United States Nuclear Regulatory Commission

Protecting People and the Environment

NUREG-1437
Supplement 6,
Second Renewal

Generic Environmental Impact Statement for License Renewal of Nuclear Plants

Supplement 6, Second Renewal

Regarding Subsequent License Renewal for Surry Power Station Units 1 and 2

Draft Report for Comment

Office of Nuclear Reactor Regulation

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U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

NUREG-1437
SUPPLEMENT 6,
SECOND RENEWAL

Generic Environmental Impact Statement for License Renewal of Nuclear Plants

Supplement 6, Second Renewal

Regarding Subsequent License Renewal for Surry Power Station Units 1 and 2

Manuscript Completed: October 2019
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Office of Nuclear Reactor Regulation

Proposed Action	Issuance of subsequent renewed facility operating licenses DPR-32 and DPR-37 for Surry Power Station, Units 1 and 2 (Surry), in Surry County, VA
Type of Statement	Draft Supplemental Environmental Impact Statement
Agency Contact	Tam Tran U.S. Nuclear Regulatory Commission (NRC) Office of Nuclear Reactor Regulation Mail Stop O-11F1 Washington, DC 20555-0001 E-mail: tam.tran@nrc.gov

Comments Any interested party may submit comments on this draft supplemental environmental impact statement. Please specify "NUREG-1437, Supplement, Second Renewal, draft," in the subject or title line for your comments. Comments on this draft SEIS should be filed no later than 45 days after the date on which the U.S. Environmental Protection Agency (EPA) notice, stating that this draft SEIS has been filed with the EPA, is published in the *Federal Register*. Comments received after the expiration of the comment period will be considered if it is practical to do so, but assurance of consideration of late comments cannot be given. You may submit comments electronically by searching for Docket ID NRC-2018-27547 at the Federal rulemaking Web site, http://www.regulations.gov. You may also mail comments to the following address:

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COVER SHEET

Responsible Agency: U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation.

Title: Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 6, Second Renewal, Regarding Subsequent License Renewal for Surry Power Station, Units 1 and 2, Draft Report for Comment (NUREG-1437).

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ABSTRACT

The U.S. Nuclear Regulatory Commission staff prepared this draft supplemental environmental impact statement (SEIS) as part of its environmental review of Dominion Energy Virginia's application to renew the operating licenses for Surry Power Station, Units 1 and 2 (Surry) for an additional 20 years. This draft SEIS includes the NRC staff's preliminary evaluation of the environmental impacts of the license renewal and alternatives to license renewal. Alternatives considered include: (1) a new nuclear (Small Modular Reactor) generation alternative, (2) a natural gas combined-cycle power plant, and (3) a combination of natural gas combined-cycle power plant, solar, and demand-side management. The NRC staff's preliminary recommendation is that the adverse environmental impacts of license renewal for Surry are not so great that preserving the option of license renewal for energy-planning decisionmakers would be unreasonable. The NRC staff based its recommendation on the following:

- the analysis and findings in NUREG-1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants"
- the environmental report submitted by Dominion Energy Virginia
- the NRC staff's consultation with Federal, State, Tribal, and local agencies
- the NRC staff's independent environmental review
- the NRC staff's consideration of public comments

Comments on this draft SEIS should be filed no later than 45 days after the date on which the U.S. Environmental Protection Agency (EPA) notice, stating that this draft SEIS has been filed with the EPA, is published in the Federal Register. Comments received after the expiration of the comment period will be considered if it is practical to do so, but assurance of consideration of late comments cannot be given.

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EXECUTIVE SUMMARY

Background

By letter dated October 15, 2018, Dominion Energy Virginia (Dominion) submitted to the U.S. Nuclear Regulatory Commission (NRC) an application requesting subsequent license renewal for the Surry Power Station, Units 1 and 2 operating licenses (Agencywide Documents Access and Management System (ADAMS) Package Accession No. ML18291A842). The Surry Unit 1 current operating license (DPR-32) expires at midnight on May 25, 2032; the Surry Unit 2 current operating license (DPR-37) expires at midnight on January 29, 2033. In its application, Dominion requests license renewal for a period of 20 years beyond the dates when the current operating licenses expire to 2052 for Surry Unit 1 and 2053 for Surry Unit 2.

Pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) 51.20(b)(2), the renewal of a power reactor operating license requires preparation of an environmental impact statement (EIS) or a supplement to an existing EIS. In addition, 10 CFR 51.95(c), "Operating License Renewal Stage," states that, in connection with the renewal of an operating license, the NRC staff shall prepare an EIS, which is a supplement to the Commission's NUREG-1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants."

Once the NRC officially accepted Dominion's application, the NRC staff began the environmental review process as described in 10 CFR Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions." The environmental review begins by the NRC publishing in the *Federal Register* a notice of intent to prepare a supplemental environmental impact statement (SEIS) and to conduct scoping for the nuclear power plant. To prepare the Surry SEIS, the NRC staff performed the following:

- conducted one public scoping meeting on January 8, 2019, near the Surry site in Surry County, VA
- conducted an onsite environmental audit at Surry from March 12 to 15, 2019 and a severe accident mitigation alternatives in-office audit in Rockville, MD, on March 25, 2019
- reviewed Dominion's environmental report (ER) and compared it to NUREG-1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (the GEIS)
- consulted with Federal, State, Tribal, and local agencies
- conducted a review of the issues following the guidance set forth in NUREG-1555, Supplement 1, Revision 1, "Standard Review Plans for Environmental Reviews for Nuclear Power Plants: Supplement 1: Operating License Renewal," Final Report
- considered public comments received during the scoping process

Proposed Action

Dominion initiated the proposed Federal action (issuance of a renewed power reactor operating license) by submitting an application for license renewal of Surry. The existing Surry operating licenses expire at midnight on May 25, 2032, for Unit 1 (DPR-32) and January 29, 2033, for

Unit 2 (DPR-37). The NRC's Federal action is to decide whether to issue renewed licenses authorizing an additional 20 years of operation. If the NRC issues the renewed licenses, Surry Units 1 and 2 would be authorized to operate until 2052 and 2053, respectively.

Purpose and Need for Actions

The purpose and need for the proposed action (issuance of renewed 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. Energy-planning decisionmakers such as States, utility operators, and, where authorized, Federal agencies (other than the NRC) may determine these future system generating needs. The Atomic Energy Act of 1954, as amended, and the National Environmental Policy Act of 1969, as amended, require the NRC to perform a safety review and an environmental review of the proposed action. The above definition of purpose and need reflects the NRC's recognition that, unless there are findings in the safety review or in the environmental review that would lead the NRC to reject a license renewal application, the NRC does not have a role in the energy-planning decisions as to whether a particular nuclear power plant should continue to operate.

Environmental Impacts of License Renewal

This SEIS evaluates the potential environmental impacts of the proposed action. The NRC designates the environmental impacts from the proposed action as SMALL, MODERATE, or LARGE. NUREG-1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (the GEIS) evaluates 78 environmental issues related to plant operation and classifies each issue as either a Category 1 issue (generic to all nuclear power plants) or a Category 2 issue (specific to individual power plants). Category 1 issues are those that meet all of the following criteria:

- The environmental impacts associated with the issue apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristics.
- A single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts except for collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal.
- Mitigation of adverse impacts associated with the issue is considered in the analysis, and it has been determined that additional plant-specific mitigation measures are likely not to be sufficiently beneficial to warrant implementation.

> **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.

For Category 1 issues, no additional site-specific analysis is required in this SEIS unless new and significant information is identified. Chapter 4 of this SEIS presents the process for identifying new and significant information.

Category 2 issues are site-specific issues that do not meet one or more of the criteria for Category 1 issues; therefore, an SEIS must include additional site-specific review for these non-generic issues.

Dominion and the NRC identified no information that is both new and significant related to Category 1 issues that has the potential to affect the conclusions in the GEIS. This conclusion is supported by the NRC staff's review of Dominion's environmental report and other documentation relevant to the applicant's activities, the public scoping process, and the findings from the NRC staff's site audits. Therefore, the NRC staff relied upon the conclusions of the GEIS for all Category 1 issues applicable to Surry.

In this SEIS, the NRC staff evaluated Category 2 issues applicable to Surry, as well as cumulative impacts, and considered new information regarding severe accident mitigation alternatives (SAMAs). Table ES-1 summarizes the Category 2 issues relevant to Surry and the NRC staff's findings related to those issues. If the NRC staff determined that there were no Category 2 issues applicable for a particular resource area, the findings of the GEIS, as documented in Appendix B to Subpart A, "Environmental Effect of Renewing the Operating License of a Nuclear Power Plant," of 10 CFR Part 51, are incorporated for that resource area.

Table ES-1 Summary of NRC Conclusions Relating to Site-Specific Impacts of License Renewal at Surry

Resource Area	Relevant Category 2 Issues	Impacts
Groundwater Resources	Groundwater use conflicts (plants that withdraw more than 100 gallons per minute)	SMALL
	Radionuclides released to groundwater	SMALL
Terrestrial Resources	Effects on terrestrial resources (noncooling system impacts)	SMALL
Aquatic Resources	Impingement and entrainment of aquatic organisms (plants with once-through cooling systems or cooling ponds)	SMALL
	Thermal impacts on aquatic organisms (plants with once-through cooling systems or cooling ponds)	SMALL
Special Status Species and Habitats	Threatened, endangered, and protected species and essential fish habitat	May affect, but is not likely to adversely affect northern long-eared bat, shortnose sturgeon, and Atlantic sturgeon May affect, but is not likely to adversely modify designated critical habitat of the Chesapeake Bay distinct population segment of Atlantic sturgeon No more than minimal adverse effects on essential fish habitat of the summer flounder (larvae,

Resource Area	Relevant Category 2 Issues	Impacts
		juveniles, and adults), Atlantic butterfish (juveniles and adults), bluefish (juveniles), and windowpane flounder (juveniles and adults) or on the prey base of the little skate (adults) or winter skate (adults) No adverse effects on the essential fish habitat of any life stages of the black sea bass, Atlantic herring, clearnose skate, or red hake
Historic and Cultural Resources	Historic and cultural resources	Would not adversely affect known historic properties
Human Health	Electric shock hazards	SMALL
Environmental Justice	Minority and low-income populations	No disproportionately high and adverse human health and environmental effects on minority and low-income populations.
Cumulative Impacts	Cumulative Impacts	See SEIS Section 4.16
Postulated Accidents	SAMA	See SEIS Appendix F

Alternatives

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

In total, the NRC staff initially considered 16 replacement power alternatives but later dismissed 13 of these because of technical, resource availability, or commercial limitations that currently exist and that the NRC staff believes are likely to still exist when the current Surry license expires. This left three feasible and commercially viable replacement power alternatives which, in addition to the no-action alternative, the staff evaluates in depth in this report:

- new nuclear (small modular reactor) alternative
- natural gas combined-cycle alternative
- combination alternative (natural gas combined-cycle, solar, and demand-side management)

These are the 13 additional alternatives that the NRC staff considered but ultimately dismissed:

- solar power
- wind power
- biomass power
- demand-side management
- hydroelectric power
- geothermal power

- wave and ocean energy
- municipal solid waste
- petroleum-fired power
- coal-fired power
- fuel cells
- purchased power
- delayed retirement

The NRC staff evaluated each alternative using the same resource areas that it used in evaluating impacts from license renewal. The NRC staff also evaluated any new and significant information that could alter the conclusions of the SAMA analysis that was performed previously in connection with the initial license renewal of Surry.

Preliminary Recommendation

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

- the analysis and findings in NUREG-1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants"
- the environmental report submitted by Dominion
- the NRC staff's consultation with Federal, State, Tribal, and local agencies
- the NRC staff's independent environmental review
- the NRC staff's consideration of public comments during the scoping process

ABBREVIATIONS AND ACRONYMS

$	$ dollar(s) (U.S.)
§	Section
°F	degrees Fahrenheit
µm	micrometer
ac	acre(s)
ACC	averted cleanup and decontamination costs
ACHP	Advisory Council on Historic Preservation
ACS	American Community Survey
ADAMS	Agencywide Documents Access and Management System
AEA	Atomic Energy Act of 1954 (as amended)
AADT	average annual daily traffic
A-R	agricultural-rural residence (zoning district)
AAF	Felker Army Airfield
ALARA	as low as reasonably achievable
AMSL	above mean sea level
ANS	American Nuclear Society
APE	area of potential effect
BCG	biota concentration guide
BEIR	Biological Effects of Ionizing Radiation
BLS	Bureau of Labor Statistics
BMP	best management practice
BOEM	Bureau of Ocean Energy Management
BTA	best technology available
Btu	British thermal unit
BWR	boiling-water reactor
CAA	Clean Air Act
CCB	Center for Conservation Biology
CCRM	Center for Coastal Resources Management
CCW	component cooling water
CDF	core damage frequency
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
cfs	cubic feet per second
CILLRWC	Central Interstate Low-Level Radioactive Waste Commission
CLB	current licensing basis/bases
CO	carbon monoxide
CO_2	carbon dioxide
CO_2/MWh	carbon dioxide per megawatt hour
CO_{2eq}	carbon dioxide equivalent

COL	combined license
CPI	consumer price index
CSP	concentrating solar power
CWA	Clean Water Act (Federal Water Pollution Control Act)
CZMA	Coastal Zone Management Act
dBA	A-weighted decibels
DEQ	Virginia Department of Environmental Quality
DMMA	dredge material management area
DOE	U.S. Department of Energy
Dominion	Virginia Electric and Power Company or Dominion Energy Virginia
EFH	essential fish habitat
EIA	Energy Information Administration
EIS	environmental impact statement
EMF	electromagnetic field
EP	emergency plan
EPA	U.S. Environmental Protection Agency
EPRI	Electric Power Research Institute
ER	environmental report
ERC	Energy Recovery Council
ESA	Endangered Species Act
FEMA	Federal Emergency Management Agency
FEIS	final environmental impact statement
FES	final environmental statement
ft	feet
fps	feet per second
FR	Federal Register
ft^3	cubic feet
FWS	U.S. Fish and Wildlife Service
GEIS	NUREG-1437, Generic Environmental Impact Statement for License Renewal of Nuclear Plants
GHG	greenhouse gas
GI	generic issue
GL	generic letter
GNCTS	Gravel Neck Combustion Turbines Station
gpd	gallons per day
gpm	gallons per minute
gpy	gallons per year
ha	hectare(s)
HDR	HDR Engineering, Inc.
HIC	high integrity container
HRSD	Hampton Roads Sanitation District

I-64	Interstate 64
I-95	Interstate 95
IEA	International Energy Agency
IGCC	integrated gasification combined cycle
in	inches
IPE	individual plant examination
IPEEE	individual plant examination of external events
IRP	integrated resource plan
ISFSI	independent spent fuel storage installation
km	kilometer(s)
kV	kilovolt
kW	kilowatt(s)
kWe	kilowatt(s) electric
kWh/m^2/day	kilowatt hour per square meter per day
L	liters
LERF	large early release frequency
LLRW	low-level radioactive waste
Lpd	liters per day
Lpm	liters per minute
LRA	license renewal application
MACCS2	MELCOR Accident Consequences Code System
MATS	Mercury and Air Toxics Standards
MELCOR	Computer code providing practical analytical tool for evaluating severe accident behavior
MACTEC	MACTEC Engineering and Consulting, Inc.
MB	maximum benefit
NOV	notice of violation
µg/m^3	micrograms per cubic meter
m	meters
m^3	cubic meter(s)
mg	mg million gallons
mgd	million gallons per day
mg/L	milligram per liter
m/s	meter(s) per second
MGD	million gallons per day
mgy	million gallons of water per year
mLy	million liters per year
mph	miles per hour
mrad	milliradiation absorbed dose
mrem	millirem
MSA	Magnuson–Stevens Fishery Conservation and Management Act

mSv	millisievert
MSW	municipal solid waste
MUR	measurement uncertainty recapture
MW	megawatt
MWd/MTU	megawatt days per metric ton uranium
MWe	megawatts electric
MWh	megawatt hour(s)
MWt	Megawatts thermal
NA	not available /not applicable
NAAQS	National Ambient Air Quality Standards
NAVD88	North American Vertical Datum 1988
NCES	National Center for Education Statistics
NEI	Nuclear Energy Institute
NEPA	National Environmental Policy Act
NETL	National Energy Technology Laboratory
NGCC	natural gas combined-cycle
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NO_x	nitrogen oxides
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NRC	U.S. Nuclear Regulatory Commission
NREL	National Renewable Energy Laboratory
NRHP	National Register of Historic Places
NRR	Nuclear Reactor Regulation, Office of (NRC)
O_3	ozone
ORNL	Oak Ridge National Laboratory
OSHA	Occupational Safety and Health Administration
Pb	lead
PCB	polychlorinated biphenyl
ppm	parts per million
ppb	parts per billion
PM	particulate matter
PNNL	Pacific Northwest National Laboratory
PRA	probabilistic risk assessment
PV	photovoltaic
PWR	pressurized water reactor
RAI	request(s) for additional information
RCRA	Resource Conservation and Recovery Act of 1976, as amended
RM	River Mile

ROI	region(s) of influence
ROP	Reactor Oversight Process
SAMA	severe accident mitigation alternative
SBO	station blackout
SCPC	supercritical pulverized coal
SEIS	supplemental environmental impact statement
SER	safety evaluation report
SO_2	sulfur dioxide
SPS	Surry Power Station, Units 1 and 2
SSC	structure, system, and component
Sv	sievert(s)
SWPP	Stormwater Pollution Prevention Plan
syngas	synthesis gas
TMDL	Total maximum daily loads
U.S.	United States
U.S.C.	United States Code
UFSAR	Updated Final Safety Analysis Report
USACE	United States Army Corps of Engineers
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
VDEQ	Virginia Department of Environmental Quality
VDOT	Virginia Department of Transportation
VOC	volatile organic compound
yd^3	cubic yard(s)

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, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions," implement the National Environmental Policy Act of 1969, as amended (42 U.S.C. 4321 et seq.). This Act is commonly referred to as NEPA. The regulations at 10 CFR Part 51 require the NRC to prepare an environmental impact statement (EIS) before making a decision on whether to issue an operating license or a renewed operating license for a nuclear power plant.

The Atomic Energy Act of 1954 (AEA), as amended (42 U.S.C. 2011 et seq.), 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. The NRC regulations permit these licenses to be renewed beyond the initial 40-year term for an additional period of time, limited to one 20-year increment per renewal, based on the results of an assessment to determine if the nuclear facility can continue to operate safely during the proposed period of extended operation. There are no limitations in the AEA or NRC regulations restricting the number of times a license may be renewed.

The decision to seek a renewed license rests entirely with nuclear power facility owners and typically is based on the facility's economic viability and the investment necessary to continue to meet NRC safety and environmental requirements. The NRC makes the decision to grant or deny a renewed license 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.

1.1 Proposed Federal Action

Dominion Energy Virginia (Dominion) initiated the proposed Federal action by submitting an application for subsequent license renewal for Surry Power Station, Units 1 and 2 (Surry). The current renewed licenses expire at midnight on May 25, 2032, for Unit 1 (DPR-32), and midnight at January 29, 2033, for Unit 2 (DPR-37). The NRC's Federal action is to decide whether to renew the licenses for an additional 20 years.

1.2 Purpose and Need for the Proposed Federal Action

The purpose and need for the proposed Federal action (issuance of renewed licenses for Surry) is to provide an option that allows for power generation capability beyond the term of a current renewed nuclear power plant operating license to meet future system generating needs. 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, unless there are findings in the NRC's safety review (required by the AEA) or findings in the NRC's environmental analysis (required by NEPA) that would lead the NRC to reject a subsequent license renewal application (SLRA), the NRC does not decide whether a particular nuclear power plant should continue to operate.

1.3 Major Environmental Review Milestones

Dominion submitted an environmental report (ER) as an appendix to its SLRA in October 2018 (Dominion 2018). After reviewing the SLRA and ER, as supplemented, the NRC staff accepted the application for a detailed technical review on December 3, 2018. On December 17, 2018, the NRC staff published a *Federal Register* notice of acceptability and opportunity for hearing (Volume 83 of the *Federal Register* (FR), page 64606 (83 FR 64606)). On December 20, 2018, the NRC published another notice in the *Federal Register* (83 FR 65367) informing members of the public of the staff's intent to conduct an environmental scoping process, thereby beginning a 30-day scoping comment period.

The NRC staff held a public scoping meeting on January 8, 2019, in Surry County, VA. In June 2019, the NRC issued its *Environmental Impact Statement Scoping Process Summary Report, Surry Power Station, Units 1 & 2, Surry County, VA*, (ADAMS Accession No. ML19135A197), which includes the comments received during the scoping process and the NRC staff's responses to those comments.

The NRC staff conducted an onsite audit at Surry in March 2019, and an in-office severe accident mitigation alternatives audit at NRC headquarters in March 2019, to independently verify information that Dominion provided in its environmental report. In a letter dated April 29, 2019, the staff summarized the onsite audit and listed the attendees (NRC 2019e). In a letter dated April 25, 2019, the staff summarized the in-office severe accident mitigation alternatives audit and listed the attendees (NRC 2019e). During these audits, the NRC staff held meetings with plant personnel, reviewed site-specific documentation, and toured the facility.

Upon completion of the scoping period and site audits, and completion of its review of Dominion's environmental report and related documents, the NRC staff compiled its findings in this draft supplemental environmental impact statement (SEIS). The NRC staff will make this draft SEIS available for public comment for 45 days. Based on the information gathered during this public comment period, the NRC staff will amend the draft SEIS findings as necessary and will then publish the final SEIS. Figure 1-1 shows the major milestones of the environmental review portion of the NRC's license renewal application review process.

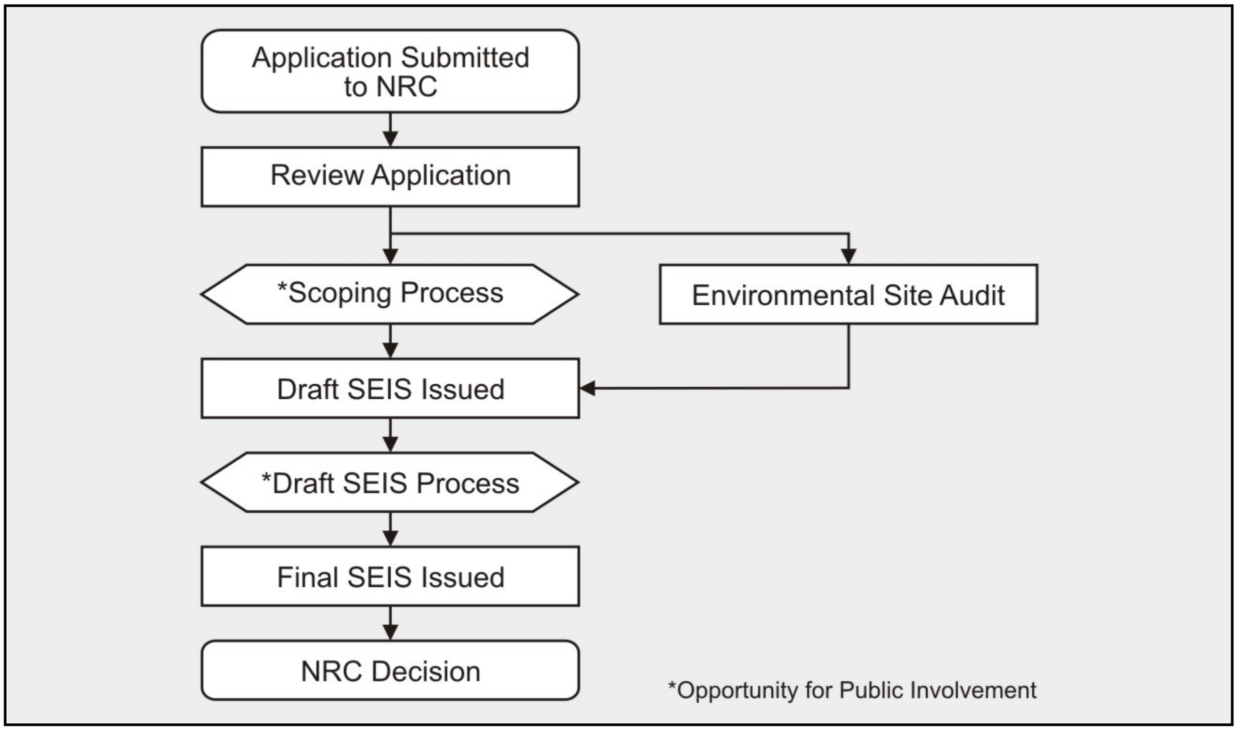


Figure 1-1 Environmental Review Process

The NRC has established a license renewal process that NRC staff and license renewal applicants can complete in a reasonable period of time and that includes clear requirements to assure safe plant operation for up to an additional 20 years of plant life. This process consists of separate environmental and safety reviews, which the NRC staff conducts simultaneously and documents in two reports: (1) the SEIS documents the environmental review and (2) the safety evaluation report (SER) documents the safety review. The staff's findings in the SEIS and the SER are both factors in the NRC's decision to issue or deny a renewed license.

1.4 Generic Environmental Impact Statement

To improve the efficiency of its license renewal review process, the NRC staff performed a generic assessment of the environmental impacts associated with license renewal. NUREG-1437, *Generic Environmental Impact Statement for License Renewal of Nuclear Power Plants* (GEIS) (NRC 1996, 1999, 2013a), documents the results of the NRC's systematic approach to evaluating the environmental consequences of renewing the licenses of individual nuclear power plants and operating them for an additional 20 years. In the GEIS, the staff analyzed in detail and resolved those environmental issues that could be resolved generically. The NRC issued the GEIS in 1996 (NRC 1996), Addendum 1 to the GEIS in 1999 (NRC 1999), and Revision 1 to the GEIS in 2013 (NRC 2013a). Unless otherwise noted, all references to the GEIS include the original 1996 GEIS, Addendum 1, and the 2013 revision (NRC 2013a).

