category 2 issue, “Threatened, endangered, and protected species and essential fish habitat,” into three separate Category 2 issues. The third of the three issues, “Magnuson-Stevens Act: essential fish habitat,” concerns the potential effects of continued nuclear power plant operation and any refurbishment during the license renewal term on essential fish habitat protected under the Magnuson-Stevens Act (MSA, TN7841).

Section 3.8.2 and 3.8.5 of this site-specific EIS find that no essential fish habitat occurs within the affected area. Accordingly, the NRC staff concluded that the proposed action would have no effect on essential fish habitat. Therefore, the environmental issue of Magnuson-Stevens Act: essential fish habitat is addressed in this site-specific EIS.

G.6 National Marine Sanctuaries Act: Sanctuary Resources

The draft rule proposes to add a new Category 2 issue, “National Marine Sanctuaries Act: sanctuary resources,” to evaluate the potential effects of continued nuclear power plant operation and any refurbishment during the license renewal term on sanctuary resources protected under the National Marine Sanctuaries Act (16 U.S.C. § 1431 et seq.-TN7197).

Under the National Marine Sanctuaries Act, the National Oceanic and Atmospheric Administration Office of National Marine Sanctuaries designates and manages the National Marine Sanctuary System. Marine sanctuaries may occur near nuclear power plants located on or near marine waters as well as the Great Lakes.

Section 3.8.3 and 3.8.6 of this site-specific EIS find that no National Marine Sanctuaries occur within the affected area. Accordingly, the NRC staff concluded that the proposed action would have no effect on sanctuary resources. Therefore, the environmental issue of National Marine Sanctuaries Act: sanctuary resources is addressed in this site-specific EIS.

G.7 Severe Accidents

With respect to postulated accidents, the draft rule proposes to amend Table B-1 in Appendix B to Subpart A of 10 CFR Part 51 (TN250) by reclassifying the Category 2 “Severe accidents” issue as a Category 1 issue. In the 2013 LR GEIS (NRC 2013-TN2654), the issue of severe accidents was classified as a Category 2 issue to the extent that only alternatives to mitigate severe accidents must be considered for all nuclear power plants where the licensee had not previously performed a severe accident mitigation alternatives (SAMA) analysis for the plant. In the 2023 LR GEIS (NRC 2023-TN7802), the NRC notes that this issue will be resolved generically for the vast majority, if not all, expected license renewal applicants because the applicants who will likely reference the LR GEIS have previously completed a SAMA analysis.

As discussed in Appendix F of this site-specific EIS, an analysis of SAMAs was performed for Oconee and evaluated by the NRC staff at the time of initial license renewal (TN8942). In Section 3.11.6.9 and Appendix F of this site-specific EIS, the NRC staff evaluated the significance of new information related to the plant-specific SAMA analysis. Therefore, the environmental issue of severe accidents is addressed in this site-specific EIS.

G.8 Greenhouse Gas Impacts on Climate Change

With respect to greenhouse gas (GHG) emissions and climate change, the draft rule proposes to amend Table B-1 in Appendix B to Subpart A of 10 CFR Part 51 (TN250) by adding a new Category 1 issue "Greenhouse gas impacts on climate change." This new issue has an impact level of SMALL. This new issue considers GHG impacts on climate change from routine operations of nuclear power plants and construction vehicles and other motorized equipment used during refurbishment activities. GHG emissions from routine operations of nuclear power plants are typically very minor because such plants, by their very nature, do not normally combust fossil fuels to generate electricity. However, nuclear power plant operations do have some GHG emission sources, including diesel generators, pumps, diesel engines, boilers, refrigeration systems, and electrical transmission and distribution systems, as well as mobile sources (e.g., worker vehicles and delivery vehicles). GHG emissions from construction vehicles and other motorized equipment for refurbishment activities would be intermittent and temporary, restricted to the refurbishment period. GHG emissions from continued operations and refurbishment activities are minor.

The issue of GHG impacts on climate change associated with nuclear power plant operations was not identified as either a generic or plant-specific issue in the 1996 LR GEIS (NRC 1996-TN288) or the 2013 LR GEIS (NRC 2013-TN2654). In the 2013 LR GEIS, however, the NRC staff presented GHG emission factors associated with the nuclear power life cycle. Following the issuance of CLI-09-21 (NRC 2009-TN6406), the NRC began to evaluate the effects of GHG emissions in plant-specific environmental reviews for license renewal applications. Accordingly, Section 3.14 of this site-specific EIS evaluates GHG emissions associated with the operation of Oconee during the SLR term. Table 3-24 of this site-specific EIS presents quantified annual GHG emissions from direct and indirect sources at Oconee for the 2020–2022 time period. Oconee's direct GHG emissions result from onsite combustion sources and indirect GHG emissions include those from workforce commuting.