The GEIS establishes separate environmental impact issues for the NRC staff to independently evaluate. In 10 CFR Part 51, Appendix B to Subpart A, "Environmental Effect of Renewing the

Operating License of a Nuclear Power Plant," provides a summary of the staff's findings in the GEIS. For each environmental issue addressed in the GEIS, the NRC staff does the following:

- describes the activity that affects the environment
- identifies the population or resource that is affected
- assesses the nature and magnitude of the impact on the affected population or resource
- characterizes the significance of the effect for both beneficial and adverse effects
- determines whether the results of the analysis apply to all plants
- considers whether additional mitigation measures would be warranted for impacts that would have the same significance level for all plants

The NRC established its standard of significance for impacts using the Council on Environmental Quality terminology for "significant." The NRC established three levels of significance for potential impacts—SMALL, MODERATE, and LARGE—as defined below.

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.

> **Significance** indicates the importance of likely environmental impacts and is determined by considering two variables: **context** and **intensity**.
>
> **Context** is the geographic, biophysical, and social context in which the effects will occur.
>
> **Intensity** refers to the severity of the impact in whatever context it occurs.

The GEIS determines whether the analysis of the environmental issue could be applied to all plants and whether additional mitigation measures would be warranted. Issues are assigned a Category 1 (generic to all plants) or Category 2 (site-specific to certain plants only) designation. As established in the GEIS, Category 1 issues are those that meet the following three criteria:

- The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants that have a specific type of cooling system or other specified plant or site characteristics.
- A single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts (except for collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal).
- Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are likely not to be sufficiently beneficial to warrant implementation.

For generic issues (Category 1), the SEIS requires no additional site-specific evaluation unless new and significant information has been identified. Chapter 4 describes the process for identifying new and significant information for site-specific analysis. Site-specific issues

(Category 2) are those that do not meet one or more of the three criteria of Category 1 issues; therefore, the SEIS requires additional site-specific review for these issues.

The GEIS evaluates 78 environmental issues, provides generically applicable findings for numerous issues (subject to the consideration of any new and significant information on a site-specific basis), and concludes that a site-specific analysis is required for 17 of the 78 issues. Figure 1-2 illustrates the license renewal environmental review process. The results of that site-specific review are documented in the SEIS.

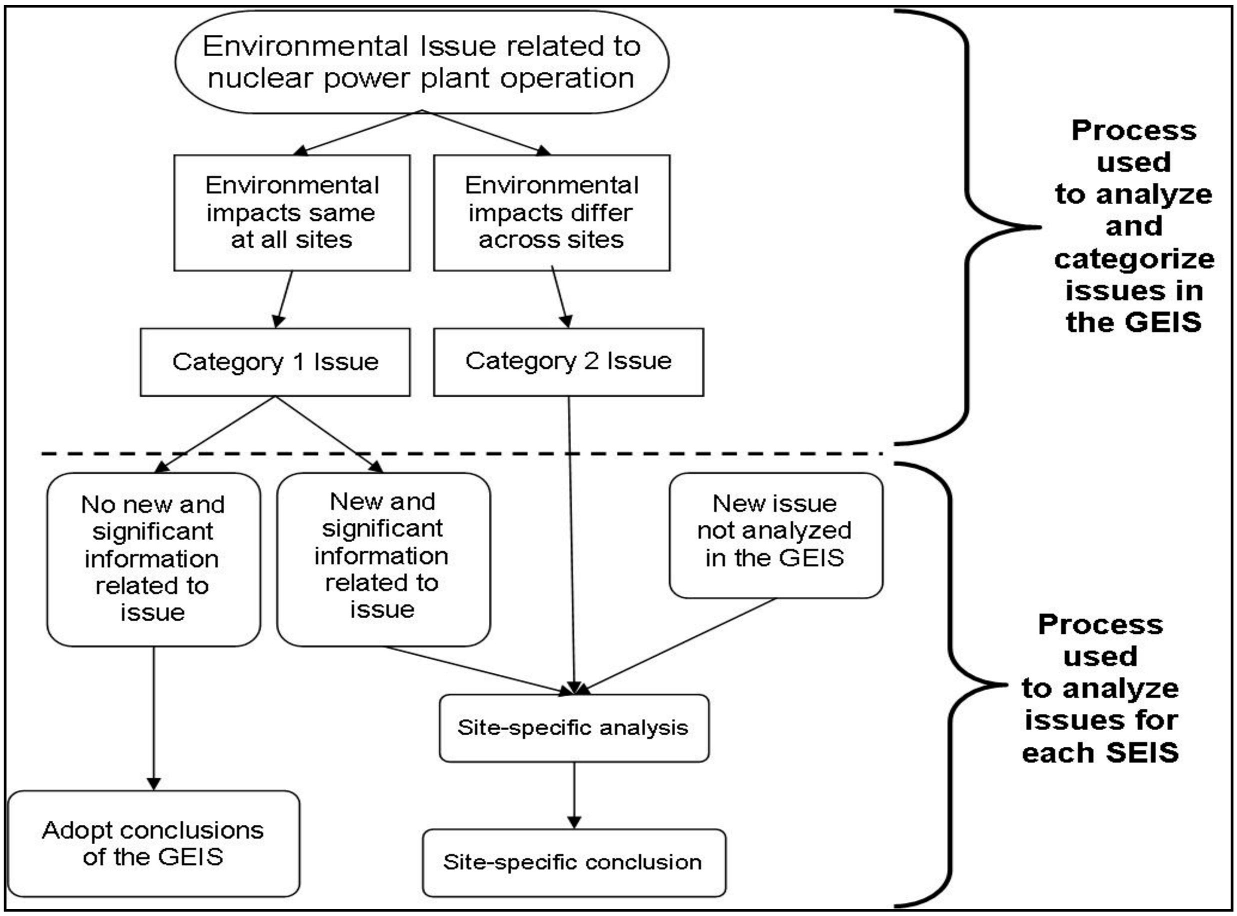


Figure 1-2 Environmental Issues Evaluated for License Renewal

1.5 Supplemental Environmental Impact Statement

This SEIS presents the NRC staff's analysis of the environmental effects of the continued operation of Surry through the license renewal period, alternatives to license renewal, and mitigation measures for minimizing adverse environmental impacts. Chapter 4, "Environmental Consequences and Mitigating Actions," contains analysis and comparison of the potential environmental impacts from license renewal and alternatives to license renewal. Chapter 5, "Conclusion," presents the NRC's recommendation on whether the environmental impacts of license renewal are so great that preserving the option of license renewal would be unreasonable. The NRC staff will make its final recommendation to the Commission on Surry license renewal in the final SEIS, which the NRC staff will issue after considering comments received on the draft SEIS during the public comment period.

In preparing the Surry draft SEIS, the NRC staff carried out the following activities:

- reviewed the information provided in Dominion's ER
- consulted with Federal agencies, State and local agencies, and Tribal Nations
- conducted an independent review of the issues, including the environmental and severe accident management analysis site audits
- considered public comments received during the environmental scoping process

New and significant information. To merit additional review, information must be both new and significant and it must bear on the proposed action or its impacts.

New information can come from many sources, including the applicant, the NRC, other agencies, or public comments. If new information reveals a new issue, the staff will first analyze the issue to determine whether it is within the scope of the license renewal environmental evaluation. If the staff determines that the new issue bears on the proposed action, the staff will then determine the significance of the issue for the plant and analyze the issue in the SEIS.

1.6 Decisions to Be Supported by the SEIS

This SEIS supports the NRC's decision on whether to renew the operating licenses for Surry for an additional 20 years. The regulation at 10 CFR 51.103(a)(5) 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 takes into consideration when deciding whether to renew the operating license of a nuclear power plant. The analyses of environmental impacts in this SEIS will provide the NRC's decisionmakers (in this case, the Commission) with important environmental information for use in the overall decisionmaking process. The NRC also makes decisions outside the regulatory scope of license renewal. These include decisions related to: (1) changes to plant cooling systems, (2) disposition of spent nuclear fuel, (3) emergency preparedness, (4) safeguards and security, (5) need for power, and (6) seismicity and flooding (NRC 2013a).

1.7 Cooperating Agencies

During the scoping process, no Federal, State, or local agencies were identified as cooperating agencies in the preparation of this SEIS.

1.8 Consultations

The Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 et seq.); the Magnuson–Stevens Fisheries Conservation and Management Act (MSA) of 1996, as amended (16 U.S.C. 1801 et seq.); and the National Historic Preservation Act (NHPA) of 1966, as amended (54 U.S.C. 300101 et seq.), 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. The NRC staff consulted with the following agencies and groups during this environmental review:

- U.S. Fish and Wildlife Service
- National Marine Fisheries Service
- Virginia State Historic Preservation Officer
- Advisory Council on Historic Preservation
- Absentee-Shawnee Tribe
- Catawba Indian Nation
- Cherokee Nation of Oklahoma
- Chickahominy Indian Tribe
- Chickahominy Indians – Eastern Division
- Delaware Nation
- Delaware Tribe of Indians
- Eastern Band of Cherokee Indians
- Eastern Shawnee Tribe of Oklahoma
- Monacan Indian Nation
- Nansemond Indian Tribe
- Pamunkey Indian Tribe
- Rappahannock Tribe
- Shawnee Tribe Oklahoma
- Tuscarora Nation
- United Keetoowah Band of Cherokee Indians in Oklahoma
- Upper Mattaponi Indian Tribe
- Cheroenhaka (Nottoway) Tribe
- Mattaponi Tribe
- Nottoway Tribe
- Patawomeck Tribe
- Meherrin Nation

Appendix C of this SEIS discusses the consultations that the NRC staff conducted in support of this environmental review.

1.9 Correspondence

During the review, the NRC staff contacted Federal, State, regional, local, and Tribal agencies listed in Section 1.8. Appendix C chronologically lists all correspondence the NRC staff sent and received associated with the Endangered Species Act, the Magnuson–Stevens Fisheries Conservation and Management Act, and the National Historic Preservation Act. Appendix D, "Projects and Actions Considered in the Cumulative Impacts Analysis Review," chronologically lists all other correspondence.

1.10 Status of Compliance

Dominion is responsible for complying with all NRC regulations and other applicable Federal, State, and local requirements. Appendix F of the GEIS describes some of the major applicable Federal statutes. Numerous permits and licenses are issued by Federal, State, and local authorities for activities at Surry. Appendix B of this SEIS contains further information about Dominion's status of compliance.

1.11 Related Federal Activities

The staff reviewed the possibility that activities of other Federal agencies might impact the renewal of the operating licenses for Surry. 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 SEIS. There are no Federal projects that would make it necessary for another Federal agency to become a cooperating agency in the preparation of this SEIS (10 CFR 51.10(b)(2)). Table 1-1 below lists Federal facilities in the vicinity of Surry.

Table 1-1 Federal Facilities (extracted from Appendix E)

Project Name	Summary of Project	Location (Relative to Surry)	Status
Naval Weapons Station Yorktown	13,200 ac (5,300 km) U.S. Navy installation primarily charged with providing ordnance logistics and supply support	Yorktown, VA, approximately 6 mi (10 km) northeast	Operational (EPA 2019j; USN 2019)
Joint Base Langley Eustis	11,000-ac (4,450-ha) joint U.S. military installation comprised of the U.S. Army's Fort Eustis (including various training, aviation support, Felker Army Air Field, and logistics units), and the U.S. Air Force's Langley Air Force Base (including units of the Air Combat Command)	Fort Eustis located 5 mi (8 km) east (Newport News, VA) and Langley Air Force Base located approximately 19 mi (31 km) east-southeast (Hampton, VA)	Operational (EPA 2019j; USAF 2019)
U.S. Department of Energy Thomas Jefferson National Accelerator Facility	206-ac (83-ha) research campus that includes the Continuous Electron Beam Accelerator Facility (CEBAF)	Newport News, VA, approximately 12.5 mi (20 km) southeast	Operational (EPA 2019; DOE 2019c, DOE 2019b)
Craney Island Dredged Material Management Area	2,500-ac (1,010-ha) confined dredged material disposal site used for disposal of maintenance, private, and permit dredged material from projects in the Hampton Roads area	Near Portsmouth, VA, approximately 24 mi (39 km) southeast	Operational (EPA 2019; USACE 2018a)

The regulation at NEPA Section 102(2)(C) 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 SEIS. For example, during the preparation of the SEIS, the NRC consulted with the State Historic Preservation Officer. Appendix C provides a complete list of consultation correspondence.

2 ALTERNATIVES INCLUDING THE PROPOSED ACTION

The U.S. Nuclear Regulatory Commission's (NRC's) decisionmaking authority in license renewal focuses on deciding whether to issue a renewed operating license to a nuclear power plant. The agency's implementation of the National Environmental Policy Act of 1969, as amended (NEPA) (42 U.S.C. 4321 et seq.), requires the NRC to consider potential alternatives to issuing a renewed operating license as well as the environmental impacts of these alternatives. Considering the environmental impacts of license renewal and comparing those 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 (Title 10 of the Code of Federal Regulations (10 CFR) 51.95(c)(4)). Ultimately, decisionmakers such as the plant operator, State, or non-NRC Federal officials will decide whether to carry out the proposed action and continue operating the plant for an additional 20 years (if the NRC renews the license) or shut down the plant and choose an alternative power generation source. Economic and environmental considerations play important roles in the decisions of these non-NRC, energy-planning decisionmakers.

In general, the NRC's responsibility is to ensure the safe operation of nuclear power facilities, not to formulate energy policy, promote nuclear power, or encourage or discourage the development of alternative power generation sources. The NRC does not engage in energy-planning decisions, and it makes no judgment as to which energy alternatives evaluated in the supplemental environmental impact statement (SEIS) would be the best or most-likely alternative to be selected in any given case.

This chapter provides (1) a description of the proposed action (NRC renewal of the operating license for Surry Power Station, Units 1 and 2 (Surry); (2) an in-depth evaluation of reasonable alternatives to the proposed action (including the no-action alternative), and (3) a brief description of the alternatives to the proposed action that the NRC staff considered but ultimately eliminated from in-depth evaluation.

2.1 Proposed Action

As stated in Section 1.1 of this document, the NRC's proposed Federal action is the decision of whether to renew the Surry operating licenses for an additional 20 years. Section 2.1.1 below provides a description of normal power plant operations during the subsequent license renewal term. In brief, Surry is a two-unit, nuclear powered, steam electric generating facility that began commercial operation in December 1972 (Unit 1), and May 1973 (Unit 2). The nuclear reactors are both Westinghouse pressurized water reactors (PWRs) that produce nominal core power rating of 2,587 megawatts thermal (MWt) (Dominion 2018b).

2.1.1 Plant Operations during the Subsequent License Renewal Term

Most plant operation activities during the subsequent license renewal term would be the same as, or similar to, those occurring during the current license term. NUREG-1437, Volume 1, Revision 1, *Generic Environmental Impact Statement for License Renewal of Nuclear Power Plants* (GEIS) (NRC 2013a), describes the issues that would have the same impact at all nuclear power plants, or a distinct subset of plants (generic issues) as well as those issues that would have different impact levels at different nuclear power plants (site-specific issues). The impacts of generic issues are described in NUREG-1437 as Category 1 issues; those impacts are set out in NUREG-1437 and Table B-1 of 10 CFR Part 51, Appendix B, and those determinations apply to each license renewal application, subject to the consideration of any new and significant information on a plant-specific basis. A second group of issues (Category 2) was identified in NUREG-1437 as having potentially different impacts at each plant, on a site-specific basis; those issues with plant-specific impact levels need to be discussed in a plant-specific SEIS such as this one.

Section 2.1.1 of the GEIS, “Plant Operations during the License Renewal Term,” describes the general types of activities that are carried out during the operation of all nuclear power plants. These general types of activities include the following:

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

As part of its subsequent license renewal application, Dominion Energy Virginia (Dominion) submitted an environmental report. Dominion’s environmental report states that Surry 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, to address structure and component aging in accordance with 10 CFR Part 54, “Requirements for Renewal of Operating Licenses for Nuclear Power Plants.”

2.1.2 Refurbishment and Other Activities Associated with Subsequent License Renewal

Refurbishment activities include replacement and repair of major structures, systems, and components. The major refurbishment class of activities characterized in the GEIS is intended to encompass actions that typically take place only once in the life of a nuclear plant, if at all (NRC 2013a). 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 plant-specific design.

In preparation for its license renewal application, Dominion evaluated major structures, systems, and components in accordance with 10 CFR 54.21, “Contents of Application—Technical Information,” to identify major refurbishment activities necessary for the continued operation of Surry during the proposed 20-year period of extended operation (Dominion 2018a).

Dominion did not identify any major refurbishment activities necessary for the continued operation of Surry beyond the end of the existing operating license (Dominion 2018b).

2.1.3 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 2002a), describes the impacts of decommissioning. The majority of plant operations activities would cease with reactor shutdown. However, some activities (e.g., security and oversight of spent nuclear fuel) would remain unchanged, whereas others (e.g., waste management, office and clerical work, laboratory analysis, surveillance, monitoring, and maintenance) would continue at reduced or altered levels. Systems dedicated to reactor operations would cease operations; 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 will occur whether Surry is shut down at the end of its current operating license or at the end of the subsequent period of extended operation 20 years later. There is no site-specific issue related to decommissioning. The license renewal GEIS concludes that license renewal would have a negligible (SMALL) effect on the impacts of terminating operations and decommissioning on all resources (NRC 2013a).

2.2 Alternatives

As stated above, the National Environmental Policy Act of 1969, as amended (NEPA), requires the NRC to consider reasonable alternatives to the proposed action of issuing subsequent renewed operating licenses for Surry. For a replacement power alternative to be reasonable, it must be both (1) commercially viable on a utility scale and (2) operational before the reactor's operating license expires or (3) expected to become commercially viable on a utility scale and operational before the reactor's operating license expires (NRC 2013a). The NRC published the most recent GEIS revision in 2013, and it incorporated the latest information on replacement power alternatives available at that time; however, rapidly evolving technologies are likely to outpace the information in the GEIS. As such, for each supplement to the GEIS, the NRC staff must perform a site-specific analysis of replacement power alternatives that accounts for changes in technology and science since the most recent GEIS revision.

The first alternative to the proposed action of the NRC issuing subsequent renewed operating licenses for Surry is for the NRC to not issue the licenses. This is called the no-action alternative. Section 2.2.1 below describes the no-action alternative. In addition to the no-action alternative, this section discusses four reasonable replacement power alternatives. These alternatives seek to replace Surry's generating capacity by meeting the region's energy needs through other means or sources. Sections 2.2.2.1 through 2.2.2.3 describe these replacement power alternatives for Surry.

2.2.1 No-Action Alternative

At some point, all operating nuclear power plants will permanently cease operations and undergo decommissioning. The no-action alternative represents a decision by the NRC to not issue renewed operating licenses to a nuclear power plant beyond the current operating license term. Under the no-action alternative, the NRC does not issue the subsequent renewed operating licenses for Surry and the units would shut down at or before the expiration of the current licenses in 2032 (Unit 1) and 2033 (Unit 2). The GEIS describes the environmental impacts that arise directly from permanent plant shutdown. The NRC expects shutdown impacts to be relatively similar whether they occur at the end of the current license term (i.e., after 60 years of operation) or at the end of a subsequent renewed license term (e.g., after 80 years of operation).

After permanent shutdown, plant operators will initiate decommissioning in accordance with 10 CFR 50.82, "Termination of license." The decommissioning GEIS (NUREG-0586) (NRC 2002) 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 Dominion terminates reactor operations at Surry. Chapter 4 of the GEIS (NUREG-1437) (NRC 2013a) and Section 4.15.2, "Terminating Plant Operations and Decommissioning," of this SEIS describe the incremental environmental impacts of subsequent license renewal on decommissioning activities.

Termination of operations at Surry would result in the total cessation of electrical power production by Surry Units 1 and 2. Unlike the replacement power alternatives described in Section 2.2.2, 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 power generated by Surry Units 1 and 2, the no-action alternative would likely create a need for a replacement power alternative. The following section describes a wide range of replacement power alternatives, and Chapter 4 assesses their potential environmental impacts. Although the NRC's authority only extends to deciding whether to issue renewed Surry Units 1 and 2 operating licenses, the replacement power alternatives described in the following sections represent possible options for energy-planning decisionmakers if the NRC decides not to issue subsequent renewed operating licenses for Surry Units 1 and 2.

2.2.2 Replacement Power Alternatives

In evaluating alternatives to subsequent license renewal, the NRC considered energy technologies or options currently in commercial operation, as well as technologies not currently in commercial operation but likely to be commercially available by the time the current Surry renewed operating licenses expire on May 25, 2032 (Unit 1), and January 29, 2033 (Unit 2).

The GEIS presents an overview of some alternative energy technologies but does not conclude which alternatives are most appropriate. Because alternative energy technologies are continually evolving in capability and cost, and because regulatory structures have changed to either promote or impede the development of particular technologies, the analyses in this chapter rely on a variety of sources of information to determine which alternatives would be available and commercially viable when the current licenses expire. Dominion's environmental report provides a discussion of replacement power alternatives. In addition to the information Dominion provided in its environmental report, the NRC staff's analyses in this chapter include updated information from the following sources:

- U.S. Department of Energy's (DOE), U.S. Energy Information Administration (EIA)
- other offices within the DOE
- U.S. Environmental Protection Agency (EPA)
- industry sources and publications

In total, the NRC staff considered 16 replacement power alternatives to the proposed action (see text box) and eliminated 13, leaving 3 reasonable replacement power alternatives for in-depth evaluation. Sections 2.2.2.1 through 2.2.2.3 contain the NRC staff's description of these three alternatives.

The NRC staff eliminated from in-depth evaluation those alternatives that could not provide the equivalent of Surry's current generating capacity, as those alternatives would not be able to satisfy the objective of replacing the power generated by these Surry units. Also, in some cases, the NRC staff eliminated those alternatives whose costs or benefits could not justify inclusion in the range of reasonable alternatives. Further, the NRC staff eliminated as unfeasible those alternatives not likely to be constructed and operational by the time the Surry licenses expire in 2032 (Unit 1) and 2033 (Unit 2). Section 2.3 of this report contains a brief discussion of each of the 13 eliminated alternatives and provides the basis for each elimination. To ensure that the alternatives considered in the SEIS are consistent with State or regional energy policies, the NRC staff reviewed energy-related statutes, regulations, and policies within the Surry region.

Alternatives Evaluated in Depth

- new nuclear (small modular reactors)
- natural gas combined cycle
- combination alternative (natural gas, solar, and demand-side management)

Alternatives Considered but Eliminated

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

The evaluation of each alternative considers the environmental impacts across the following impact categories: land use and visual resources, air quality and noise, geologic environment, water resources, ecological resources, historic and cultural resources, socioeconomics, human health, environmental justice, and waste management.

The GEIS assigns most site-specific issues (called Category 2 issues) a significance level of SMALL, MODERATE, or LARGE. For ecological resources subject to the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.) (ESA) and the Magnuson–Stevens Fishery Conservation and Management Act of 1996, as amended (16 U.S.C. 1801 et seq.); and historic and cultural resources subject to the National Historic Preservation Act of 1966, as amended (54 U.S.C. 300101 et seq.) (NHPA), the impact significance determination language is specific to the authorizing legislation. The order in which this SEIS presents the different alternatives does not imply increasing or decreasing level of impact; nor does the order presented imply that an energy-planning decisionmaker would be more (or less) likely to select any given alternative.

Region of Influence

If the NRC does not issue subsequent renewed licenses, procurement of replacement power for Surry may be necessary. The power station is located on the James River in Surry, VA, and is owned and operated by the Virginia Electric and Power Company (Dominion). Dominion provides electricity to customers in Virginia and northeastern North Carolina, and is also a member of PJM, the operator of the wholesale electric grid in the Mid-Atlantic region of the United States (Dominion 2018d). Dominion's service territory within Virginia contains the company's largest proportion of generation facilities and constitutes the region of influence (ROI) for the NRC staff's analysis of Surry replacement power alternatives.

In 2017, electric generators in Virginia had a net summer generating capacity of approximately 28,000 megawatts (MW). This capacity included units fueled by natural gas (46 percent), hydroelectric and pumped storage (15 percent), coal (14 percent), nuclear power (13 percent), and petroleum (9 percent). Biomass and solar sources comprised the balance of generating capacity in the State (EIA 2019b).

The electric industry in Virginia generated approximately 90,000 gigawatt hours (GWh) of electricity in 2017. This electrical production was dominated by natural gas (49 percent), nuclear power (34 percent), and coal (12 percent). Biomass, hydroelectric, petroleum, and solar energy sources collectively fueled the remaining 5 percent of this electricity (EIA 2019c).

In the United States, natural gas generation rose from 16 percent of electricity generated in 2000 to 31 percent in 2017. Given known technological and demographic trends, the EIA predicts that by 2050, natural gas will account for 35 percent of electricity generated in the United States (EIA 2013, 2016, 2018c). Electricity generated from renewable energy is expected to grow from 13 percent of total generation in 2015 to 30 percent in 2050 (EIA 2016, 2018a). However, renewable energy growth within the Surry region of influence may not follow nationwide forecasts. Although Virginia has a renewable portfolio goal of 15 percent renewable energy production by 2025, 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 (Power 2018, LBNL 2017).

The remainder of this section describes in depth the three reasonable replacement power alternatives to Surry license renewal. These three reasonable alternatives are as follows:

- a new nuclear alternative (Section 2.2.2.1)
- a natural gas combined-cycle alternative (Section 2.2.2.2)
- a combination alternative of natural gas combined-cycle, solar power, and demand-side management (Section 2.2.2.3)

Table 2-1 below summarizes key design characteristics of these three alternative replacement power technologies.

1 **Table 2-1 Overview of Replacement Power Alternatives Considered in Depth**

Alternative	New Nuclear (Small Modular Reactor)	Natural Gas Combined-Cycle	Combination (Natural Gas Combined-Cycle, Solar, and Demand-Side Management)
Summary	Four or more modular reactor units for a total of approximately 1,600 MWe	Three 560-MWe units for a total of approximately 1,680 MWe	Approximately 1,300 MWe from natural gas combined-cycle (two units), 200 MWe from solar PV, and 180 MWe from demand-side management.
Location	Located within the Surry site on developed and undeveloped land. Could require relocation of existing buildings. Would use Surry's existing transmission lines and some existing infrastructure (Dominion 2018b, 2019b)	Located within the Surry site on previously undisturbed land. Would use Surry's existing transmission lines and some existing infrastructure (Dominion 2018b, 2019b)	The natural gas component would be located within the Surry site on previously undisturbed land (Dominion 2018b, 2019b) The solar component would be located at multiple sites distributed across the ROI, offsite of Surry (Dominion 2018b, 2019b). Assumes demand-side management energy savings within Dominion's service territory.
Cooling System	Closed cycle with mechanical draft cooling towers. Cooling water withdrawal—53 mgd; Consumptive water use—37 mgd (NRC 2018c)	Closed cycle with mechanical draft cooling towers. Cooling water withdrawal—10 mgd; Consumptive water use—7.9 mgd (NETL 2013)	Natural gas combined-cycle units would use closed-cycle cooling systems with mechanical draft cooling towers. Cooling water withdrawal for these natural gas units—7.9 mgd; Consumptive water use for these natural gas units—6.1 mgd (NETL 2013). No cooling system would be required for the solar facilities and demand-side management.

Alternative	New Nuclear (Small Modular Reactor)	Natural Gas Combined-Cycle	Combination (Natural Gas Combined-Cycle, Solar, and Demand-Side Management)
Land Required	Approximately 50 ac (20 ha) for plant facilities and 83 acres (34 ha) for relocation of existing buildings (Dominion 2018b, 2019b).	Approximately 80 ac (32 ha) for plant facilities. A small amount of additional onsite land would be needed for a short spur to access existing gas pipelines. No new gas wells would be needed to support the facility (Dominion 2018b, 2019b).	The natural gas plant would require approximately 80 ac (32 ha) for plant facilities. A small amount of additional onsite land would be needed for a short spur to access existing gas pipelines. No new gas wells would be needed to support the facility (Dominion 2018b, 2019b). Solar facilities would collectively require approximately 5,000 ac (2,000 ha) (NRC 2013a). Demand-side management requires no land.
Work Force	2,200 workers during peak construction and 1,000 workers during operations (NRC 2018c).	1,300 workers during peak construction and 170 workers during operations (NRC 2016a).	Natural gas combined-cycle and solar units would collectively require approximately 1,800 workers during peak construction and 200 workers during operations. (NRC 2016a; DOE 2011b).

2.2.2.1 New Nuclear Alternative (Small Modular Reactor)

The NRC staff considers the construction of a new nuclear plant to be a reasonable alternative to Surry subsequent license renewal. Nuclear generation currently accounts for approximately 34 percent of the electricity produced in Virginia (EIA 2019c). In addition to Surry, one other nuclear power plant operates within the region of influence: North Anna Power Station, Units 1 and 2, located approximately 86 miles (138 km) to the northwest.

For the new nuclear alternative, the NRC staff considered the installation of multiple small modular reactors (SMRs). Small modular reactors, in general, are light-water reactors that use water for cooling and enriched uranium for fuel in the same manner as conventional, large light-water reactors currently operating in the United States. Each SMR typically generates 300 megawatts electric (MWe) or less, compared to today's larger designs that can generate 1,000 MWe or more per reactor. However, their smaller size means that several SMRs can be bundled together in a single containment. Smaller size also means greater siting flexibility, because they can fit in locations not large enough to accommodate a conventional nuclear reactor (NRC 2018a; DOE 2018). SMR design features include underground 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 are 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 2018c).

The NRC established the Advanced Reactor Program in its Office of New Reactors because of considerable interest in SMRs along with anticipated license applications from vendors. The NRC received the first design certification application for an SMR in December 2016 (NRC 2019b). Following NRC certification, this design could potentially achieve operation on a commercial scale by 2026 (NuScale 2018). Therefore, SMRs could be constructed and operational by the time the Surry licenses expire in 2032 and 2033, respectively.

For this subsequent license renewal analysis, the NRC staff assumed that two colocated SMR facilities would replace Surry. The analysis is based upon a generic SMR plant design and representative construction and operating parameters derived from several commercial designs (NRC 2018c). The NRC staff further assumed that each of the SMR facilities would contain two or more modular reactor units, which collectively would replace approximately 1,600 MWe, or 95 percent, of the 1,676 MWe that Surry currently provides. The reactors would be located at the Surry site on developed and undeveloped land in the area between Units 1 and 2 and the existing independent spent fuel storage installation. Use of this area could require the relocation of existing buildings (including the current radwaste facility) to other parts of the Surry site, specifically to the 83 ac (34 ha) forested area on the western half of the Surry property adjacent to the Hog Island Wildlife Management Area. The SMR facilities would use a closed-cycle cooling system with mechanical draft cooling towers. To support the plant's cooling needs, this cooling system would withdraw approximately 53 million gallons per day (mgd) (200,000 cubic meters per day (m3/d)) of water and consume 37 mgd (140,000 m3/d) of water (NRC 2018c). Although some infrastructure upgrades may be required, it is assumed that the existing transmission line infrastructure would be sufficient to support the SMR alternative (Dominion 2018b, 2019a).

2.2.2.2 Natural Gas Combined-Cycle Alternative

As discussed earlier, natural gas represents approximately 46 percent of the installed generation capacity and 49 percent of the electrical power generated in Virginia (EIA 2019b, 2019c). The NRC staff considers the construction of a natural gas combined-cycle power plant to be a reasonable alternative to Surry subsequent license renewal because natural gas is a feasible, commercially available option for providing baseload electrical generating capacity beyond the expiration of Surry's current licenses.

Baseload natural gas combined-cycle power plants (abbreviated in this section as natural gas plants) have proven their reliability and can have capacity factors as high as 87 percent (EIA 2015b). 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 2013a).

For the natural gas alternative, the NRC staff assumes that three approximately 645 MWe natural gas units would be constructed and operated using an 87 percent capacity factor, to collectively replace Surry's generating capacity of 1,676 MWe. Each unit configuration 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 NRC staff assumes that the natural gas power plant will incorporate a selective catalytic reduction system to minimize the plant's nitrogen oxide emissions (NETL 2007). Natural gas would be extracted from the ground through wells, treated to remove impurities, and then blended to meet pipeline gas standards before being piped through the State's pipeline system to the Surry site. The natural gas alternative would produce waste, primarily in the form of spent catalysts used for control of nitrogen oxide emissions.

Dominion indicated that the gas plant would be located at Surry on previously undisturbed forested land in the western half of the Surry property, north and west of the existing independent spent fuel storage installation, and would allow for the maximum use of the location's existing ancillary facilities (e.g., support buildings and transmission infrastructure). This area extends north to the Surry property boundary with the Hog Island Wildlife Management Area alternative (Dominion 2018b, 2019a).

Approximately 80 acres (32 ha) would be used to construct and operate the natural gas plant (Dominion 2018b). The natural gas plant would require a short spur to be connected to the existing pipeline corridor that supplies gas to the adjacent Gravel Neck Combustion Turbines Station, but no new gas wells would be required. Although some infrastructure upgrades may be required in association with the natural gas alternative, it is assumed that the existing transmission line infrastructure at the selected location would be adequate to support the alternative.

The NRC staff assumes that the natural gas combined-cycle plant would use a closed-cycle cooling system with mechanical draft cooling towers. To support the plant's cooling needs, this cooling system would withdraw approximately 10 mgd (38,000 m^3/d) of water and consume 7.9 mgd (30,000 m^3/d) of water (NETL 2013). Because of the high overall thermal efficiency of this type of plant, the natural gas combined-cycle alternative would require less cooling water than Surry subsequent license renewal. Onsite visible structures could include cooling towers, exhaust stacks, intake and discharge structures, transmission lines, natural gas pipelines, and an electrical switchyard.

2.2.2.3 Combination Alternative (Natural Gas Combined-Cycle, Solar, and Demand-Side Management)

This alternative combines natural gas and solar replacement power generation with demand-side management to meet the needs and purpose of the Surry subsequent license renewal. Natural gas and solar power generating facilities currently operate within the region of influence. For this evaluation, the NRC staff assumes that (1) a natural gas combined-cycle plant would supply 1,300 MWe, (2) solar photovoltaic power plants would supply 200 MWe, and (3) 180 MWe of energy savings would be gained from energy efficiency initiatives (i.e., demand-side management).

Natural Gas Combined-Cycle Portion of Combination Alternative

The natural gas portion of the combination alternative would entail construction and operation of a natural gas combined-cycle plant located at Surry. The plant would be similar in function and appearance to the natural gas plant described in Section 2.2.2.2 for the natural gas-only alternative. Although some infrastructure upgrades may be required in association with the natural gas portion of the combination alternative, it is assumed that the existing transmission line infrastructure at the selected location would be adequate to support the alternative. Like the natural gas plant described in Section 2.2.2.2, the natural gas portion of the combination alternative would be located on approximately 80 ac (32 ha) of previously undisturbed land.

For this analysis, the NRC staff assumes that the plant would consist of three approximately 500 MWe natural gas units that would be constructed and operated using an 87 percent capacity factor (EIA 2015b) to collectively provide an approximate net generating capacity of 1,300 MWe.

The natural gas plant would use a closed-cycle cooling system with mechanical draft cooling towers. To support the plant's cooling needs, this system would withdraw approximately 7.9 mgd) (30,000 m^3/d) of water and consume 6.1 mgd (23,000 m^3/d) of water (NETL 2013). Similar to the standalone natural gas alternative discussed in Section 2.2.2.2, onsite visible structures could include cooling towers, exhaust stacks, intake and discharge structures, transmission lines, natural gas pipelines, and an electrical switchyard.

<u>Solar Portion of Combination Alternative</u>

The solar portion of the combination alternative would be generated using solar photovoltaic energy facilities located in the region of influence. For this analysis, the NRC staff assumes that two approximately 400 MWe standalone, utility scale solar facilities would be constructed and operated to provide a gross generating capacity of 800 MWe. Both of these facilities would be located at offsite locations within the region of influence (Dominion 2018b). Assuming a 25 percent capacity factor (EIA 2018b), the solar units collectively would have an approximate net generating capacity of 200 MWe. Nationwide, growth in utility scale solar photovoltaic facilities (greater than 1 MW) has resulted in an increase from 70 MW in 2008 to over 20,000 MW installed capacity in 2017 (EIA 2017).

Solar photovoltaic resources across Virginia range from 4.0 to 5.0 kilowatt hours per square meter per day (kWh/m^2/day) (NREL 2017). The feasibility of solar energy resources serving as alternative baseload power depends on the location, value, accessibility, and constancy of solar radiation. 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 whenever 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) (DOE 2011a). Because the region of influence contains average solar photovoltaic resources and because solar photovoltaic technology is a commercially available option for providing electrical generating capacity, the NRC staff considers the construction and operation of solar photovoltaic facilities to be reasonable when combined with other generation sources.

Utility-scale solar facilities require large areas of land to be cleared for the solar panels. For standalone sites, solar photovoltaic facilities may require approximately 6.2 ac (2.5 ha) per megawatt (NRC 2013a). Therefore, a total of approximately 5,000 ac (2,000 ha) would be required to construct and operate the two proposed solar power installations needed under this alternative. Although not all of this land would be cleared of vegetation and permanently impacted, it represents the land enclosed in the total site boundary of the solar facility (NREL 2013). Solar photovoltaic systems do not require water for cooling purposes, but they do require a small amount of water to clean the panels and for potable water for the workforce.

Demand-Side Management Portion of Combination Alternative

Energy conservation and efficiency programs are more broadly referred to as demand-side management. Energy conservation programs can include reducing energy demand through consumer behavioral changes or through altering the shape of the electricity load and does not require the addition of new generating capacity. Conservation and energy efficiency programs can be initiated by a utility, transmission operators, the State, or other load serving entities.

Although Virginia does not have a mandatory energy efficiency resource standard, demand-side management programs represent a fundamental component of Dominion's 2018 Integrated Resource Plan (IRP) (Dominion 2018b).

Under the combination alternative, demand-side management could be used to replace approximately 180 MW of the electrical generating capacity that Surry currently provides. A 2018 study of Dominion-approved demand-side management programs projected that these initiatives could reduce electrical demand across Dominion Energy's service area by more than 300 MWe by 2033 (Dominion 2018b, 2018d). Therefore, the NRC staff determined that replacement of 180 MWe of Surry output through demand-side management programs to be a reasonable assumption supporting the combination alternative.

2.3 Alternatives Considered but Eliminated

The NRC staff originally considered 16 replacement power alternatives to Surry's subsequent license renewal but ultimately eliminated 13 of these from detailed study. The NRC staff eliminated these 13 alternatives because of technical reasons, resource availability limitations, or commercial or regulatory limitations. Many of these limitations will likely still exist when the current Surry licenses expire in 2032 (Unit 1) and 2033 (Unit 2), such that these 13 alternatives are not expected to be reasonably available when needed to replace the power generated by Surry Units 1 and 2. This section describes the 13 eliminated alternatives as well as the reasons why the NRC staff eliminated each alternative.

2.3.1 Solar Power

Solar power, including solar photovoltaic (PV) and concentrating solar power (CSP) technologies, produces power generated 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. The steam then drives a turbine connected to a generator to ultimately produce electricity (NREL 2014). To be considered a viable alternative, a solar alternative must replace the amount of electricity that Surry would provide during the period of extended operation (PEO) for this proposed action. Assuming a capacity factor of 25 percent (EIA 2018b), approximately 6,700 MWe of additional solar energy capacity would need to be installed in the region of influence to replace the electricity provided by Surry during the PEO.

Solar generators are considered an intermittent resource because their availability depends on ambient exposure to the sun, also known as solar insolation (EIA 2017). Insolation rates of solar photovoltaic resources in Virginia are average and range from 4.0 to 5.0 kWh/m^2/day (NREL 2017). With only 347 MWe of capacity installed across Virginia as of 2017, solar PV represents a small but increasing contribution to the state's electrical generation (EIA 2018d, 2019b).

Considering the above factors, the NRC staff concludes that solar power energy facilities alone do not provide a reasonable alternative to Surry subsequent license renewal. However, the NRC staff does consider an alternative using solar power in combination with other power technologies, as described in Section 2.2.2.3.

2.3.2 Wind Power

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

To be considered a reasonable replacement power alternative to Surry subsequent license renewal, the wind power alternative must replace the amount of electricity that Surry provides. Assuming a capacity factor of 40 percent, a combination of land based and offshore wind energy facilities in the region of influence would have to generate approximately 4,200 MWe of electricity.

The American Wind Energy Association reports a total of more than 96,000 MW of installed wind energy capacity nationwide as of December 31, 2018. Texas leads all other States in installed land-based wind energy capacity with nearly 25,000 MW (DOE 2019d). In contrast, Virginia currently has no installed utility-scale wind energy capacity and limited onshore wind potential available to support the development of future wind energy systems (EIA 2018d; Dominion 2018b).

In 2016, a 30 MW project off the coast of Rhode Island become the first operating offshore wind farm in the United States (Energy Daily 2016). Although wind projects proposed for State and Federal waters off the coast of Virginia are in the planning stages, no utility scale offshore wind farms are currently in operation in the region (EIA 2018d).

Given the amount of wind capacity necessary to replace Surry, the intermittency of the resource, and the status of wind development in the region of influence, the NRC staff finds a wind power—either land based, offshore, or some combination of the two—to be an unreasonable alternative to Surry subsequent license renewal.

2.3.3 Biomass Power

Biomass resources used for biomass-fired 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). Using biomass-fired generation for baseload power depends on the geographic distribution, available quantities, constancy of supply, and energy content of biomass resources. For this analysis, the NRC staff assumes that biomass would be combusted for power generation in the electricity sector.

In 2017, biomass facilities in the region of influence had a total installed capacity of approximately 890 MW, and approximately 4 percent of the total power in the region of influence was generated from biomass sources (EIA 2019b, 2019c).

For utility scale biomass electricity generation, the NRC staff assumes that the technologies used for biomass conversion would be similar to the technology used in other fossil fuel plants, including the direct combustion of biomass in a boiler to produce steam (NRC 2013a). Biomass generation is generally more cost effective when co-fired with coal plants (IEA 2007). However, most biomass-fired generation plants generally only reach capacities of 50 MW, which means replacing the approximately 1,680 MWe generating capacity of Surry using only biomass would require the construction of more than 33 new, average-sized biomass facilities. Sufficiently increasing biomass-fired generation capacity by expanding existing biomass units or constructing new biomass units by the time Surry's licenses expire in 2032 and 2033, respectively, is unlikely. For this reason, the NRC staff does not consider biomass-fired generation to be a reasonable alternative to Surry subsequent license renewal.

2.3.4 Demand-Side Management

Energy conservation and efficiency programs are more broadly referred to as demand-side management. Energy conservation programs can include reducing energy demand through consumer behavioral changes or through altering the shape of the electricity load and does not require the addition of new generating capacity. Conservation and energy efficiency 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 programs is voluntary (NRC 2013a). Therefore, the mere existence of a program does not guarantee that reductions in electricity demand will occur. The GEIS concludes that, although the energy conservation or energy efficiency potential in the United States is substantial, the NRC is aware of no cases where an energy efficiency or conservation program alone has been implemented expressly to replace or offset a large baseload generation station (NRC 2013a).

Although Dominion 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 energy supply that would be lost by the shutdown of Surry (Dominion 2018b, 2018 d). Therefore, the NRC staff does not consider demand-side management programs alone to be a reasonable alternative to Surry subsequent license renewal. However, the NRC staff does consider an alternative using demand-side management in combination with other power technologies, as described in Section 2.2.2.3.

2.3.5 Hydroelectric Power

Currently, approximately 2,000 hydroelectric facilities operate in the United States. Hydroelectric technology captures flowing water and directs it to a turbine and generator to produce electricity (NRC 2013a). There are three variants of hydroelectric power: (1) run of the river (diversion) facilities that redirect the natural flow of a river, stream, or canal through a hydroelectric 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 load periods to be released during peak load periods through the turbines to generate additional electricity. Although Virginia is home to the largest hydroelectric storage facility in the world—the 3,000-MW Bath County Pumped Storage Station—hydroelectric power accounts for less than 2 percent of Virginia's electric power production (EIA 2018d, 2019c).

A comprehensive survey of hydropower resources, completed in 1997, identified Virginia as having 617 MW of potential new hydroelectric capacity when adjusted for environmental, legal, and institutional constraints (Conner et al. 1998). These constraints could include (1) scenic, cultural, historical, and geological values; (2) Federal and State land use; and (3) legal protection issues, such as scenic rivers legislation and threatened or endangered fish and wildlife legislative protection. In a separate assessment of nonpowered dams (dams that do not produce electricity), the DOE concludes that hydropower resources in the region of influence could potentially generate 50 MW of electricity (ORNL 2012). These nonpowered dams serve various purposes, such as providing water supply to inland navigation. 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 in the region of influence (Dominion 2018b; EIA 2013). The potential for future construction of large hydropower facilities has diminished because of increased public concerns over flooding, habitat alteration and loss, and destruction of natural river courses (NRC 2013a).

Given the projected lack of growth in hydroelectric power production, the competing demands for water resources, and the expected public opposition to the large environmental impacts and significant changes in land use that would result from the construction of hydroelectric facilities, the NRC staff concludes that the expansion of hydroelectric power is not a reasonable alternative to Surry subsequent license renewal.

2.3.6 Geothermal Power

Geothermal technologies extract the heat contained in geologic formations to produce steam to drive a conventional steam turbine generator. Facilities producing electricity from geothermal energy have demonstrated capacity factors of 95 percent or greater, 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 geothermal energy generation requires geothermal reservoirs with a temperature above 200 °F (93 °C). Known 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. In general, most assessments of geothermal resources have been concentrated on these Western States (DOE 2013b; USGS 2008a). Geothermal resources are used in the Surry region of influence for heating and cooling purposes, but no electricity is currently being produced from geothermal resources in the region of influence (EIA 2018d). Given the low resource potential in the region of influence, the NRC staff does not consider geothermal power to be a reasonable alternative to Surry subsequent license renewal.

2.3.7 Wave and Ocean Energy

Waves, currents, and tides are often predictable and reliable, making them attractive candidates for potential renewable energy generation. Four major technologies may be suitable 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). Point absorbers and attenuators use floating buoys to convert wave motion into mechanical energy, driving a generator to produce electricity. Overtopping devices trap a portion of a wave at a higher elevation than the sea surface; waves then enter a tube and compress air that is used to drive a generator that produces electricity (NRC 2013a). Some of these technologies are undergoing demonstration testing at commercial scales, but none are currently used to provide baseload power (BOEM undated).

The United States' Mid-Atlantic coast is characterized by substantial amounts of wave energy arriving from the north (EPRI 2011). However, wave and ocean energy generation technologies are still in their infancy and currently lack commercial application. For these reasons, the NRC staff does not consider wave and ocean energy to be a reasonable alternative to Surry subsequent license renewal.

2.3.8 Municipal Solid Waste

Energy recovery from municipal solid waste converts nonrecyclable waste materials into usable heat, electricity, or fuel through combustion. The three types of 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 used to drive a turbine generator to produce electricity. Ash is collected and taken to a landfill, and particulates are captured through a filtering system (EPA 2019b).

Currently, 75 waste-to-energy plants are in operation in 21 States, processing approximately 29 million tons of waste per year. These waste-to-energy plants have an aggregate capacity of 2,725 MWe (Michaels and Krishnan 2019). Although some plants have expanded to handle additional waste and to produce more energy, only one new plant has been built in the United States since 1995 (Power 2019). Because the average waste to energy plant produces about 50 MWe (Michaels 2010), more than 33 average-sized waste-to-energy plants would be necessary to provide the same level of output as Surry.

The decision to burn municipal waste to generate energy is usually driven by the need for an alternative to landfills rather than a need for energy. Given the improbability that additional stable supplies of municipal solid waste would be available to support more than 33 new facilities in the region of influence, the NRC staff does not consider municipal solid waste combustion to be a reasonable alternative to Surry subsequent license renewal.

2.3.9 Petroleum-Fired Power

Petroleum-fired electricity generation accounted for less than 1 percent of Virginia's total electricity generation in 2017 (EIA 2019c). The variable costs and environmental impacts of petroleum-fired 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 (EIA 2013, 2015a). Dominion's Integrated Resource Plan similarly anticipates no increase in the use of petroleum-fired power through 2033 (Dominion 2018d). Therefore, the NRC staff does not consider petroleum-fired generation to be a reasonable alternative to Surry subsequent license renewal.

2.3.10 Coal-Fired Power

Although coal has historically been the largest source of electricity in the United States, the EIA expects natural gas generation—and potentially even renewable energy generation—to surpass coal generation at the national level by 2040 (EIA 2016). Virginia exemplifies this trend, with coal historically fueling the largest share of electricity generated in the State until 2009, when coal's contribution fell below that of nuclear power (EIA 2018d). In 2017, coal-fired generation accounted for approximately 12 percent of all electricity generated in Virginia, a 40 percent decrease from 2000 levels (EIA 2019c).

Baseload coal units have proven their reliability and can routinely sustain capacity factors as high as 85 percent. Among the technologies available, pulverized coal boilers producing supercritical steam (supercritical pulverized coal, or SCPC boilers) are increasingly common for new coal-fired plants given their generally high thermal efficiencies and overall reliability. Supercritical pulverized coal facilities are more expensive than subcritical coal-fired plants to construct, but they consume less fuel per unit output, reducing environmental impacts. In a supercritical coal-fired power plant, burning coal heats pressurized water. As the supercritical steam and water mixture moves through plant pipes to a turbine generator, the pressure drops and the mixture flashes to steam. The heated steam expands across the turbine stages, which then spin and turn the generator to produce electricity. After passing through the turbine, any remaining steam is condensed back to water in the plant's condenser. Integrated gasification combined cycle is another technology that generates electricity from coal. It 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 from the gas stream before combustion.

An integrated gasification combined-cycle power plant consists of coal gasification and combined-cycle power generation. Coal gasifiers convert coal into a gas (synthesis gas, also referred to as syngas), which fuels the combined-cycle power generating units. Nearly 100 percent of the nitrogen from the syngas is removed before combustion in the gas turbines, which results in lower nitrogen oxide emissions when compared to conventional coal fired power plants (DOE 2010).

Although several smaller, integrated gasification combined-cycle power plants have been in operation since the mid-1990s, more recent large-scale projects using this technology have experienced a number of setbacks and opposition that have hindered the technology from being fully integrated into the energy market. The most significant roadblock has been the high capital cost of an integrated gasification combined-cycle power plant as compared to conventional coal-fired power plants. Both the Duke Energy Edwardsport Generation Station project in Indiana and the Kemper County integrated gasification combined-cycle project in east central Mississippi have experienced cost and schedule overruns. The Kemper County project suspended work toward startup of the gasifier component in June 2017 (Energy Daily 2017). Other issues associated with integrated gasification combined cycle include a limited track record for reliable performance and opposition based on environmental concerns. In its IRP, Dominion states that it has steadily reduced the coal-powered portion of its fleet and identifies no plans to add new coal-fired generation to its energy production portfolio (Dominion 2018d). Based on these considerations, the NRC staff concludes that coal-fired technologies would not provide a reasonable source of baseload power to replace Surry Units 1 and 2 by the time their current licenses expire in 2032 and 2033, respectively.

2.3.11 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 2013a). Hydrogen fuel can come from a variety of hydrocarbon resources. Natural gas is a typical hydrogen source.