Duke Energy has no plans to conduct major refurbishment during the Oconee SLR term, and therefore, no GHG emissions from refurbishment or increases in GHG emissions from routine operations at Oconee are anticipated. The NRC staff concludes that there would be no impacts on climate change beyond the impacts discussed in the 2023 LR GEIS (NRC 2023-TN7802) and in Table B-1 in Appendix B to Subpart A of 10 CFR Part 51 of the proposed rule (88 FR 13329-TN8601). Based on this information, the NRC staff concludes that GHG impacts on climate change for Oconee during the SLR term are SMALL. Therefore, the environmental issue of greenhouse gas impacts on climate change is addressed in this site-specific EIS.

G.9 Climate Change Impacts on Environmental Resources

With respect to climate change, the draft rule proposes to amend Table B-1 in Appendix B to Subpart A of 10 CFR Part 51 (TN250) by adding the new Category 2 issue "Climate change impacts on environmental resources." This new issue considers the additive effects of climate change on environmental resources that may also be directly affected by continued operations and refurbishment during the license renewal term. The effects of climate change can vary regionally and climate change information at the regional and local scale is necessary to assess trends and the impacts on the human environment for a specific location. The impacts of climate change on environmental resources during the license renewal term are location-specific and cannot be evaluated generically.

The issue of climate change impacts was not identified as either a generic or plant-specific issue in the 1996 LR GEIS (NRC 1996-TN288) or the 2013 LR GEIS (NRC 2013-TN2654). However, the 2013 LR GEIS described the environmental impacts that could occur on resources areas (air quality, water resources, etc.) that may also be affected by LR. In plant-specific initial license renewal and SLR environmental reviews prepared since the development of the 2013 LR GEIS, the NRC staff has considered projected differences in climate changes in the United States and climate change impacts on the resource areas that could be incrementally affected by the proposed action as part of its cumulative impacts analysis. Accordingly, Section 3.14.3.2 of this site-specific EIS discusses the observed changes in climate and the potential future climate change across the Southeast region of the United States during the Oconee SLR term based on climate model simulations under future global GHG emissions scenarios. The NRC staff considered regional projected climate changes from numerous climate assessment reports, including the U.S. Global Change Research Program (SGCRP 2009-TN18; USGCRP 2014-TN3472, USGCRP 2017-TN5848, USGCRP 2018-TN5847), the Intergovernmental Panel on Climate Change (IPCC 2000-TN7652, IPCC 2007-TN7421, IPCC 2013-TN7434, IPCC 2021-TN7435, IPCC 2023-TN8557), the EPA (EPA 2016-TN7561, EPA 2022-TN9163), and the National Oceanic and Atmospheric Administration (NOAA 2013-TN7424). Furthermore, in Section 3.14.3.2 of this site-specific EIS, the NRC staff evaluated the impacts from climate change on environmental resources (e.g., air quality and water resources) that are incremental affected by the proposed action. Therefore, this issue, "Climate change impacts on environmental resources," has been addressed in this site-specific EIS.

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11. ABSTRACT (200 words or less)

The U.S. Nuclear Regulatory Commission (NRC) prepared this site-specific environmental impact statement (EIS) as part of its environmental review of the Duke Energy Carolinas, LLC (Duke Energy) request to renew the operating licenses for Oconee Nuclear Station, Units 1, 2, and 3 (Oconee Station) for an additional 20 years. This EIS includes the site-specific evaluation of the environmental impacts of the proposed action, Oconee Station subsequent license renewal (SLR), and alternatives to SLR. The NRC staff prepared this site-specific EIS in accordance with two memorandums and orders issued by the Commission in February 2022: CLI-22-02 and CLI-22-03. This EIS considers the impacts of all SLR issues applicable to Oconee Station SLR on a site-specific basis. Based on the evaluation of environmental impacts, the NRC staff's preliminary recommendation is that the adverse environmental impacts of Oconee Station SLR are not so great that preserving the option of SLR for energy-planning decisionmakers would be unreasonable.

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