Fuel cells are not economically or technologically competitive with other alternatives for electricity generation. The EIA estimates that fuel cells may cost $7,197 per installed kilowatt (total overnight capital costs in 2018 dollars), which is high compared to other alternative technologies analyzed in this section (EIA 2019a). More importantly, fuel cell units are likely to be small (approximately 10 MW). The world's largest fuel cell facility is a 59 MWe plant that came online in South Korea in 2014 (PEI 2017). Using fuel cells to replace the power that Surry provides would be extremely costly. It would require the construction of approximately 170 average-sized units and modifications to the existing transmission system. Given the immature status and high cost of fuel cell technology, the NRC staff does not consider fuel cells to be a reasonable alternative to Surry subsequent license renewal.

2.3.12 Purchased Power

It is possible that replacement power may be purchased and imported from outside the Surry region of influence. Although purchased power would likely have little or no measurable environmental impact in the immediate vicinity of Surry, impacts could occur where the power is generated or anywhere along the transmission route, depending on the generation technologies used to supply the purchased power (NRC 2013a). Dominion is currently planning to purchase 760 MW of solar PV capacity under long-term contracts with other generators in Virginia and North Carolina by 2020 to augment existing system generation (Dominion 2018d).

However, 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 (NRC 2013a). Power purchase agreements also carry the inherent risk that the supplying plant will not deliver the contracted power.

Based on these considerations, the NRC staff concludes that purchased power does not provide a reasonable alternative to Surry subsequent license renewal.

2.3.13 Delayed Retirement

Retiring a power plant ends its ability to supply electricity. Delaying the retirement of a power plant enables it to continue supplying electricity. A delayed retirement alternative would delay the retirement of generating facilities (other than Surry) within or near the region of influence.

Power plants retire for several reasons. Because generators are required to adhere to additional regulations that will require significant reductions in plant emissions, some power plant owners may opt for early retirement of older units (which often generate more pollutants and are less efficient) rather than incur the cost for compliance. Additional retirements may be driven by low competing commodity prices (such as low natural gas prices), slow growth in electricity demand, and the requirements of the EPA's Mercury and Air Toxics Standards (EIA 2015a; EPA 2015).

Dominion's IRP identifies that 2,785 MW of generation powered by older, less-efficient coal, oil, and natural gas technologies potentially could be retired between 2019 and 2033 (Dominion 2018d). Dominion further notes in its environmental report that it does not consider the reactivation and/or continued operation of older fossil fuel plants to be viable alternatives for providing replacement power because it would not support Dominion's goals of a reduction in air emissions in its energy generation portfolio (Dominion 2018b). Because of these conditions, the NRC staff concludes that delayed retirement does not provide a reasonable alternative to Surry subsequent license renewal.

2.4 Comparison of Alternatives

In this chapter, the NRC staff considered in depth one alternative to Surry license renewal that does not replace the plant's energy generation (the no-action alternative) and three alternatives to license renewal that may reasonably replace Surry's energy generation. These three replacement power alternatives are (1) new nuclear generation (small modular reactor), (2) natural gas combined-cycle generation, and (3) a combination of natural gas combined-cycle generation, solar generation, and demand-side management. The environmental impacts of the proposed action and the alternatives are described and assessed in Chapter 4. Table 2-2 summarizes the environmental impacts of these three replacement power alternatives to Surry license renewal. The environmental impacts of the proposed action (issuing renewed Surry operating licenses) would be SMALL for all impact categories.

In comparison, each of the three reasonable replacement power alternatives has environmental impacts in at least two resource areas that are greater than the environmental impacts of the proposed action of license renewal. In addition, the replacement power alternatives also bring the environmental impacts inherent in new construction projects. If the NRC takes the no-action alternative and does not issue renewed licenses for Surry, energy-planning decisionmakers would likely implement one of the three replacement power alternatives discussed in depth in this chapter. Based on the NRC staff's review of these three reasonable replacement power alternatives, the no-action alternative, and the proposed action, the NRC staff concludes that the environmentally preferred alternative is the proposed action of license renewal. Therefore, the NRC staff proposes to recommend that the NRC issue the renewed Surry operating licenses.

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

Impact Area (Resource)	Surry License Renewal (Proposed Action)	No-Action Alternative	New Nuclear Alternative (Small Modular Reactor)	Natural Gas Combined-Cycle Alternative	Combination Alternative (Natural Gas Combined-Cycle, Solar, and Demand-Side Management)
Land Use	SMALL	SMALL	SMALL to MODERATE	SMALL to MODERATE	SMALL to LARGE
Visual Resources	SMALL	SMALL	SMALL to MODERATE	SMALL to MODERATE	SMALL to LARGE
Air Quality	SMALL	SMALL	SMALL	SMALL to MODERATE	SMALL to MODERATE
Noise	SMALL	SMALL	SMALL	SMALL	SMALL to MODERATE
Geologic Environment	SMALL	SMALL	SMALL	SMALL	SMALL
Surface Water Resources	SMALL	SMALL	SMALL	SMALL	SMALL
Groundwater Resources	SMALL	SMALL	SMALL	SMALL	SMALL
Terrestrial Resources	SMALL	SMALL	MODERATE	MODERATE	MODERATE
Aquatic Resources	SMALL	SMALL	SMALL	SMALL	SMALL to MODERATE
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	SMALL to MODERATE	SMALL to LARGE	SMALL to LARGE	SMALL to MODERATE
Transportation	SMALL	SMALL	SMALL to LARGE	SMALL to LARGE	SMALL to MODERATE
Human Health	SMALL[g]	SMALL[g]	SMALL[g]	SMALL[g]	SMALL[g]
Environmental Justice	See Note[h]	See Note[h]	See Note[h]	See Note[h]	See Note[h]
Waste Management and Pollution Prevention	SMALL[i]	SMALL[i]	SMALL [i]	SMALL	SMALL

(a) May affect, but is not likely to adversely affect, northern long-eared bat, shortnose sturgeon, and Atlantic sturgeon. May affect, but is not likely to adversely modify, designated critical habitat of the Chesapeake Bay distinct population segment of Atlantic sturgeon. No more than minimal adverse effects on essential fish habitat of the summer flounder (larvae, juveniles, and adults), Atlantic butterfish (juveniles and adults), bluefish (juveniles), and windowpane flounder (juveniles and adults) or on the prey base of the little skate (adults) or winter skate (adults). No adverse effects on the essential fish habitat of any life stages of the black sea bass, Atlantic herring, clearnose skate, or red hake.

(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.

(c) The types and magnitudes of adverse impacts to species listed in the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.), designated critical habitat, and EFH would depend on the proposed alternative site, 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) Based on the location of historic properties within and near the area of potential effect, tribal input, Dominion's administrative procedures, a site-specific cultural resource management plan, and no planned physical changes or ground-disturbing activities, the proposed action (license renewal) would not adversely affect historic properties.

(e) Until the post-shutdown decommissioning activities report is submitted, the NRC cannot determine whether historic properties would be affected outside the existing industrial site boundary after the nuclear plant is shut down.

(f) The impact determination of this alternative would depend on the specific location of the new facility. The Virginia Department of Historic Resources would need to be consulted prior to any ground-disturbing activities in undisturbed land areas at Surry.

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

(h) With the exception of the no-action alternative, there would be no disproportionately high and adverse impacts to minority and low-income populations. For the no-action alternative, the loss of jobs and income could have an immediate socioeconomic impact. This could disproportionately affect minority and low-income populations that may have become dependent on these services.

(i) NUREG-2157, "Generic Environmental Impact Statement for Continued Storage of Spent Nuclear Fuel," (NRC 2014b) discusses the environmental impact of spent fuel storage for the timeframe beyond the licensed life for reactor operations.

3 AFFECTED ENVIRONMENT

In conducting its environmental review of the Surry Power Station, Units 1 and 2 (Surry, or Surry Units 1 and 2) subsequent license renewal application, the U.S. Nuclear Regulatory Commission (NRC) first defines and describes the environment that could be affected by the subsequent license renewal. For this review, the NRC staff defines the affected environment as the environment that currently exists at and around the Surry site. Because existing conditions are at least partially the result of past construction and operations at the plant, this chapter presents the nature and impacts of these past actions as well as ongoing actions, and evaluates how, together, these actions have shaped the current environment. The effects of ongoing reactor operations at Surry have become well established as environmental conditions have adjusted to the presence of the nuclear power plant. Sections 3.2 through 3.13 describe the affected environment for each resource area. The resource discussions in this chapter include new and updated information that became available since the NRC issued the supplemental environmental impact statement (SEIS) for the initial Surry license renewal in 2002, as NUREG-1437, Supplement 6 (NRC 2002b).

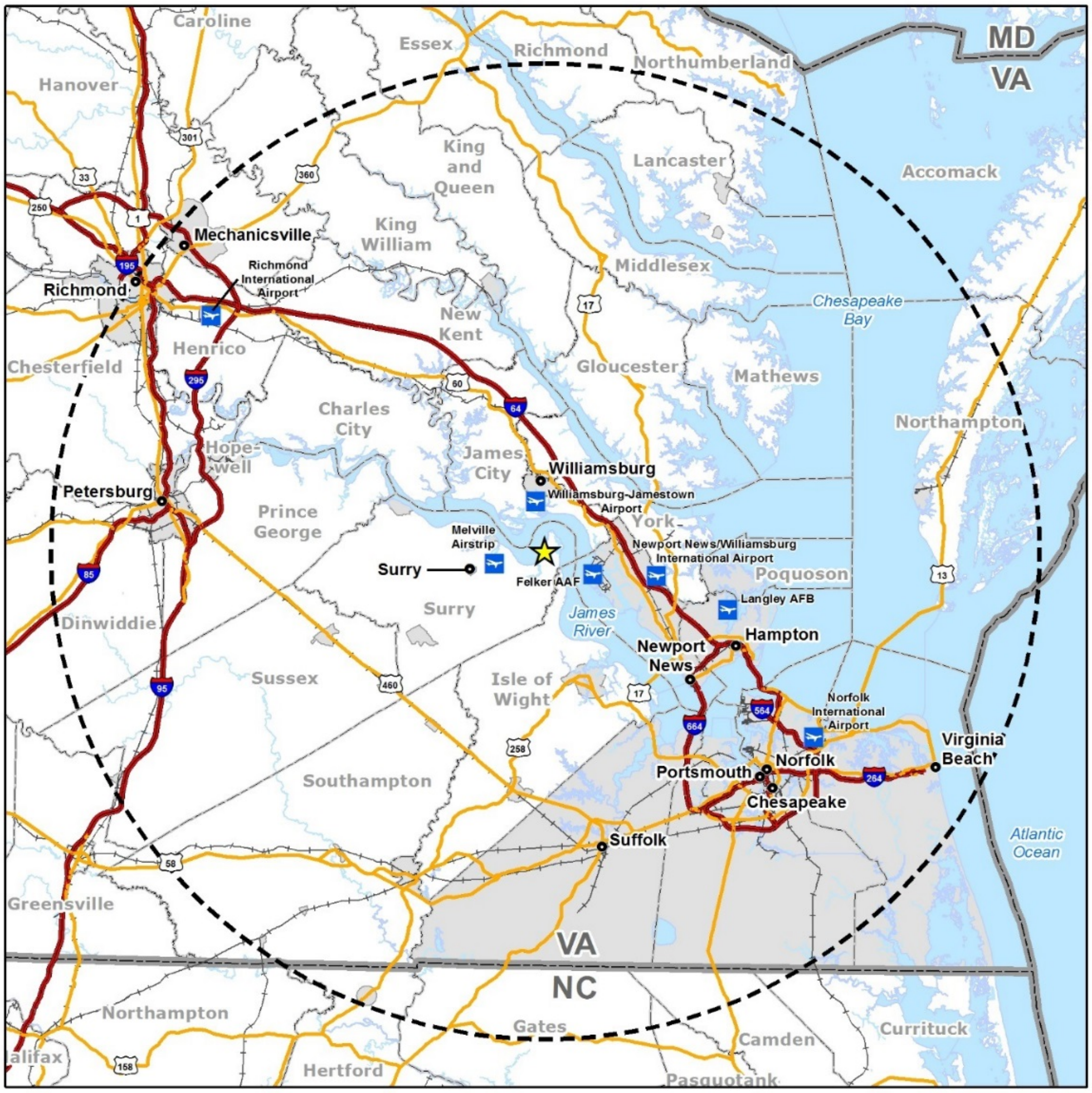
3.1 Description of Nuclear Power Plant Facility and Operation

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

3.1.1 External Appearance and Setting

The site is located 13 km (8 mi) east-northeast of the town of Surry, Virginia and 10 km (7 mi) south of Williamsburg, Virginia on the opposite side of the James River (Figure 3-1). Jamestown Island, part of the Colonial National Historic Park, is to the northwest on the northern shore of the James River. The area within 16 km (10 mi) of the site includes Surry, Isle of Wight, York, and James City Counties, and parts of the cities of Newport News and Williamsburg. The counties surrounding Surry are predominantly rural, characterized by farmland, woods, and marshy wetlands. East and south of the site, at distances between 16 and 48 km (10 and 30 mi), are the urban areas of Hampton, Newport News, Norfolk, and Portsmouth, Virginia, and others, collectively known as Hampton Roads. The city of Virginia Beach is the largest population center in the region (about 72 km (45 mi) east-southeast of the Surry site) (Dominion 2018b).

The Surry site is the location of the Gravel Neck Combustion Turbines Station (oil and natural gas-fired power plant), a switchyard, and an independent spent fuel storage installation (ISFSI), in addition to the reactors, turbine and auxiliary buildings, and intake and discharge canals (NRC 2002b). Surry is located on a point of land called the Gravel Neck Peninsula. Gravel Neck is at the upstream limit of saltwater incursion to the James River. Upstream of Gravel Neck is tidal river and downstream is an estuary. The 340-ha (840-ac) site extends as a band across the peninsula. Steep bluffs drop to the river on either side and to the tip of the peninsula. Hog Island Wildlife Management Area (HIWMA), a Commonwealth of Virginia wildlife management area, is located on the tip of the peninsula.



Source: Dominion 2018h

Figure 3-1 Surry Power Station 50 mi (80 km) Radius Map

3.1.2 Nuclear Reactor Systems

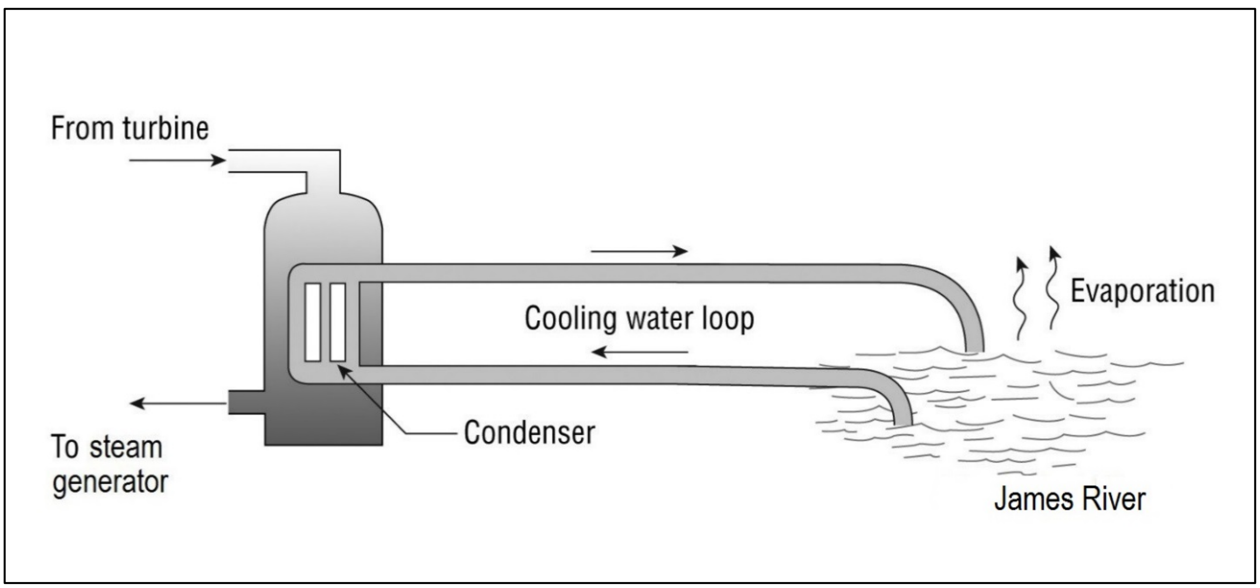
Surry Units 1 and 2, are Westinghouse pressurized water reactors (PWRs) with dry containments (steel-lined and reinforced-concrete). The NRC issued Surry Units 1 and 2, operating licenses on May 25, 1972, and January 29, respectively (NRC 2018a). The nuclear reactors produce a nominal core power rating of 2,587 megawatts thermal (MWt) (Dominion 2018b).

Surry fuel is low-enriched uranium dioxide (less than 5 percent by weight uranium-235) ceramic pellets. The pellets are sealed in tubes made of standard Zircaloy-4, ZIRLO, or optimized ZIRLO (Dominion 2018c). Surry refueling occurs on an 18-month schedule (Dominion 2018b).

3.1.3 Cooling and Auxiliary Water Systems

Surry uses a once-through circulating water system for heat dissipation. The circulating water system provides cooling water for the main condensers and the service water systems of both units. Surry withdraws water from the James River on the east side of the site into an intake canal. Heated cooling water from the main condenser, along with comingled effluents from auxiliary systems, returns to the James River on the west end of the site through a discharge canal (see Figure 3-3).

In pressurized water reactors, such as Surry, water is heated to a high temperature under pressure inside the reactor. This type of system uses three heat transfer (exchange) loops. Water (primary coolant) that absorbs heat from the reactor is first pumped from the primary loop to steam generators that serve each nuclear unit. Within the steam generators, water in the secondary loop is converted to steam. The steam is discharged to drive turbines, and the turbines turn the generator to produce electricity. The tertiary condenser cooling water loop condenses the steam exiting the turbines, and this condensate returns to the steam generators. The condenser cooling water does not come into direct contact with the primary coolant or water in the secondary loop. Heated water from the condenser cooling water loop can either flow to cooling towers where it evaporates to dissipate waste heat, or it can discharge directly to a body of water. At Surry, this heated water is returned directly back to the James River. Figure 3-2 provides a basic schematic diagram of the once-through cooling water system at Surry.



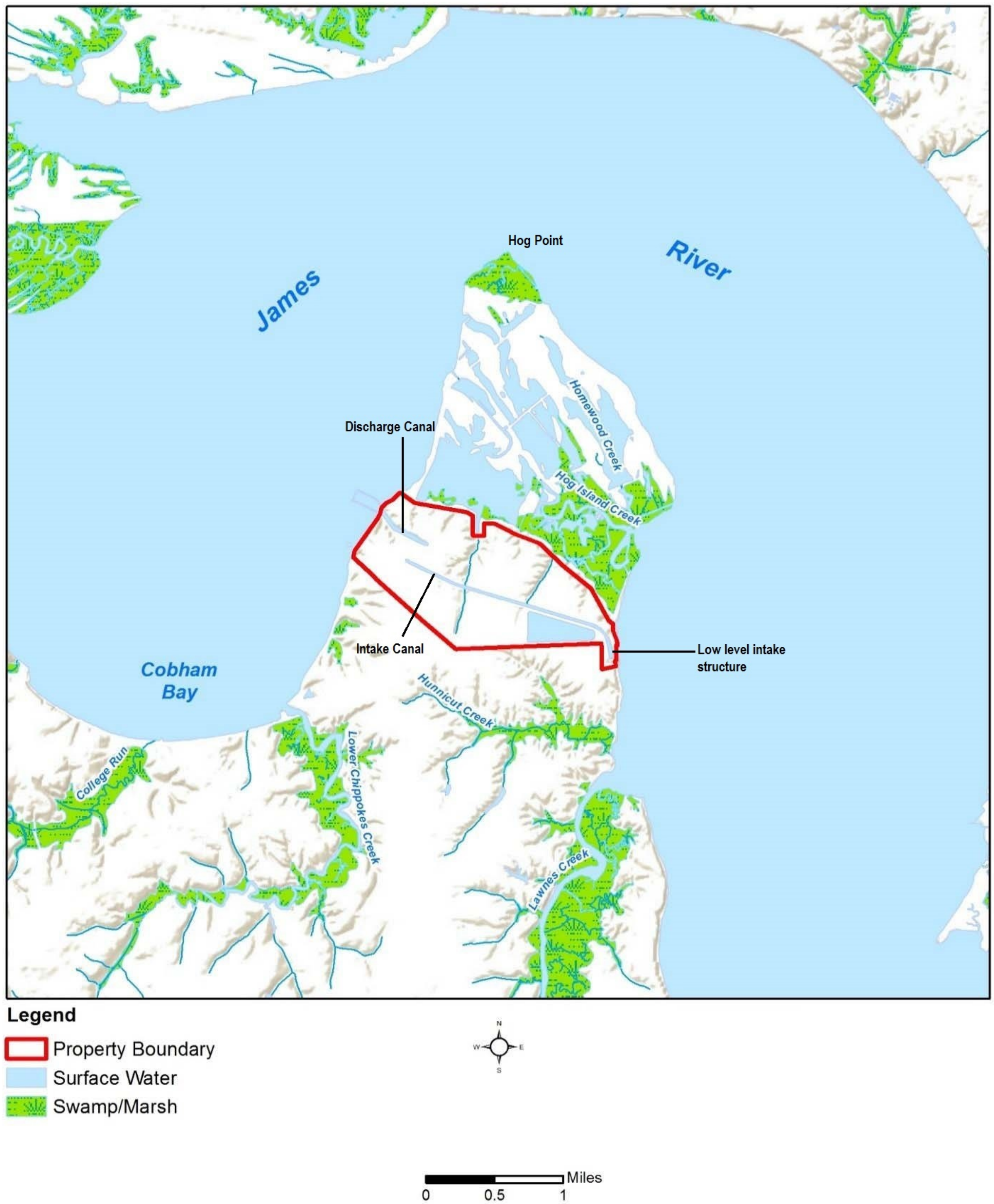
Source: Modified from NRC 2013a

Figure 3-2 Once-through cooling water system with River Water Source

3.1.3.1 River Water Intake and Discharge

The Surry circulating water system provides cooling water for the main condensers and the service water systems of both units. The circulating water system is designed to withdraw water from the James River on the east side of the site and to discharge to the James River on the west end of the site. Water returns to the James River approximately 5.7 mi (9.2 km) downstream of the intake, see Figure 3-3 (Dominion 2018b). The overland distance between the intake and discharge and across the peninsula is about 1.9 mi (3.1 km) (Dominion 2018b).

Each of Surry's two units requires 840,000 gallons per minute (gpm) (53 cubic meters per second (m^3/s)) of river water to supply condensing and service water needs when operating at full power. Cooling water is withdrawn from the James River via a dredged channel in the river bed. Water then enters a common low-level intake structure that lies parallel to and flush with the western shore of the river. The low-level intake structure consists of eight 15.3-ft (4.7-m)-wide reinforced concrete bays. Each bay is separated by a reinforced concrete wall and contains trash racks, Ristroph travelling water screens, and a circulating water pump (HDR 2017). Trash racks remove coarse trash prior to water entering the low-level intake structure, and Ristroph traveling screens prevent fish and finer debris from entering the intake cooling canal. The system contains a total of 47 Ristroph screen panels, each of which are 14-ft (4.6-m) wide by 2-ft (0.6-m) high with 1/8-inch (0.32-cm) by 1/2-inch (1.3-cm) rectangular screen mesh openings (HDR 2017).



Source: Modified from Dominion 2018b

Figure 3-3 Surry Water Intake and River Discharge Locations and Hydrological Features

The traveling screens rotate continuously during operation at a speed of 5-10 ft per minute (30-50 centimeters (cm) per second). However, at times of high fish abundance or low river levels, the screens can be rotated at a faster speed to reduce fish impingement time to roughly 1.5 minutes or less (HDR 2017). A low-pressure water spray washes impinged fish and debris from the traveling screens into steel fish buckets. A single return trough upstream of the screens transports fish and debris back to the James River approximately 1,000 ft (300 m) south of the intake structure and 300 ft (91 m) from the shore (HDR 2017).

Eight circulating water pumps, which are each rated at 220,000 gpm (13.8 m3/s), discharge water over the embankment of and into the high-level intake canal via a 96-inch (2.4-m) diameter steel pipe (Dominion 2018c). The intake canal is approximately 1.7 mi (2.7 km) long, has a bottom width of 32 ft (9.8 m), and is lined with reinforced concrete (Dominion 2018c). The intake canal supplies water to the circulating water system and service water system (Dominion 2018a). Water levels in the canal vary between 26 and 30 ft (7.9 and 9.1 m) above mean sea level (Dominion 2018a, SLR FSAR 10.3.4.2). Within the intake canal, cooling water flows towards two (one per unit) reinforced concrete high-level intake structures. Each high-level intake structure consists of four bays, and each bay contains a trash rack, traveling screen, and an inlet to a 96-inch-(2.4-m) diameter condenser intake line (Dominion 2018b, Dominion 2018a). Cooling water flows from the high-level intake bays for Surry Units 1 and 2 through an 8-ft (2.4-m) diameter pipe to the turbine steam condensers (Dominion 2018b).

Dominion Energy Virginia (Dominion) uses oxidizing biocides (sodium hypochlorite and sodium bromide) to control biofouling of cooling systems components (e.g., condenser tubes). Additionally, Dominion uses chemical additives to control pH, scale, and corrosion in the circulating water system. The Virginia Department of Environmental Quality regulates use of such chemicals under Surry's Virginia Pollutant Discharge Elimination System (VPDES) permit. The VPDES permit limits the discharge total residual chlorine to 0.016 mg/L to the James River via Outfall 001 (VDEQ 2016).

After passing through the condensers for use as cooling water, the now heated water flows through a discharge tunnel and into the discharge canal. Water in the discharge canal then flows into the James River. Average condenser inlet and outlet temperatures for the month of August from 2013–2017 show that water temperature can rise up to 17 °F (9.4 °C) after passing through the condensers (Dominion 2019a).

The discharge canal has an overall length of 2,900 ft (884 m), of which approximately 1,200 ft (366 m) extends into the James River (Dominion 2018a). This portion of the canal contains rock-filled groins along each side to control sedimentation and exit velocity. The velocity of water flowing in the discharge canal is approximately 2.2 ft per second (fps) (0.67 m/s) and the exit velocity at the terminal opening of the discharge canal is 6 fps (1.8 m/s) (VEPC 1980; Dominion 2018b).

Service water for auxiliary cooling systems is diverted and withdrawn from the system before the circulating water enters the condensers (NRC 2002b; Dominion 2018b). Heated water from the service water system is conveyed to the James River via the discharge canal. The service water systems include diesel-driven emergency service water pumps. In the event of a loss of station power at the river intake, three diesel-driven emergency service water pumps are located at the low-level intake structures designed to provide water from the James River to the intake canal (Dominion 2018c).

3.1.3.2 Well Water Supply System

The well-water supply system provides makeup water to the fire protection system and the domestic water supply system. Water is supplied via three onsite wells (Dominion 2019c). There are two 300,000-gallon water storage tanks (Fire Protection and Domestic Storage Tanks), each with 250,000 gallons reserved exclusively for the fire protection system and 50,000 gallons for domestic water use. The fire protection and domestic storage tanks supply water to a hydropneumatic tank that in turn supplies a potable domestic water supply to safety showers, drinking water coolers, and domestic cold water throughout the station (Dominion 2018c). Section 3.5.2.2 of this SEIS discusses Surry groundwater withdrawals.

3.1.4 Radioactive Waste Management Systems

As a result of normal operations, equipment repairs and replacements, and normal maintenance activities, nuclear power plants routinely generate both radioactive and nonradioactive waste. Nonradioactive waste includes hazardous and nonhazardous waste. There is also a class of waste—called mixed waste—that is both radioactive and hazardous. This section describes the systems that Dominion uses to manage (i.e., treat, store, and dispose of) these wastes. This section also discusses other waste minimization and pollution prevention measures that nuclear power plants commonly employ.

The NRC licenses all nuclear 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 Title 10 of the *Code of Federal Regulations* (10 CFR) Part 20, “Standards for Protection Against Radiation,” and the as low as reasonably achievable (ALARA) criteria in 10 CFR Part 50, 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.

Surry uses the liquid, gaseous, and solid waste management systems to collect and process radioactive materials contained in liquid, gaseous, and solid waste produced as a byproduct of plant operations. These systems are common to Surry Units 1 and 2, with exceptions for the primary drain transfer tanks and gaseous drain system in each reactor containment. The liquid, gaseous, and solid waste management systems assures that the dose to members of the public from radioactive effluents is reduced to levels that are ALARA in accordance with NRC regulations.

Dominion has 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 Surry. The REMP is discussed in Section 3.1.4.5.

Dominion 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 Surry meet NRC and U.S. Environmental Protection Agency (EPA) regulatory dose standards. The Offsite Dose Calculation Manual also contains the requirements for the REMP (Dominion 2018b).

3.1.4.1 Radioactive Liquid Waste Management

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

Potentially radioactive liquid wastes originating from the containment, auxiliary building, fuel building, safeguards facility, component cooling water heat exchanger and decontamination sumps, and from the laboratory drains at both Surry Units 1 and 2 are collected in waste drain tanks located in the auxiliary building. Liquid wastes in the waste drain tanks are transferred to liquid waste collection tanks in the Surry Radwaste Facility. Liquid wastes are then processed through the radwaste facility's liquid waste reverse osmosis and demineralizer system, which removes radioactive material and dissolved solids. The processed liquid waste is collected in one of two liquid-waste monitor tanks and sampled prior to release to the discharge canal via the radwaste facility liquid-effluent release line. A radiation monitor is located on this line. Potentially radioactive liquid wastes originating from the laundry and personal decontamination shower and sink are collected in contaminated drain tanks located in the auxiliary building. From the contaminated drain tanks, liquid waste flows through the laundry drain filter in the Surry Radwaste Facility. Filtered waste is collected in one of two laundry waste monitor tanks where liquids are sampled and released to the discharge canal via the radwaste facility liquid-effluent release line. The ODCM prescribes the alarm/trip setpoints for the liquid-effluent radiation monitors, which are derived from 10 times the effluent concentration limits provided in 10 CFR Part 20, Appendix B, Table 2, Column 2. There are liquid-effluent radiation monitors located on the radwaste facility liquid-effluent release line, the service water system effluent line, and the condenser circulating water line. The alarm/trip setpoint for each liquid-effluent monitor is based on the measurements of radioactivity in a batch of liquid to be released or in the continuous liquid discharge (Dominion 2018b).

Dominion's use of these radioactive waste systems and the procedural requirements in the ODCM assures the NRC that the dose from radioactive liquid effluents at Surry complies with NRC and EPA regulatory dose standards. Dominion calculates dose estimates for members of the public using radioactive liquid effluent release data and aquatic transport models. Dominion's annual radiological effluent release report contains a detailed presentation of the radioactive liquid effluents released from Surry and the resultant calculated doses.

The NRC staff reviewed 5 years of radioactive effluent release data from 2014 through 2018 (Dominion 2015a, 2016a, 2017a, 2018a, 2019b). 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 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) over the period spanning from 2014 through 2018.

The following summarizes the calculated doses from radioactive liquid effluents released from Surry during 2018:

Surry Unit 1 in 2018

- The total-body dose to an offsite member of the public from Surry Unit 1 radioactive effluents was 2.81×10^{-4} millirem (mrem) (2.81×10^{-8} millisievert (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 Surry Unit 1 radioactive effluents was 4.36×10^{-4} mrem (4.36×10^{-8} millisievert (mSv)), well below the 10 mrem (0.1 mSv) dose criterion in Appendix I to 10 CFR Part 50.

Surry Unit 2 in 2018

- The total-body dose to an offsite member of the public from Surry Unit 2 radioactive effluents was 2.81×10^{-4} millirem (mrem) (2.81×10^{-8} millisievert (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 Surry Unit 2 radioactive effluents was 4.36×10^{-4} mrem (4.36×10^{-8} millisievert (mSv)), well below the 10 mrem (0.1 mSv) dose criterion in Appendix I to 10 CFR Part 50.

The NRC staff's review of Dominion's radioactive liquid effluent control program shows that the applicant maintained radiation doses to members of the public that were within the NRC and EPA radiation protection standards as contained in Appendix I to 10 CFR Part 50, 10 CFR Part 20, and Title 40, *Protection of Environment*, of the *Code of Federal Regulations* (40 CFR) Part 190, "Environmental Radiation Protection Standards for Nuclear Power Operations." The NRC staff observed no adverse trends in the dose levels.

Routine plant refueling and maintenance activities at Surry will continue during the subsequent license renewal term. Based on Dominion's past performance in operating a radioactive waste system at Surry that maintains ALARA doses from radioactive liquid effluents, the NRC staff expects Dominion will maintain similar performance during the subsequent license renewal term.

3.1.4.2 Radioactive Gaseous Waste Management

Dominion calculates dose estimates for members of the public based on radioactive gaseous effluent release data and atmospheric transport models. Dominion's annual radioactive effluent release report contains a detailed presentation of the radioactive gaseous effluents released from Surry and the resultant calculated doses. The NRC staff reviewed 5 years of radioactive effluent release data from 2014 through 2018 (Dominion 2015a, 2016a, 2017a, 2018a, 2019b). 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, non-refueling outage years, routine operation, and maintenance activities that can affect the generation of radioactive effluents. 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 of 2014 through 2018.

The following summarizes the calculated doses from radioactive gaseous effluents released from Surry during 2018:

Surry Unit 1 in 2018

- The air dose due to noble gases with resulting gamma radiation in gaseous effluents was 3.06×10^{-4} millirad (mrad) (3.06×10^{-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 from Surry Unit 1 was 1.53×10^{-3} millirad (mrad) (1.53×10^{-5} milligray) dose, 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 7.1×10^{-2} mrem (7.1×10^{-4} mSv), which is below the 15 mrem (0.15 mSv) dose criterion in Appendix I to 10 CFR Part 50.

Surry Unit 2 in 2018

- The air dose due to noble gases with resulting gamma radiation in gaseous effluents was 3.06×10^{-4} millirad (mrad) (3.06×10^{-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 from Surry Unit 2 was 1.53×10^{-3} millirad (mrad) (1.53×10^{-5} milligray) dose, 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 7.1×10^{-2} mrem (7.1×10^{-4} mSv), which is below the 15 mrem (0.15 mSv) dose criterion in Appendix I to 10 CFR Part 50.

The NRC staff's review of Surry's radioactive gaseous effluent control program showed radiation doses to members of the public that were well below the NRC and EPA radiation protection standards contained in Appendix I to 10 CFR Part 50, 10 CFR Part 20, and 40 CFR Part 190. The NRC staff observed no adverse trends in the dose levels over the time period reviewed.

Routine plant refueling and maintenance activities currently performed will continue during the license renewal term. Based on Dominion's past performance operating the radioactive waste system to maintain ALARA doses from radioactive gaseous effluents, the NRC staff expects similar performance during the license renewal term.

3.1.4.3 Radioactive Solid Waste Management

Solid radioactive wastes are logged, processed, packaged, and stored for subsequent shipment and offsite burial by the solid radioactive waste management system. Solid radioactive wastes and potentially radioactive wastes include spent resin material, concentrated liquid sludge, water, spent resin, spent filter cartridges, solid non-compactible and compactible trash, and miscellaneous materials from station and radwaste facility operation and maintenance.

Concentrated liquid sludge is separated by type, flushed to storage tanks, stored into an appropriate container, and stored onsite prior to shipment offsite for disposal. Spent resin from the plant's ion exchangers located in the auxiliary building is collected in tanks and then transferred to a high integrity container (HIC) for shipment to a burial site. Spent filter cartridges are placed in prefabricated metal containers and placed in an appropriately shielded location prior to shipment. Solid non-compactible and compactible trash is placed in appropriate containers and shipped to an offsite facility for compacting. A storage area in the radwaste facility serves as a staging area for waste ready for shipment to offsite processing and disposal facilities (Dominion 2018 ER).

3.1.4.4 Radioactive Waste Storage

At Surry, low-level radioactive waste (LLRW) is stored temporarily onsite at the radwaste facility, LLRW building, and sea van storage pad before being shipped offsite for treatment or disposal at licensed LLRW treatment and disposal facilities. As indicated in its environmental report (ER) and observed by the NRC staff at the site audit, Surry has sufficient existing capability to store all generated LLRW onsite. No additional construction of onsite storage facilities is necessary for LLRW storage during the period of extended operation.

Surry Units 1 and 2 each store spent fuel in a spent fuel pool and in an onsite independent spent fuel storage installation (ISFSI). The ISFSI safely stores spent fuel onsite in licensed and approved dry cask storage containers. Currently, the Surry ISFSI includes three separate spent fuel storage pads, and Dominion is in the process of adding a fourth pad to the site to accommodate additional storage. Installation of the fourth pad within the current ISFSI area is scheduled to be completed by the end of 2020. The addition of a fifth spent fuel storage pad to the current Surry ISFSI area to further increase storage capacity is under consideration, but plans are in the conceptual stage and no installation schedule has been established (Dominion 2018 ER).

3.1.4.5 Radiological Environmental Monitoring Program

Dominion Energy Virginia (Dominion) conducts a REMP to assess the radiological impact, if any, to the public and the environment from the operations at Surry.

The REMP measures the aquatic, terrestrial, and atmospheric environment for ambient radiation and radioactivity. Monitoring is conducted for the following: direct radiation, air, water, groundwater, milk, food products (corn, soybeans, and peanuts), fish, oysters, clams, crabs, 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, Surry has an onsite groundwater protection program designed to monitor the onsite plant environment for detection of leaks from plant systems and pipes containing radioactive liquid (Dominion 2018b). Information on the groundwater protection program is contained in Section 3.5.2, "Groundwater Resources," of this SEIS.

Dominion states in its environmental report that it has detected tritium in groundwater but has not detected Surry Units 1 and 2-related gamma-emitting isotopes since establishing its NEI 07-07, "Industry Ground Water Protection Initiative," program (Dominion 2018b). Section 3.5.2 provides a summary of radionuclides detected in groundwater. Tritium contamination has been detected in the groundwater in fill material at the power block area and near the discharge canal. Due to the makeup of the ground underneath those areas, it is unlikely that tritium contamination has moved into any deeper underlying aquifers. Other than tritium, no radionuclides have been detected above background concentrations.

There is no evidence of tritium contamination in water samples obtained from the Upper Potomac aquifer. The stratigraphy and structure of the sediments that overlie the Upper Potomac aquifer should prevent tritium from reaching the aquifer. Water supply wells are located where they cannot become pathways for tritium to reach the Upper Potomac aquifer. While tritium concentrations in groundwater contamination are above background concentrations, they are all below the EPA established drinking water maximum contaminant level of 20,000 picocuries per liter (pCi/L).

As discussed in Section 3.5.2.3, the quality of offsite groundwater aquifers and surface water bodies has not been impacted by radiological contamination in the groundwater at Surry. These water resources should continue to be unaffected over the period of license renewal. The NRC staff has concluded that over the period of extended operation, groundwater contamination will likely remain onsite and no offsite wells should be impacted.

The site has implemented a groundwater corrective action program to identify and stop leaks and is actively pumping groundwater in the power block area to reduce tritium concentrations. The monitor well system is robust enough that should future releases of tritium into the groundwater occur, they should be readily detected. Therefore, over the period of continued operations, there is little chance of significant impacts to the groundwater quality of onsite and offsite aquifers. Present and future operations at Surry are not expected to impact the quality of groundwater in any aquifers that are a current or potential future source of water for offsite users.

The NRC staff reviewed 5 years of annual radiological environmental monitoring data from 2014 through 2018 (VEPC 2015a, 2016a, 2017a, 2018a, 2019b). 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 (e.g., increasing radioactivity levels) over the period of 2014 through 2018.

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 Surry. The groundwater monitoring program at Surry is robust, and any future leaks that might occur during the subsequent license renewal period should be readily detected. All spills are well monitored, characterized, and actively remediated. The data show that there were no significant radiological impacts to the environment from operations at Surry.

3.1.5 Nonradioactive Waste Management Systems

Like any other industrial facility, nuclear power plants generate wastes that are not contaminated with either radionuclides or hazardous chemicals. Surry generates nonradioactive waste as a result of plant maintenance, cleaning, and operational processes that occur at the site.

Surry has a nonradioactive waste management system to handle its nonradioactive hazardous and nonhazardous wastes. The nonradioactive waste management system receives and processes nonradiological wastes, including hazardous, nonhazardous, and universal wastes.

Dominion manages wastes in accordance with applicable Federal and State regulations as implemented through its corporate procedures. Listed below is a summary of the types of waste materials generated and managed at Surry.

- Hazardous Wastes: Surry is classified as a small-quantity hazardous waste generator. The amounts of hazardous wastes generated are only a small percentage of the total wastes generated. These wastes 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. Surry has contracts with vendors to remove and dispose of these hazardous wastes offsite (Dominion 2018 ER).
- Nonhazardous Wastes: These generally includes glycol and antifreeze (state-specific), used polishing resin, nonhazardous paint, coatings, sealants, lubricants, grease, two-part epoxies, and fire barrier foam. Recycled waste typically consists of scrap metal, batteries, and used oil. Municipal waste is disposed of at the local permitted solid waste management facility. Surry has contracts with vendors to remove and dispose of these hazardous wastes offsite (Dominion 2018 ER).
- Universal Wastes: These typically consist of used oil, fluorescent lamps, batteries, mercury devices, and electronics (state-specific). Dominion has contracts with universal waste vendors for proper transport and disposal of these wastes (Dominion 2018 ER).

Dominion maintains a list of waste vendors that are approved for use across the entire company. Dominion facilities should only use the hazardous and nonhazardous waste treatment, storage, and disposal facilities contained on the current approved waste disposal list managed by Dominion Energy Environment and Sustainability (Dominion 2018 ER).

3.1.6 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 Surry. Site-specific information in this section is derived from the environmental report unless otherwise cited.

3.1.6.1 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 plant. Planned independent backup power sources provide power in the event that power is interrupted from both the plant itself and offsite power sources.

3.1.6.2 Fuel

Surry operates with low-enriched uranium dioxide fuel. With the NRC approval of optimized ZIRLO cladding fuel usage, Dominion operates the reactor cores at up to a maximum fuel discharge burnup rate of 62,000 megawatt-days per metric ton uranium (MWd/MTU) (i.e., the lead rod average burnup limit is 62,000 MWd/MTU). Refueling occurs approximately on an 18-month schedule. Dominion stores spent fuel in the spent fuel pool in the fuel handling building or in the ISFSI. Currently, the Surry ISFSI includes three separate spent fuel storage pads, and Dominion is in the process of adding a fourth pad to the site to accommodate additional storage, which is scheduled to be completed by the end of 2020 (Dominion 2018b).

3.1.6.3 Water

In addition to cooling and auxiliary water, potable water is used for sanitary and everyday uses by personnel (e.g., drinking, showering, cleaning, laundry, toilets, and eye washes). Section 3.1.3, "Cooling and Auxiliary Water Systems," describes the Surry water systems in more detail.

3.1.6.4 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 plants also have railroad connections for moving heavy equipment and other materials. Plants located on navigable waters may have facilities to receive and ship loads on barges. Section 3.10.6, "Local Transportation," describes the Surry transportation systems in more detail.

3.1.6.5 Power Transmission Systems

For license renewal and subsequent license renewal, the NRC (NRC 2013a) evaluates, as part of the proposed action, the continued operation of those Surry 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 Surry subsequent license renewal environmental review are onsite and are not accessible to the general public. 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 in more detail.

3.1.7 Nuclear Power Plant Operations and Maintenance

Maintenance activities conducted at Surry include inspection, testing, and surveillance to maintain the current licensing basis of the facility and to ensure compliance with environmental and safety requirements. Various programs and activities are currently in place at Surry to maintain, inspect, and monitor the performance of facility structures, components, and systems. 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. Reactor refueling occurs on an 18-month schedule (Dominion 2018b).

3.2 Land Use and Visual Resources

Section E3.2 of Dominion's Environmental Report (Dominion 2018b) describes current onsite and offsite land use conditions, as well as visual resources with respect to Surry. Unless otherwise cited, this information is incorporated here by reference and summarized below with an emphasis on new information (Dominion 2018b: E-3-15 to E-3-23).

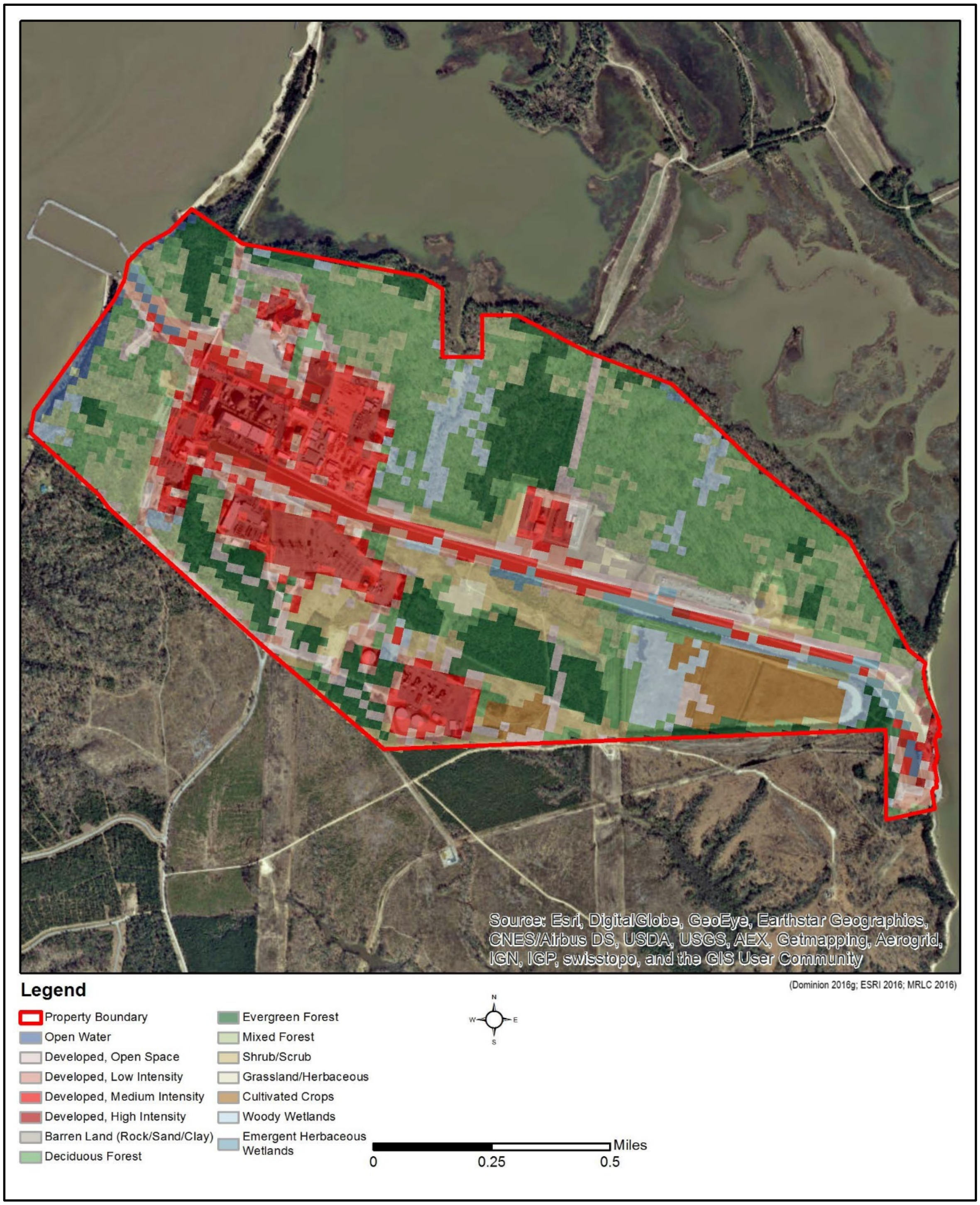
3.2.1 Land Use

Surry is located approximately 8 mi (13 km) northeast of the town of Surry, the county seat of Surry County. The cities of Williamsburg and Newport News, both on the Virginia peninsula, are located across the James River from Surry. Surry is approximately 6 mi (10 km) south of Williamsburg and about 5 mi (8 km) east of the city of Newport News; both distances are measured as direct linear distance. Land uses in the affected area are described below in terms of onsite or offsite land uses. Onsite land uses are described for Surry, and offsite land uses are described within a 6-mi (10-km) radius of the Surry site. The Virginia coastal zone is also described, with an emphasis on the statutory and regulatory provisions that govern its use.

3.2.1.1 Onsite Land Use

Surry Units 1 and 2 are located in Surry County, Virginia, on the south bank of the James River (Figure 3-1). The built-up land occupied by Surry is otherwise situated on the relatively low-lying and marshy Gravel Neck Peninsula that protrudes into the James River from the southwest. Steep bluffs occupy the west and east sides of the plant site along the river and on the site's northern boundary with the tip of the peninsula.

The Surry site consists of 840 acres (ac) (340 hectares (ha)) of land and is zoned for industrial use (i.e., M-2 zoning by Surry County). An M-2 zoning designation allows for utility service and power plant land use. As illustrated in Figure 3-4, deciduous, evergreen, and mixed forest types together comprise about 48 percent of the land use cover within the Surry site. The next largest land use category is developed land (to support power plant operations), which totals 31 percent of the site. The remaining 21 percent of the site consists of wetlands, shrub/scrub, cultivated lands, barren land, open water, and grasslands.



Source: Modified from Dominion 2018b: Figure E3.2-1

Figure 3-4 Surry Site Land Use/Land Cover

3.2.1.2 Coastal Zone

Section 307(c)(3)(A) of the Coastal Zone Management Act (CZMA) (16 U.S.C. 1456(c)(3)(A)) requires that applicants for Federal licenses who conduct activities in a coastal zone provide a certification to the licensing agency (here, the NRC) that the proposed activity complies with the enforceable policies of the State's coastal zone program. The Federal regulations that implement the CZMA 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)). Surry Units 1 and 2, located in Surry County, Virginia, lie within the Virginia coastal zone that encompasses all of Tidewater Virginia (VDEQ 2019d). The Virginia Department of Environmental Quality (VDEQ) is the lead agency for the Virginia Coastal Zone Management Program and is responsible for coordinating the Commonwealth's review of Federal consistency determinations and certifications with cooperating agencies and responding to the appropriate Federal agency or applicant (VDEQ 2019b).

As stated in its environmental report (Dominion 2018b), and in accordance with the Virginia Coastal Zone Management Program (VDEQ 2019b), Dominion prepared a CZMA consistency certification package for submittal to VDEQ in support of renewal of the Surry operating licenses. Dominion submitted its certification package on August 3, 2017. In its submittal, Dominion asserts that the Surry license renewal project is consistent to the maximum extent practicable with the enforceable policies of the Virginia Coastal Zone Management Program and that activities will be conducted in a manner consistent with the program (Dominion 2017). On February 2, 2018, the VDEQ submitted its completed review and analysis of Dominion's Federal consistency certification package for the proposed renewal of Surry's operating licenses. VDEQ issued a conditional concurrence to Dominion in accordance with 15 CFR 930.4. The consistency concurrence requires in part that Dominion obtain all applicable permits and approvals and adhere to relevant conditions with respect to all proposed license renewal activities as documented in the VDEQ's review. Additionally, the concurrence includes a specific condition requiring that the Virginia Department of Game and Inland Fisheries (VDGIF) be afforded input and concurrence on the intake technology and conditions implemented in compliance with Clean Water Act (CWA) Section 316(b) to minimize impacts to fisheries resources (including from impingement and entrainment) during the period of continued plant operations and incidental take of endangered species, including the Atlantic sturgeon. The VDGIF suggests measures to protect the Atlantic sturgeon and other species, such as intake screen mesh or design, intake velocity restrictions, or time-of-year restrictions on certain dredging or instream construction activities. The VDGIF specifically requested the opportunity to participate in consultation discussions between the NRC, Dominion, and Federal agencies (VDEQ 2018a).

In its response to the NRC requests for additional information, Dominion states that it is currently in the process of preparing the required studies and analyses as part of its best technology available demonstration to comply with CWA Section 316(b). Dominion is required to submit all required information to the VDEQ by June 3, 2020, as required by Dominion's current Virginia Pollutant Discharge Elimination System permit. Dominion also states that the required analysis will include consideration of impingement and entrainment reduction technologies (e.g., screen design) and operating modes (e.g., intake velocity modifications). Meanwhile, as part of subsequent license renewal and CWA-related permit and compliance activities, Dominion is continuing consultations with other Federal and State agencies, including the National Oceanic and Atmospheric Administration (NOAA) and the U.S. Fish & Wildlife Service (USFWS). Dominion indicates that it continues to communicate with VDEQ regarding actions to meet and support Surry's VPDES permit conditions, including CWA Sections 316(a) and (b) requirements. Finally, Dominion plans to participate in any NRC-initiated consultations (Dominion 2019c).

The NRC staff anticipates that the outcome from the NRC Endangered Species Act Section 7 consultations with the National Marine Fisheries Service (NMFS) will resolve any issues with respect to threatened and endangered species. However, at present, due to the conditions imposed by the VDEQ's conditional concurrence determination, Dominion fails to demonstrate to the NRC that the proposed license renewal is consistent with and complies with the enforceable policies of the Virginia Coastal Zone Management Program.

3.2.1.3 Offsite Land Use

The immediate area around the Surry site on the south bank of the James River consists predominantly of open water, wetlands, forests, shrub-scrub, and cropland. This is in contrast with the developed uses to the north and east on the Virginia peninsula associated with the cities of Williamsburg and Newport News, as well as area military installations, as depicted in Figure 3-5.

Immediately adjacent to the Surry site and comprising the north end of the Gravel Neck Peninsula is the Hog Island tract of the Hog Island Wildlife Management Area. To the south of the Surry site lies the Carlisle and Stewart tracts of the Hog Island Wildlife Management Area that protrudes into the James River from the southwest. Owned and operated by the VDGIF, the 3,600-ac (1,460-ha) resource management area includes open lands and pine forests interspersed with tidal marshes and controlled ponds to produce native plant foods for wintering waterfowl (VDGIF 2019g). Predominant land uses along the remainder of the peninsula include deciduous, evergreen and mixed forest; shrub/scrub, woody wetlands, and grasslands. Further to the south and west in the eastern portions of Surry County, forested land uses are replaced by a predominance of cultivated crop and pasture lands with some low intensity, rural development.

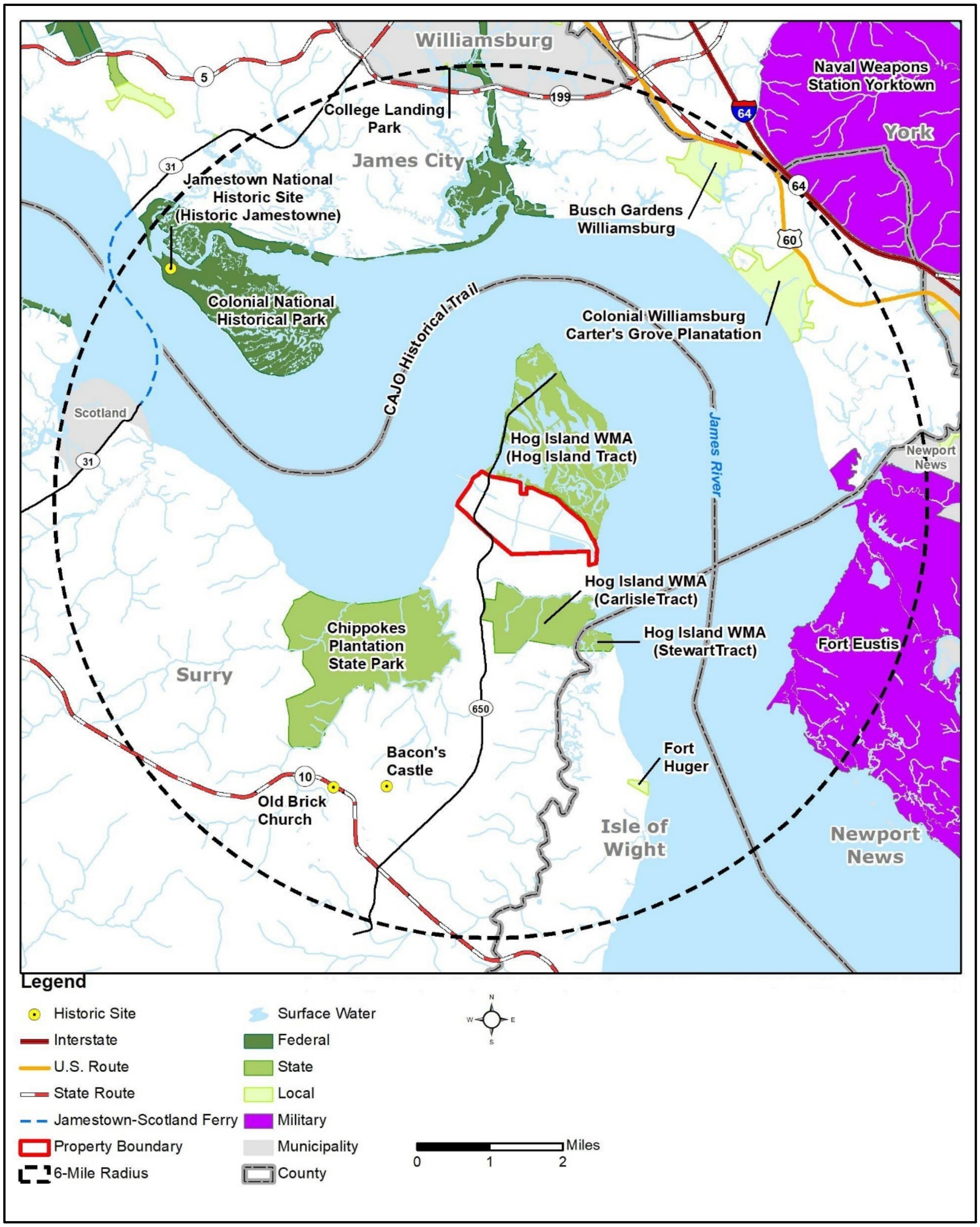
In 2016, Dominion initiated plans to develop a new dredge material management area (DMMA) as a replacement for the existing dredge material management pond located on the Surry site. The facility will be used for the management of dredged materials removed from the Surry intake and supporting infrastructure during the period of continued operations of Surry. The new DMMA site is located about 4 mi (6.4 km) south of the Surry site and encompasses a total area of approximately 400 ac (162 ha) (Dominion 2019c). The site is bordered by Hog Island Road to the west and by Lawnes Creek to the east. Based on land use mapping and aerial photography of the area, the DMMA sits on land that previously consisted of open cropland surrounded by deciduous, mixed, and evergreen forest (Dominion 2018b).

Dominion began facility construction in February 2019, and the NRC staff observed ongoing construction at the time of the NRC's environmental site audit in March 2019. As designed, the engineered DMMA facility will have a disposal capacity of 1,500,000 cubic yards (1,150,000 m^3) of dredge spoils and will comprise about 58 ac (23 ha) when completed. The disposal area will be enclosed by a 20-ft (6.1-m) high earthen embankment, and the facility will be underlain by a 1-ft (0.3-m) thick clay liner. Most of the facility construction will take place in an open field. However, approximately 3 ac (1.2 ha) of tree removal is necessary to support facility access. In addition, installation of the facility's return river water discharge pipe to Lawnes Creek will result in the permanent conversion of 4,200 ft^2 (390 m^2) of non-tidal forested wetlands. Dominion states that permitting will be completed by early November 2019, and that construction will be completed by the end of November 2019 (Dominion 2019c).

3.2.2 Visual Resources

The Surry site is located on Gravel Neck Peninsula on the south side of the James River. Developed areas of the plant complex are visible from portions of the James River, including the Captain John Smith Chesapeake National Historic Trail (Figure 3-5). The most prominently visible features on the plant site are the Surry Units 1 and 2 containment buildings, which are 159 ft (48 m) in height. Dominion also operates and maintains a meteorological tower that is 151.2 ft (46 m) high. Nonetheless, because these plant structures are set back from the shoreline and partially surrounded by forested lands, their visibility from offsite areas and from the James River is limited.

In addition to structures within the Surry plant complex, another visible Surry-related structure is Dominion's new Surry-Skiffes Creek 500-Kv transmission line, which became operational on February 26, 2019 (Dominion 2019c). This transmission line totals 8 mi (13 km) in length and originates in the Surry switchyard, located on the south side of the main plant complex, and runs north to a point north of the intake canal, and then runs in an easterly direction adjacent to the intake canal across the peninsula to the James River. From the shoreline, the overhead transmission line traverses the river mounted on 17 tower structures for a total of 4.1 mi (6.6 km), first running north along a portion of the Gravel Neck Peninsula and then east across the James River to the shoreline of southern James City County. Thirteen of the towers average 165 ft (50.3 m) in height while the four towers that span the river's shipping channels range from 275 to 295 ft (83.8 to 89.9 m) in height (Dominion 2019f).



Source: Modified from Dominion 2018b: Figure E3.1-5

Figure 3-5 Federal, State, and Local Lands Within a 6-Mi (10-Km) Radius of Surry

3.3 Meteorology, Air Quality, and Noise

This section describes the meteorology, air quality, and noise environment in the vicinity of Surry.

3.3.1 Meteorology and Climatology

Virginia has a generally humid climate characterized by very warm summers and moderately cold winters. However, substantial regional variations in temperature and precipitation patterns occur due to the state's diverse geographic features. Specifically, the influence of the Appalachian Mountains and Blue Ridge Mountains result in the western and northern portions of the state being relatively cooler and drier. In contrast, the open waters of the Chesapeake Bay and the Atlantic Ocean contribute to higher temperatures and humidity in the eastern coastal region where Surry is located (Runkle et al. 2017). As such, the Surry site, situated in a humid subtropical climate zone, is characterized by warm, humid summers and cool to mild winters. During the summer months, this region is dominated by tropical maritime airmasses, while during the winter months it is in a transitional zone between polar continental and tropical maritime airmasses (Dominion 2018b).

The NRC staff obtained climatological data from the Norfolk International Airport (KORF) weather station. This station is approximately 33 mi (53 km) southeast of Surry and is used to characterize the region's climate because of its relative location and long period of record. Dominion also maintains a meteorological monitoring system comprised of a primary and a backup meteorological tower. The primary meteorological tower, located near the southeastern boundary of the Surry site and east of Dominion's Gravel Neck Combustion Turbines Station, measures wind speed and direction, ambient, differential, and dew point temperatures, horizontal wind direction fluctuation, and precipitation. The backup meteorological tower is located approximately 1,650 ft (500 m) northwest of the primary tower and measures wind speed and direction, temperature, and horizontal wind direction fluctuation (Dominion 2018b).

The mean annual temperature for a 73-year period of record (1946–2018) at the KORF station is 60.1°F (15.6 °C), with the mean monthly temperature ranging from a low of 40.7 °F (4.8 °C) in January to a high of 79.3 °F (26.3 °C) in July. The average annual precipitation for the same 73-year period of record at the KORF station is 46.4 inches (118 cm), with mean monthly precipitation ranging from a low of 3.0 inches (7.6 cm) in November to a high of 5.6 inches (14.2 cm) in July. The mean annual wind speed during a 35-year period of record (1984–2018) at the KORF station is 9.6 mph (15.4 km/h), with prevailing winds being from the southwest (NCEI 2018).

Virginia is subject to occasional extreme weather events including severe thunderstorms, tornadoes, winter storms, tropical storms, hurricanes, droughts, and heat waves (Runkle et al. 2017, NOAA 2013a). In the past 69 years (1950–2018), the following number of severe weather events have been reported in Surry County, VA (NCEI 2019):

- Hurricane 3 events
- Tornado 9 events
- Thunderstorm 55 events
- Flood 4 events

3.3.2 Air Quality

Under the Clean Air Act (CAA), (42 U.S.C. 7401–7671), the EPA has set primary and secondary National Ambient Air Quality Standards (NAAQS) (40 CFR Part 50, "National Primary and Secondary Ambient Air Quality Standards") for six common criteria pollutants to protect sensitive populations and the environment: carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO_2), ozone (O_3), sulfur dioxide (SO_2), and particulate matter (PM). NAAQS further categorize particulate matter under two sizes—PM_{10} (diameter between 2.5 and 10 micrometers) and $PM_{2.5}$ (diameter of 2.5 micrometers or less). Table 3-1 presents the NAAQS for the six criteria pollutants.

Table 3-1 Ambient Air Quality Standards

Pollutant	Averaging Time	National Standard Concentration
Carbon Monoxide (CO)	8-hour	9 ppm (primary standard)
	1-hour	35 ppm (primary standard)
Lead (Pb)	Rolling 3-month average	0.15 μg/m^3 (primary and secondary standard)
Nitrogen Dioxide (NO_2)	1-hour	100 ppb (primary standard)
	Annual	53 ppb (primary and secondary standard)
Ozone (O_3)	8-hour	0.070 ppm (primary and secondary standard)[(a)]
Particulate matter less than 2.5 μm ($PM_{2.5}$)	Annual	12 μg/m^3 (secondary) 15 μg/m^3 (secondary)
	24-hour	35 μg/m^3 (primary and secondary standard)
Particulate matter less than 10 μm (PM_{10})	24-hour	150 μg/m^3 (primary and secondary standard)
Sulfur Dioxide (SO_2)	1-hour	75 ppb (primary standard)
	3-hour	0.5 ppm (secondary standard)

Key: ppb = parts per billion; ppm = parts per million; μg/m^3 = micrograms per cubic meter. To convert ppb to ppm, divide by 1000.

[(a)] Final rule signed October 1, 2015, and effective December 28, 2015. The previous (2008) ozone (O_3) standards additionally remain in effect in some areas.

Primary standards provide public health protection, including the health of sensitive populations such as asthmatics, children, and the elderly. Secondary standards provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings.

Source: EPA 2019f

With respect to meeting NAAQS, the EPA designates areas that meet the standards as areas of attainment and areas that do not meet the standards as areas of nonattainment. Areas for which there is insufficient data to determine attainment or nonattainment, the EPA designates as unclassifiable. Areas that once did not meet the standards but now do meet the standards, the EPA designates as maintenance areas; maintenance areas are under a 10-year monitoring plan to maintain the attainment designation status. States bear the primary responsibility for ensuring attainment and maintenance under NAAQS. Under Section 110 of the Clean Air Act

(CAA) (42 U.S.C. 7401) and related provisions, states must submit, for EPA approval, state implementation plans (SIPs) that provide for the timely attainment and maintenance of NAAQS.

In Virginia, air quality designations are made at the county level. For planning and maintaining ambient air quality under NAAQS, the EPA has developed air quality control regions. Air quality control regions are intrastate or interstate areas that share a common airshed. Surry is located in Surry County, which is part of the EPA State Capital Intrastate Air Quality Control Region (40 CFR 81.145, "State Capital Intrastate Air Quality Control Region"). This air quality control region consists of 12 Virginia counties: Charles City, Chesterfield, Dinwiddie, Goochland, Greensville, Hanover, Henrico, New Kent, Powhatan, Prince George, Surry, and Sussex. With respect to meeting NAAQS, the EPA designates Surry County as "unclassifiable/attainment or better than national standards" for all criteria pollutants (40 CFR 81.347, "Virginia"). The nearest designated nonattainment area (for the 2008 (8-hour) ozone standard) is the Baltimore, MD, area, which is more than 130 mi (210 km) from Surry (EPA 2019h).

The Clean Air Act, Title V, "Permits," requires states to develop and implement an air pollution permit program. The Virginia Department of Environmental Quality (VDEQ) jointly regulates air emissions at Surry and at the adjacent fossil fuel Gravel Neck Combustion Turbines Station (GNCTS) under Title V Federal Operating Permit PRO50336 (Dominion 2018b). The VDEQ issued this permit in January 2018, and it will expire in 2023 (Dominion 2018b; VDEQ 2019c). Table 3-2 lists permitted air pollutant emission sources and associated permit conditions for Surry. Dominion is in compliance with Surry's Title V operating permit, and Surry has not received any notices of violation pertaining to the air permit for the 2012–2018 period (Dominion 2018b, 2019a).

Table 3-2 Permitted Air Emission Sources at Surry Units 1 and 2

Equipment (no. of units)	Air Permit Condition
Oil-fired Boilers (2)	Opacity < = 20 percent PM and SO_2 limit
Station Blackout Diesel Generator	Opacity < = 20 percent 40 CFR Part 63, Subpart ZZZZ (NESHAP RICE)
Other Emergency Diesel Generators (3) Backup Electric Generators (5) Emergency Diesel Water Pumps (3) Fire Pump Backup Air Compressors (4)	Opacity < = 20 percent NOx and SO_2 limit 40 CFR Part 63, Subpart ZZZZ (NESHAP RICE)
Propane Emergency Generators (2)	None

Key: PM = particulate matter, NOx = nitrogen oxides, CO = carbon monoxide, NESHAP = National Emission Standards for Hazardous Air Pollutants, RICE = reciprocating internal combustion engines, SO_2 = sulfur dioxide

Source: Dominion 2018b

Table 3-3 shows reported annual emissions from permitted sources at Surry. According to the 2014 National Emissions Inventory, estimated annual emissions in tons per year for Surry County are approximately 40 (sulfur dioxide), 450 (nitrogen oxides); 2,800 (carbon monoxide), 950 (particulate matter less than 10 microns), 7,100 (volatile organic compounds), and 140 (hazardous air pollutants) (EPA 2019a). The contribution of air emissions from permitted sources at Surry Units 1 and 2 constitute 1.6 percent or less of Surry County's total annual emissions of these pollutants. Greenhouse gas emissions from operation of Surry Units 1 and 2 are discussed in Section 4.15.3, "Greenhouse Gas Emissions and Climate Change," of this SEIS.

Table 3-3 Reported Air Pollutant Emissions from Surry Units 1 and 2

			Emissions (tons/year)		
Year	SO_2	NO_x	CO	PM_{10}	VOCs
2014	0.17	7.01	1.79	0.20	0.26
2015	0.12	12.3	3.16	0.64	0.58
2016	0.11	6.57	1.62	0.21	0.28
2017	0.17	7.65	1.91	0.27	0.35
2018	0.19	9.90	2.54	0.27	0.34

Key: CO = carbon monoxide, NO_x = nitrogen oxides, SO_2 = sulfur dioxide, PM_{10} = particulate matter less than 10 micrometers, VOC = volatile organic compounds

To convert tons per year to metric tons per year, multiply by 0.90718.

Source: Dominion 2018b, Dominion 2019c

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 51.308–51.309). Specifically, 40 CFR Part 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 to Surry is the James River Face Wilderness Area, located approximately 150 mi (240 km) to the west (Dominion 2018b). Federal land management agencies that administer Federal Class I areas consider an air pollutant source that is located greater than 31 mi (50 km) away to have negligible impacts on these areas if the total SO_2, NO_X, PM_{10}, and sulfuric acid annual emissions from the source are less than 500 tons per year (70 FR 39104, NRR 2010). Given the distance of Surry to Class I areas and the air emissions presented in Table 3-3, there is little likelihood that ongoing activities at Surry adversely affect air quality and air quality related values (e.g., visibility or acid deposition) in any such designated area.

3.3.3 Noise

Section E3.4 of Dominion's environmental report (Dominion 2018b) describes the current noise environment at Surry from industrial plant operations and site activities. Unless otherwise cited, this information is incorporated here by reference and summarized below (Dominion 2018b: E-3-54 through E-3-55). No new and significant information about noise at Surry Units 1 and 2 was identified during the review of available information, including Dominion's environmental report (Dominion 2018b), the site visit, or during the scoping process.

Noise is unwanted sound and can be generated by many sources. Sound intensity is measured in logarithmic units called A-weighted decibels (dBA) to represent noise as closely as possible to the noise levels people experience. Noise 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).

As described in Section 3.2.1.3, Surry is located in a rural area with surrounding land uses that include open water, wetlands, forests, shrub-scrub, and cropland. Common noise sources from nuclear power plant operations include transformers, loudspeakers, auxiliary equipment, and worker vehicles (NRC 2013a). Major noise sources at Surry include turbine generators, transformers, loudspeakers, transmission lines, the firing range, and the main steam safety valves. The nearest residence is approximately 0.4 mi (0.6 km) west-southwest from the plant complex.

Surry County’s zoning ordinance does not set maximum permissible sound levels. However, the Surry site is zoned for industrial use (Section 3.2.1.1) and the site exceeds the buffer zone distance between site industrial activities and the nearest residence as prescribed in the zoning ordinance. Dominion monitors noise for levels at or above 85 dBA at and around the plant site for occupational and ambient effects when needed, such as for scheduled outages, systems testing, or when noise-generating equipment is modified or moved.

Dominion has occasionally received noise complaints over the years, such as those related to increased traffic noise during outages, emergency plan siren activations, and weapons training at the firing range. When noise complaints are received, the Surry station manager or department director performs outreach to the public and answers questions about the activity.

3.4 Geologic Environment

This section describes the geologic environment of the Surry site and vicinity, including landforms, geology, soils, and seismic conditions.

3.4.1 Physiography and Geology

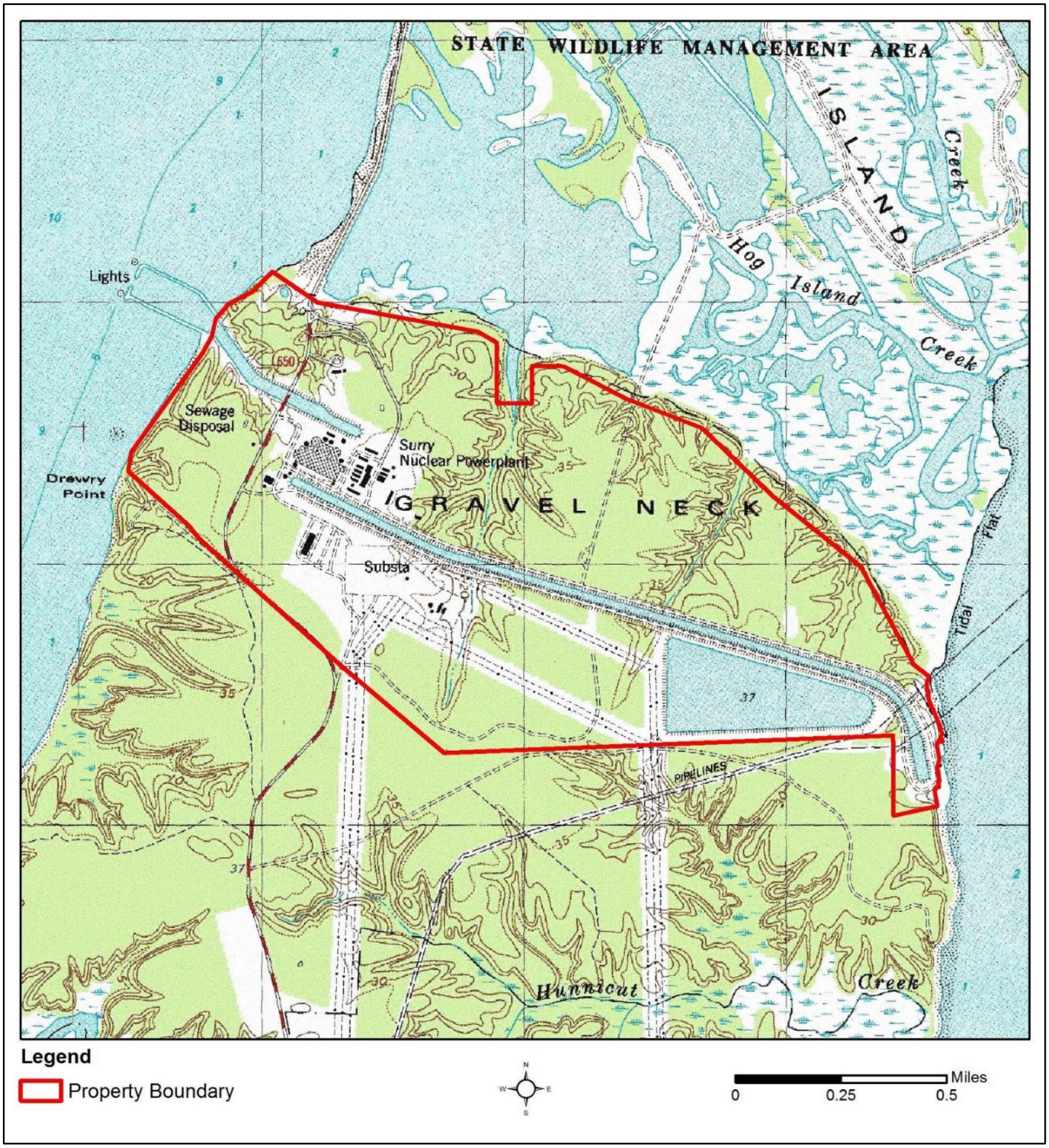
Surry lies within the Gravel Neck Peninsula. The Gravel Neck Peninsula is bounded on three sides by the south shore of the James River. The land surface at Surry is flat lying with an average elevation of 30 ft above mean sea level (AMSL) (Figure 3-6) (Dominion 2018b).

Surry is in the Virginia Coastal Plain Physiographic Province. This is a lowland that borders the Atlantic Ocean. It is a gently rolling terrain with broad stream valleys and extensive wetlands. The river valleys, including the Potomac, Rappahannock, York, James, and others, drain toward the east and the Atlantic Ocean. Major rivers within the Coastal Plain Physiographic Province are estuarine (USGS 2013b).

The province is composed of semi-consolidated to unconsolidated sedimentary layers that are underlain by older crystalline rocks. The crystalline rocks are made up of various types of igneous and metamorphic rocks. The sedimentary layers that lay on top of the crystalline rocks were formed from material eroded from the Appalachian Mountains and then deposited in the Coastal Plain Physiographic Province (USGS 2006). The sediments are composed of layers of silt, clay, and sand, with some gravel and lignite. Consolidated beds of limestone and sandstone are also sometimes present. The sedimentary layers thicken and dip gently toward the ocean (USGS 1997). Two miles (3.2 km) southeast of Surry, the depth to the crystalline rocks is estimated to be about 1,300 ft (396 m) (Dominion 2018b), whereas approximately 40 mi (66 km) west of Surry, the crystalline rocks are found at the land surface (see fall line in Figures 3-7 and 3-8).

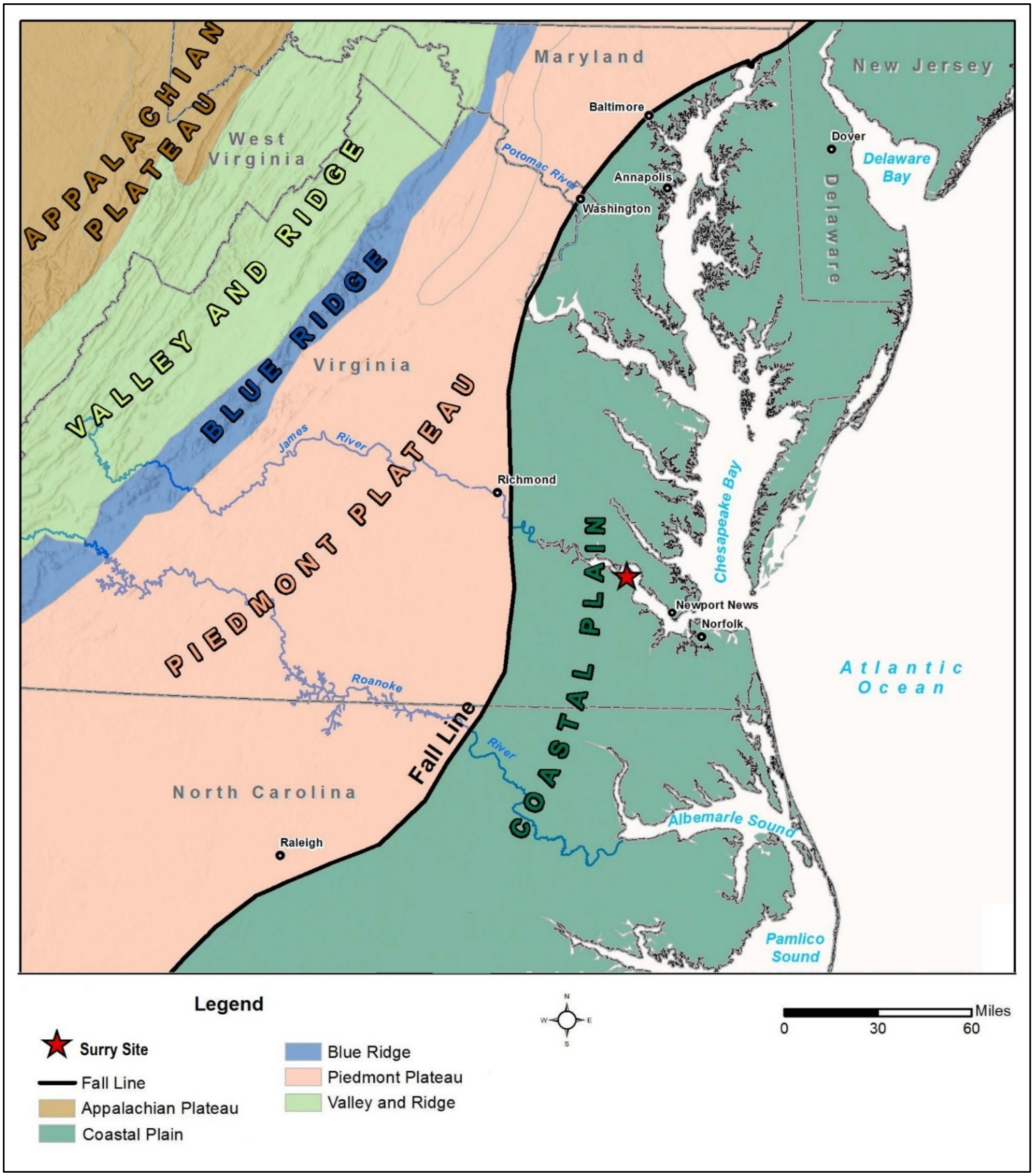
Figures 3-7 and 3-8 illustrate the relationship of the Virginia Coastal Plain Physiographic Province relative to the other physiographic provinces in Virginia. Depending on the province, the rocks that form the landscape in these other provinces have experienced some combination of metamorphism, folding, and uplift.

The general thickening and slope of sedimentary rock layers toward the east was disrupted by the creation of a large impact crater in the southeastern section of the Virginia Coastal Plain Geologic Province. Approximately 35 million years ago, a large comet or meteorite crashed into the Atlantic Ocean near the mouth of present-day Chesapeake Bay. The high velocity impact created a 56 mi (90 km) wide impact crater that is almost 1.2 mi (1.9 km) deep. Upon impact, some sediments and crystalline rocks were melted and the rocks beneath and around the crater were faulted and fractured (USGS 2000).



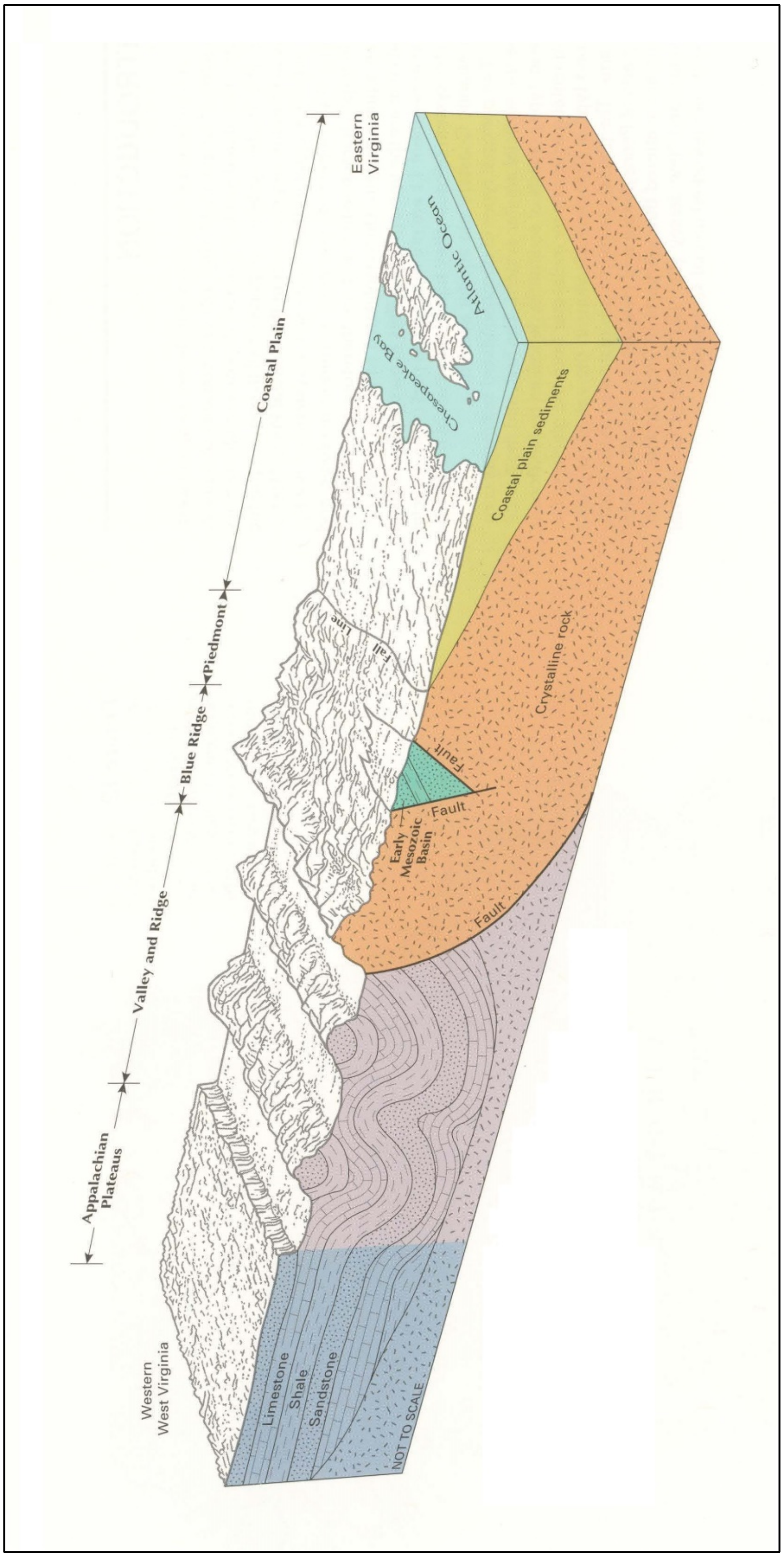
1 Source: Modified from Dominion 2018b

2 **Figure 3-6 Surry Topography**



Source: Modified from Dominion 2018b

Figure 3-7 Virginia Physiographic Provinces



1 Source: Modified from USGS 1997

2 **Figure 3-8 Illustrative Cross Section of Virginia Physiographic Provinces**

The impact structure is known as the Chesapeake Bay Impact Crater. Of the known impact features on Earth, it is one of the largest and best preserved. The crater is located beneath the lower Chesapeake Bay and its surrounding peninsulas. Surry is located just outside and on the west side of the impact crater (USGS 2000). The crater is not visible at the land surface because it has been filled by collapse debris, tsunami deposits, and sediments that were deposited after the impact event. Creation of the crater caused the James River to discharge to the north-east and into the crater. Today, the James River continues to discharge in this direction even though the crater is now filled with sediment. The crater has also influenced the lateral extent of aquifers and groundwater flow and quality (see Section 3.5.2, "Groundwater Resources") (USGS 2006, 2013b, 2019c).

Figure 3-9 shows the impact crater in relation to the Surry site and Figure 3-10 contains a geologic cross section through the crater. The geologic cross section shows the crater structure, rock types, depth of the crater, and the depth of fracturing and faulting into the crystalline rocks.

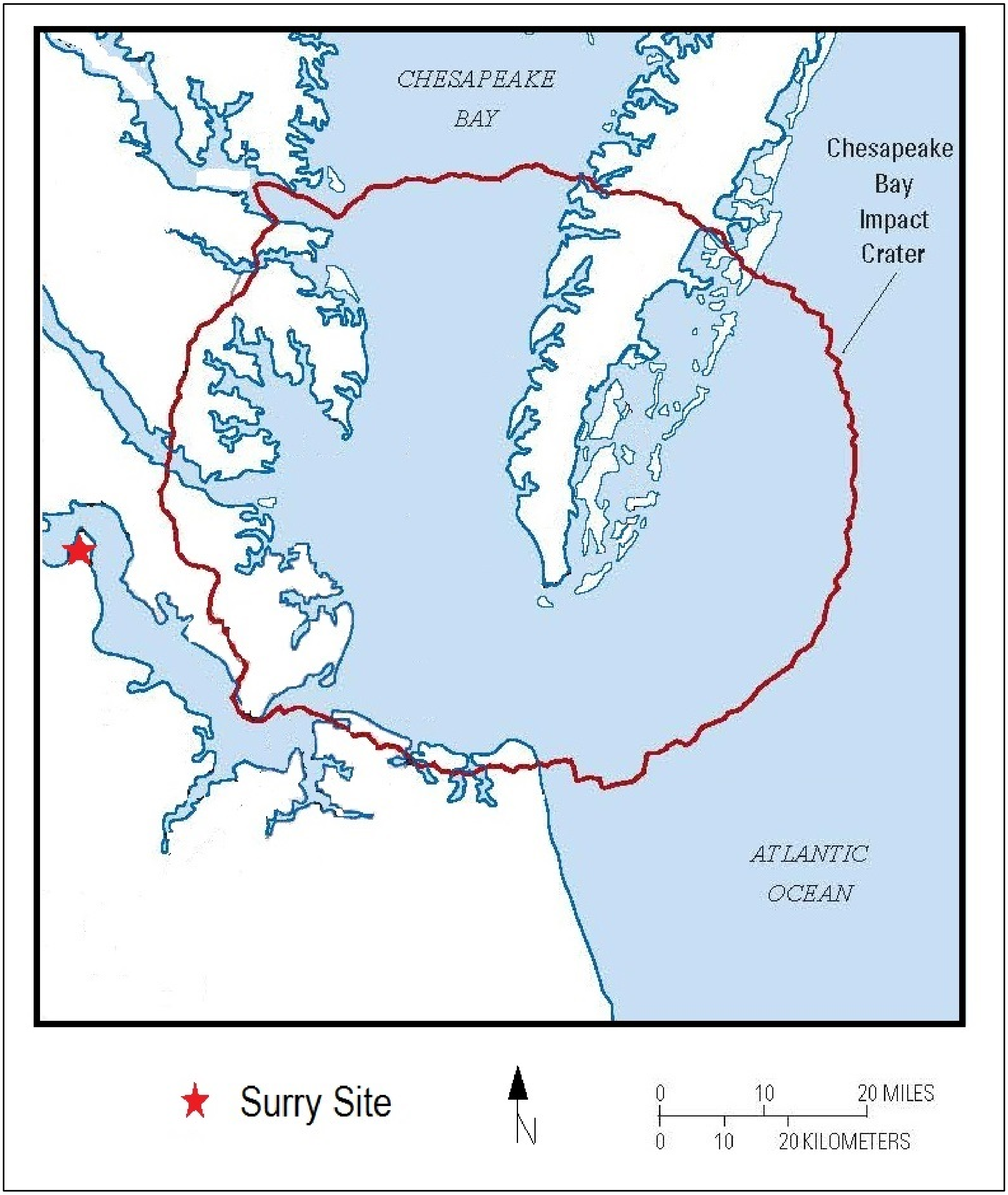
3.4.2 Economic Resources

There is no history of surface mining or the withdrawal of large quantities of fluids, such as petroleum, at the Surry site (Dominion 2018b).

3.4.3 Soils

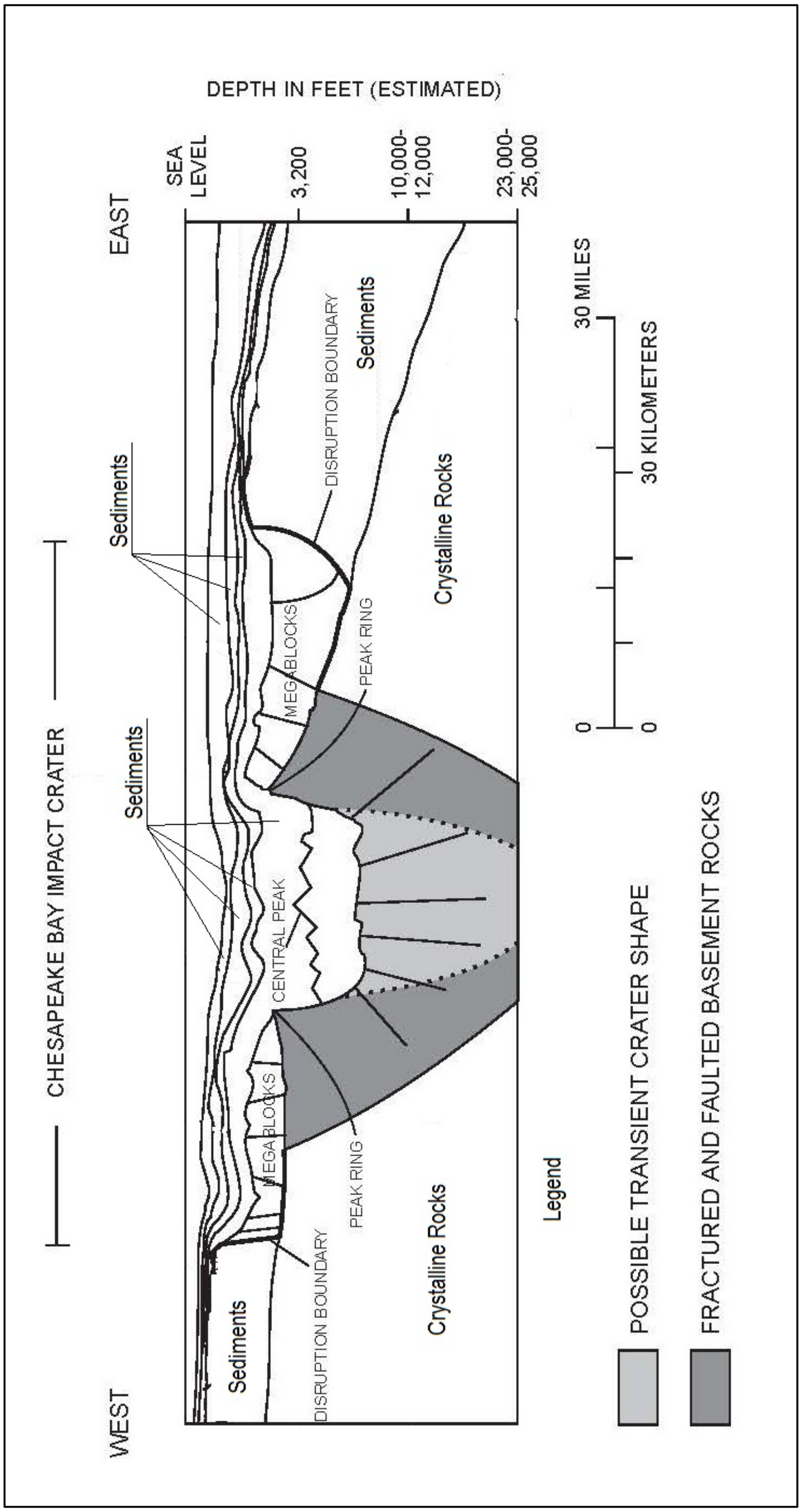
Within Surry's boundary, most of the soils are silt loams with a few soils made up of clay loam, sandy loam, or mucky clay loam. Approximately 32 percent of Surry is occupied by buildings, roads, parking lots, canals, and other structures associated with facility operations. Another 32 percent of Surry is occupied by soils that are classified as suitable for use as prime farmland, with 36 percent occupied by soils that are classified as not suitable for prime farmland (Dominion 2018b; USDA 2019b).

As part of its current ongoing operations, Dominion is developing an offsite dredge material management area. It will be used to dispose of dredged material from the Surry intake canal constructed in the James River (see Section 3.5.2, "Surface Water Resources"). The site is under construction and in the process of finishing permitting activities with State and local agencies (USACE 2018b). It is located approximately 4 mi (6.3 km) south of Surry and will be utilized once the present dredge material management pond reaches capacity. Construction and operation at this location will disturb around 86.1 ac (35 ha). The soils at the site are primarily silty or sandy loams, with some clay loams. Much of the site is located on prime farmland soils or on prime farmland soils if drained. During construction, soils will be stripped from the site and stored for future restoration activities. Best soil erosion and management practices will be followed (Surry audit, USDA 2019a).



Source: Modified from USGS 2013b

Figure 3-9 Location of Chesapeake Bay Impact Crater



Source: Modified from USGS 2000

Figure 3-10 Cross Section Through Chesapeake Bay Impact Crater

3.4.4 Land Subsidence

Land subsidence is the sinking or lowering of the land surface. It can result in increased flooding and alter wetland and coastal ecosystems. Land subsidence is occurring in the southern Chesapeake Bay region. The relatively flat topography in this area means small decreases in land elevations can have a measurable increase in the potential for flooding. Land subsidence in combination with rising sea levels have resulted in the highest rates of sea level rise on the Atlantic Coast of the United States. Since the 1940s, land subsidence in this region has occurred at rates from 0.4 to 0.19 inch (1.1 to 4.8 mm/yr). More than half of this subsidence has been caused by extensive groundwater pumping, which causes the aquifers and aquitards to compact. Another likely contributor is isostatic adjustment of the land in response to the melting of ice age glaciers (USGS 2013a).

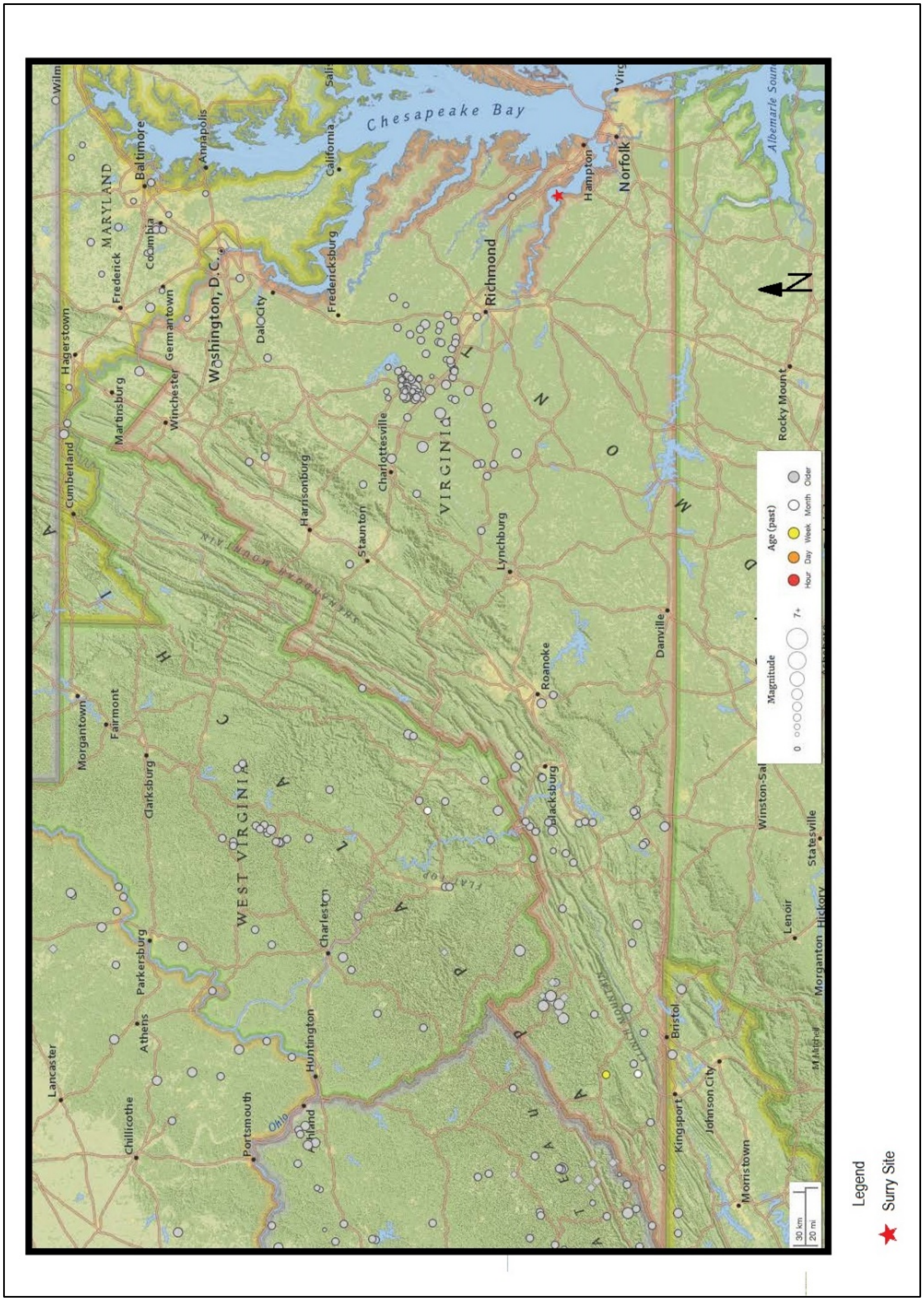
Two areas on the coastal plan in southeast Virginia, with high subsidence rates, roughly coincide with groundwater pumping centers at Franklin and West Point, Virginia (Figure 3-21). Between 1940 and 1971, the land in these two areas is calculated to have been subsiding at a rate of 0.19 to 0.15 inch/yr (4.8 to 3.8 mm/yr). Over the same time period, at Surry, the land is calculated to have been subsiding at a rate of 0.11 inch/yr (2.8 mm/yr). At this rate, between 1940 and 1971, the land may have subsided by 3.42 inches (86.8 mm) (USGS 2013a). By the end of the proposed subsequent renewal period, the land may have subsided by 1.54 inches (39 mm) from current elevations.

3.4.5 Seismic Setting

Surry is in an area with a very small probability of experiencing damaging earthquake effects (FEMA 2019a). As previously discussed, Surry is in the Virginia Coastal Plain Physiographic Province (see Figures 3-7 and 3-8). Earthquakes are rare in this province, with most recorded earthquakes occurring in the Piedmont Physiographic Province. No known earthquakes with a magnitude larger than 3 have been recorded within a 50-mi (80-km) radius of the site (Dominion 2018b). Figure 3-11 shows the location of earthquake epicenters in and around Virginia from 1900 to 2019.

On August 23, 2011, an earthquake with a magnitude of 5.8 occurred within the Piedmont Physiographic Province near Mineral, Virginia. It was located within the central Virginia Seismic Zone, which is an area in the Piedmont Physiographic Province with persistent, low-level seismicity. This was the largest seismic event recorded in this zone. The earthquake was felt at the Surry site. However, no issues were noted by Dominion in post-event Surry inspections (Dominion 2018b).

The NRC evaluates the potential effects of seismic activity on a nuclear power plant in an ongoing process that is separate from the license renewal process. The NRC requires every nuclear plant to be designed for site-specific ground motions that are appropriate for its location. Nuclear power plants, including Surry, are designed and built to withstand site-specific ground motion based on their location and the potential for nearby earthquake activity (e.g., design-basis earthquake (DBE)). Using site-specific seismic hazard assessments, the seismic design basis (DBE) for a plant is established during the initial siting process.



1 Source: Modified from USGS 2019f

2 **Figure 3-11 Earthquakes In and Around Virginia from 1900 to 2019**

During siting for each nuclear power plant, applicants estimate a design-basis ground motion based on potential earthquake sources, seismic wave propagations, and site responses. They then account for these factors in the plant's design. In this way, nuclear power plants are designed to safely withstand the potential effects of large earthquakes. 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 2014c). As new seismic information becomes available, the NRC expects licensees to evaluate the new information to determine if changes are needed to the safety systems at a plant. Independently, the NRC also evaluates new seismic information and confirms that a licensee's actions appropriately consider potential changes in seismic hazards.

3.5 Water Resources

This section describes surface water and groundwater resources at and around the Surry site.

3.5.1 Surface Water Resources

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

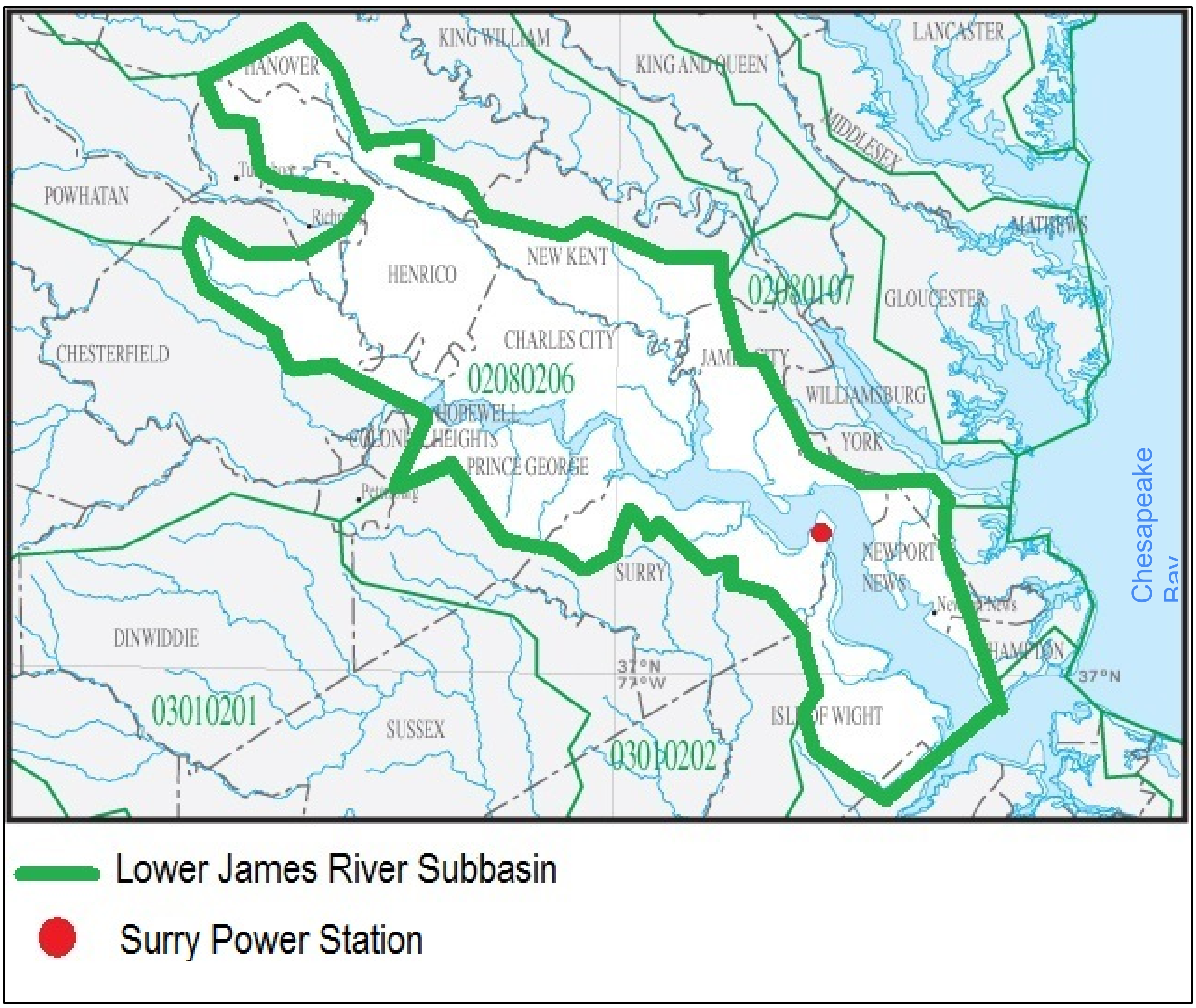
3.5.1.1 Surface Water Hydrology

Local and Regional Hydrology

Surry is located on the south shore of the James River, situated on a peninsula known as Gravel Neck, approximately 30 River Miles (RM) (48 River Kilometers (RKM)) upstream from the Chesapeake Bay. The James River is the southernmost major tributary of the Chesapeake Bay and the largest tributary estuary in Virginia (Brooks and Fang 1983). The headwaters of the James River originate along the Virginia/West Virginia State line and the river formed by the confluence of the Jackson and Cowpasture rivers in the Allegheny Mountains. The James River is approximately 350 mi (563 km) long, has 14 major tributaries, and an annual mean river flow of 5,437 mgd (VDEQ 2015a; VDEQ 2018b). The James River basin encompasses approximately 10,300 mi^2 (26,680 km^2), approximately 24 percent of Virginia's total land area (VDEQ 2015a).

Regionally, Surry is located within the Lower James River subbasin (hydrologic unit 02080206) portion of the James River basin (see Figure 3-12) and the tidally influenced portion of the James River. The Lower James River subbasin encompasses the land area that drains from approximately the fall line (see Section 3.4 and Figure 3-7) in Richmond, VA, to Newport News Point, VA, approximately an area of 1,440 mi^2 (3,730 km^2) (HRPDC 2011; VDEQ 2015a). Specifically, Surry withdraws water from the James River within the James River-Lawnes Creek watershed (hydrologic unit 0208020607) and discharges water to the James River within the James River-Lawnes Creek watershed (hydrologic unit 0208020608) (VDCR 2019d). The tidally influenced portion of the James River is approximately 110 mi (177 km) from the fall line in Richmond, VA, to its confluence with the Chesapeake Bay (Bukaveckas et al. 2011; Brooks and Fang 1983; Bukaveckas and Isenberg 2013). Tides in the James River are semi-diurnal, with two high tides and two low tides each day. At Fort Eustis (located approximately 3.5 mi (5.6 km) east of Surry's intake structure), the mean low tide water in the James River is 1.12 ft (0.34 m) below mean sea level and the high tide level is 1.07 ft (0.33 m) above mean sea level, resulting in a mean tidal range of 2.19 ft (NOAA 2019f). At Hog Point, the average maximum ebb and flood tidal currents are 2.2 ft/s (1.3 knots) and 1.7 ft/s (1.0 knots), respectively (NOAA 2018).

Flow and salinity in the Lower James River is complex and governed by freshwater discharge, tides, and density circulation and mixing as a result of freshwater and saline water interactions (Shen et al. 2017; VEPC 2001). Major tributaries to the Lower James River include the Appomattox River and Chickahominy River (see Figure 3-13). Both of these rivers are upstream of Surry. In the Lower James River, the less dense saline water flows downstream toward the Chesapeake Bay, while the dense saline water flows upstream (VEPC 1980; USGS 2011). This creates a non-tidal downstream directed flow near the surface of the river and upstream flow in the deeper bottom layers of the river. The ebb and flood of the tide represents the dominant motion of the tidal segment of the James River. Previous studies have found that near Hog Point, tidal flow is 10-20 times greater than non-tidal flow or freshwater discharge (VEPC 1977, 1980).



Source: Modified from USGS 2019b

Figure 3-12 Lower James River Subbasin

The tidally influenced portion of the James River is classified as a partially mixed estuary (VEPC 1977, 1980; Bradshaw and Kuo 1987). The mixture of saline and freshwater is commonly referred to as brackish water that can range in salinity from 0.5 to 35 parts per thousand (ppt). Salinity can vary daily and seasonally, but in general, salinity decreases from the mouth to the head of the estuary and increases with depth (Brooks and Fang 1983; Bradshaw and Kuo 1987). The tidally influenced portion of the James River is classified into segments based on salinity levels: freshwater (salinity levels less than 0.5 ppt), oligohaline (salinity levels of 0.5-5.0 ppt), mesohaline (salinity level of 5.0-18 ppt), or polyhaline (18.0 to 30.0 ppt). The tidal freshwater segment within the James River stretches from Richmond, VA, to the Prince George/Surry County boundary (see Figure 3-12) at approximately River Mile (RM) 52 (River Kilometer (RKM) 84). The oligohaline segment of the James River stretches approximately from the Prince George/Surry County boundary to approximately Surry's water intake structure (RM 29 (RKM 47)). The mesohaline segment of the James River stretches from Surry's water intake structure to Newport News Point.

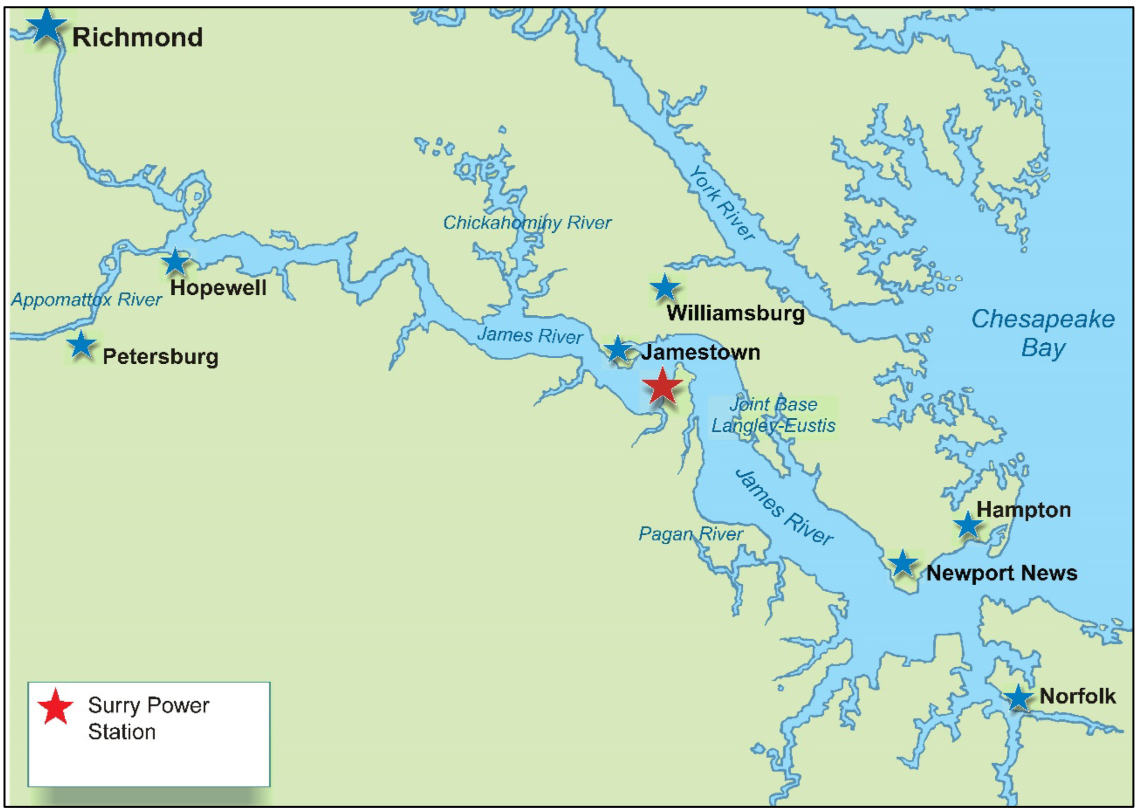


Figure 3-13 Lower James River

Recent salinity measurements in the immediate vicinity of Surry's intake and discharge points are not available (Dominion 2019c). However, water salinity measurements are available upstream and downstream of Surry's discharge canal. The Chesapeake Bay Monitoring Program maintains monitoring stations throughout the James River. Monitoring station LE 5.1 has measured the salinity of the James River northwest of the Gravel Neck Peninsula since 1984; between September 1984 and June 2018, salinity ranged between 0.0 and 18.8 ppt, and the average water salinity during this time period was approximately 5.5 ppt (CBP 2019a). Additionally, salinity data of the James River near Jamestown are available from 2008 through 2018 through the Chesapeake Bay Interpretive Buoy System. For this period of record, salinity ranged between 0.0 and 12 ppt, and the average water salinity was approximately 2.8 ppt (NOAA 2019a).

The U.S. Geological Survey (USGS) maintains gaging stations on the James River that measure freshwater discharge. Tides can prevent accurate measurements of freshwater flow in lower estuaries and in the vicinity of Surry (Moftakhair et al. 2013). The nearest USGS station that has both long-term and complete discharge data is located upstream of the Surry site near Richmond, VA (USGS 02037500). River discharge data have been collected at this station since water year 1937. The mean annual freshwater discharge for the James River measured at the USGS station at Richmond, for water years 1937 through 2018, is 6,896 cubic ft per second (cfs) (3,711 mgd). The highest annual freshwater mean discharge was 13,540 cfs (8,751 mgd) in 1973 and the lowest annual mean discharge was 2,110 cfs (1,364 mgd) in 2002 (USGS 2019d).

Water temperatures measured in the Lower James River by the USGS and Chesapeake Bay Program exhibit annual cyclic temperatures, with maximum water temperatures occurring during the summer months and minimum water temperatures occurring in the winter months. The nearest USGS station to Surry that measures water temperature is located near Charles City, approximately 27 RM (43 RKM) upstream from Surry (USGS 02042222). Data at this USGS station were collected from July 2014 through October 2017. During this time period, the maximum water temperature recorded was 33.3 °C (91.9 °F) in July 2016, and the minimum water temperature recorded was -0.1 °C (31.8 °F) in February 2015 (USGS 2019e). The water temperature data from the Chesapeake Bay Program long-term monitoring station LE5.1 northwest of Hog Point were available from September 1984 through June 2018. During this period, the maximum water temperature recorded was 31.3 °C (88.3 °F) in August 1986, and the minimum water temperature recorded was 1.5 °C (34.7 °F) in February 1985 (CBP 2019a).

Surry is located on a segment of the James River designated as a scenic river under Virginia's Scenic Rivers Program (HRPDC 2011). A total of 25 mi (40 km) of the Lower James River is designated as a State scenic river (from 1.2 mi (1.9 km) east of Tress Point to Lawnes Creek). Scenic river designation recognizes the natural, scenic, historic, and recreational value of the river segment and declares it protected (VDCR 2019c). The Virginia Department of Conservation and Recreation administers the Scenic Rivers Program.

Flooding

The James River is subject to flooding due to watershed runoff and surge from severe storms (e.g., hurricanes). The Federal Emergency Management Agency (FEMA) has delineated the flood hazard areas along the James River in the vicinity of Surry (FEMA 2019b). With the exception of the discharge canal and drainage areas along the northern property line, the Surry property is mapped as Zone X, which represents areas of minimal flood hazard. The eastern and western property lines along the James River border are designated coastal flood zones with base flood elevations between 10-19 ft (3-5.8 m) NAVD88 (North American Vertical Datum of 1988).

The NRC evaluates the potential effects of floods on nuclear power plants in a separate and distinct process from the license renewal process. In accordance with the General Design Criteria in Appendix A to 10 CFR Part 50, plant structures, systems, and components important to safety are required to be designed to withstand the effects of natural phenomena, such as flooding, without loss of capability to perform safety functions. Structures important to safety at Surry are flood protected to a minimum of elevation 24.0 ft (7.3 m) above mean sea level

(Dominion 2018b, Dominion 2018c). A minimum freeboard of greater than 4 ft (1.2 m) is maintained between the canal water surface and the berm to prevent overtopping (Dominion 2018b).

Additionally, the NRC evaluates nuclear power plant operating conditions and physical infrastructure to ensure ongoing safe operations through its Reactor Oversight Process. If new information about changing environmental conditions becomes available, the NRC will evaluate the new information to determine whether any safety-related changes are needed at existing nuclear power plants.

3.5.1.2 Surface Water Use

As described in Section 3.1.3, Surry withdraws surface water from the James River for the plant circulating water system and service water cooling system. Heated cooling water from the main condenser, along with comingled effluents from auxiliary systems, are discharged back to the James River via Outfall 001, in accordance with Surry's Virginia Pollutant Discharge Elimination System (VPDES) permit (VDEQ 2016). At the Surry intake structure, the James River is approximately 3.75-mi (6-km) wide and at the discharge canal, the James River is approximately 2.6-mi (4.2-km) wide (VEPC 1977). Before Surry began operating, salinity measurements in the James River were recorded in the vicinity of Surry's discharge and intake points from 1942 through 1965. Near the discharge canal, salinities in the James River ranged from 0 to 9.2 ppt. Near the intake, salinities ranged from 0.0 to 17.0 ppt (VEPC 1977). Surry post-operational salinity measurements were taken during the summer of 1975 within the discharge canal and three other monitoring stations located in the James River (near the discharge canal, upstream of the discharge canal, and further downstream near Hog Point). Average salinity within the discharge canal was higher than the average surface salinity at the three stations on the James River. The higher salinity in the discharge canal is due to the higher salinity water being withdrawn from the water intake, which is located further downstream on the other side of Hog Point (see Figure 3-3). Although the sampling data showed that in the James River near the discharge canal, average water salinity increased near the mouth of the discharge canal, the increase was not observed further downstream (Fang and Parker 1976, Parker and Fang 1975).

At Surry, the maximum (hypothetical) surface water withdrawal rate from the James River is 1,760,000 gpm (4,709 cfs; 111 m^3/s). This rate is equivalent to about 2,534 mgd (9.6 million cubic meters per day (m^3/d)) and assumes eight circulating water pumps in operation at their rated capacity. Table 3-4 provides Surry's annual James River water withdrawals from 2013 to 2018. Surry's average water withdrawals from the James River from 2013 and 2018 was 1,972 mgd (7.5million m^3/d) (VDEQ 2018b).

After passing through the condensers and service water system, the majority of water withdrawn is returned to the river. Actual consumption water use is not measured at Surry. The NRC (1972) estimated that for a heat rejection rate of $12x10^9$ Btu/hr and withdrawal rate of 1,680,000 gpm (2,419 mgd), approximately 22,500 gpm (50 cfs; 32 mgd) of Surry water intake withdrawals would be lost to evaporation. This water consumption represents approximately 1 percent of James River annual average discharge and approximately 2.3 percent of the James River lowest annual mean discharge on record between 1937 and 2018. Surface water consumptive use has not been found to be a problem at operating nuclear power plants with once-through heat dissipation systems, such as Surry, because such systems inherently return all but a very small fraction of the water they withdraw to the water source, as compared to closed-cycle systems (NRC 2013a).

Table 3-4 Surry Annual James River Water Withdrawals (2013–2018)

Year	Surface Water Withdrawals (MG)[a]
2013	716,700
2014	713,500
2015	677,500
2016	815,050
2017	735,000
2018	662,900
AVERAGE	720,100

[a]Values rounded from Dominion 2018b and Dominion 2019c. To convert million gallons per year (MGY) to million cubic meters (m^3) divide by 264.2.

Source: Dominion 2018b, Dominion 2019c

The Virginia Water Protection Program protects state water from being filled, excavated, drained, or dredged without a Virginia Water Protection Permit. Withdrawals from surface waters within Virginia, unless excluded, require a Virginia Water Protection Permit. Pursuant to §62.1-44.15:22B of the Code of Virginia, a Virginia Water Protection Permit is not required for any water withdrawal in existence on July 1, 1989; however, a permit is required if a new certification under Section 401 of the Clean Water Act of 1972 is required to increase a withdrawal. Therefore, the licensee stated that Surry's surface water withdrawals are not currently subject to Virginia's Water Protection Program permitting requirements (Dominion 2018b).

3.5.1.3 Surface Water Quality and Effluents

Water Quality Assessment and Regulation

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), 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 anti-degradation policy with respect to ambient water quality. As set forth under Section 101(a) of the Clean Water Act, 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 the protection and propagation of fish, shellfish, and wildlife and provides for human recreation in and on the water. The EPA reviews state promulgated water quality standards to ensure they meet the goals of the Clean Water Act and Federal water quality standards regulations (40 CFR Part 131, "Water Quality Standards").

The Virginia Department of Environmental Quality promulgates surface water quality standards in Virginia. There are six designated uses for surface waters in Virginia: (1) aquatic life; (2) fish consumption; (3) public water supplies; (4) recreation (e.g., swimming and boating); (5) shellfishing; and (6) wildlife. Additionally, there are aquatic life subcategory uses for the Chesapeake Bay and its tidal tributaries. Not all uses exit in a given water segment. Section 303(d) of the Federal Clean Water Act 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, Clean Water Act Section 305(b) requires states to assess and report on the overall quality of waters in their state. States prepare a Clean Water

Act Section 303(d) list that comprises those water quality limited stream segments that require the development of total maximum daily loads (TMDLs) to assure future compliance with water quality standards. The list also identifies the pollutant or stressor causing the impairment 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 waterbody 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 the National Pollutant Discharge Elimination System (NPDES) permit program, pursuant to Section 402 of the Clean Water Act, and associated point and nonpoint source water quality improvement plans and associated best management practices (BMPs). States are required to update and resubmit their impaired waters list every 2 years. This process ensures that impaired waters continue to be monitored and assessed by the State until applicable water quality standards are met.

The Virginia Department of Environmental Quality released a 2018 Draft Water Quality Assessment Integrated Report on January 22, 2019. The entire Lower James River, from Richmond, VA, to the Chesapeake Bay is designated as impaired. The James River segment located at Outfall 001 (Figure 3-14) fully supports the designated use for recreation. However, it is impaired for aquatic life as a result of the health of the benthic community (bottom-dwelling community) and is impaired for fish consumption due to polychlorinated biphenyl (PCB) in fish tissue (VDEQ 2019a). The James River segment located at Outfall 052 fully supports the designated use for recreation and shellfishing. However, the segment is impaired for aquatic life due to the health of the benthic community and impaired for fish consumption due to PCB in fish tissue. The James River segment located at Outfall 053 fully supports the designated use for recreation and shellfishing. However, the segment is impaired for aquatic life due to aquatic submerged vegetation acreage and health of benthic community and impaired for fish consumption due to PCBs in fish tissue. The VPDES permit for Surry prohibits the discharge of PCBs. Furthermore, according to the VDEQ, Surry is considered a non-significant Chesapeake Bay discharger and effluent limits are in conformance with technology-based requirements that are consistent with the Chesapeake Bay TMDL (VDEQ 2019 undated). The streams that receive stormwater from Surry discharges were not assessed for any designated use in the 2018 draft Water Quality Assessment Integrated Report (VDEQ 2019 undated and VDEQ 2019a).

<u>Virginia Pollutant Discharge Eliminating System Permitting Status and Plant Effluents</u>

To operate a nuclear power plant, NRC licensees must comply with the CWA, including associated requirements imposed by the EPA or the state, as part of the NPDES permitting system under Section 402 of the CWA. The Federal NPDES permit program addresses water pollution by regulating point sources (i.e., pipes, ditches) that discharge pollutants to waters of the United States. NRC licensees must also meet state water quality certification requirements under Section 401 of the CWA. The EPA or the States, not the NRC, sets the limits for effluents and operational parameters in plant-specific NPDES permits. Nuclear power plants cannot operate without a valid NPDES permit and a current Section 401 Water Quality Certification.

The EPA authorized the State of Virginia to assume NPDES program responsibility. The Virginia Department of Environmental Quality (VDEQ) administers the program as the Virginia Pollutant Discharge Elimination System (VPDES). The State of Virginia's regulations for administering the NPDES program are contained in Virginia Administrative Code 9 VAC 25-31. VDPES permits are issued by VDEQ on a 5-year cycle.

Surry is authorized to discharge various wastewater (effluent) streams under VDPES permit VA00094090, effective March 1, 2016, until it expires on February 28, 2021. Surry and Gravel Neck Combustion Turbines Station are jointly permitted under VPDES permit VA00094090 (VDEQ 2016). The VPDES permit authorizes discharge from 28 outfalls (6 external outfalls and 22 internal outfalls). The permit specifies the discharge limitations and monitoring requirements of effluent discharges at each outfall. External Outfall 001 is a wastewater outfall for process discharge, while the remaining five external outfalls (Outfall 002, 050, 051, 052, and 053) are stormwater discharges. Internal Outfalls 101 through 122 comingle and ultimately discharge to external Outfall 001(VDEQ 2016). The locations of Surry's six external outfalls are shown in Figure 3-14. Table 3-5 summarizes the contributing processes discharged through the outfalls. The VPDES permit requires that Dominion monitor and report various parameters for Surry's effluent discharges. As noted in Table 3-5, depending on the outfall, Dominion is required to monitor and report flow rate, total suspended solids, pH, heat rejection, total residual chlorine, biochemical oxygen demand, total suspended solids, enterococci, fecal coliform, total phosphorus, total kjeldahl nitrogen (organic and inorganic forms of nitrogen), nitrite and nitrate, and total nitrogen monitoring.

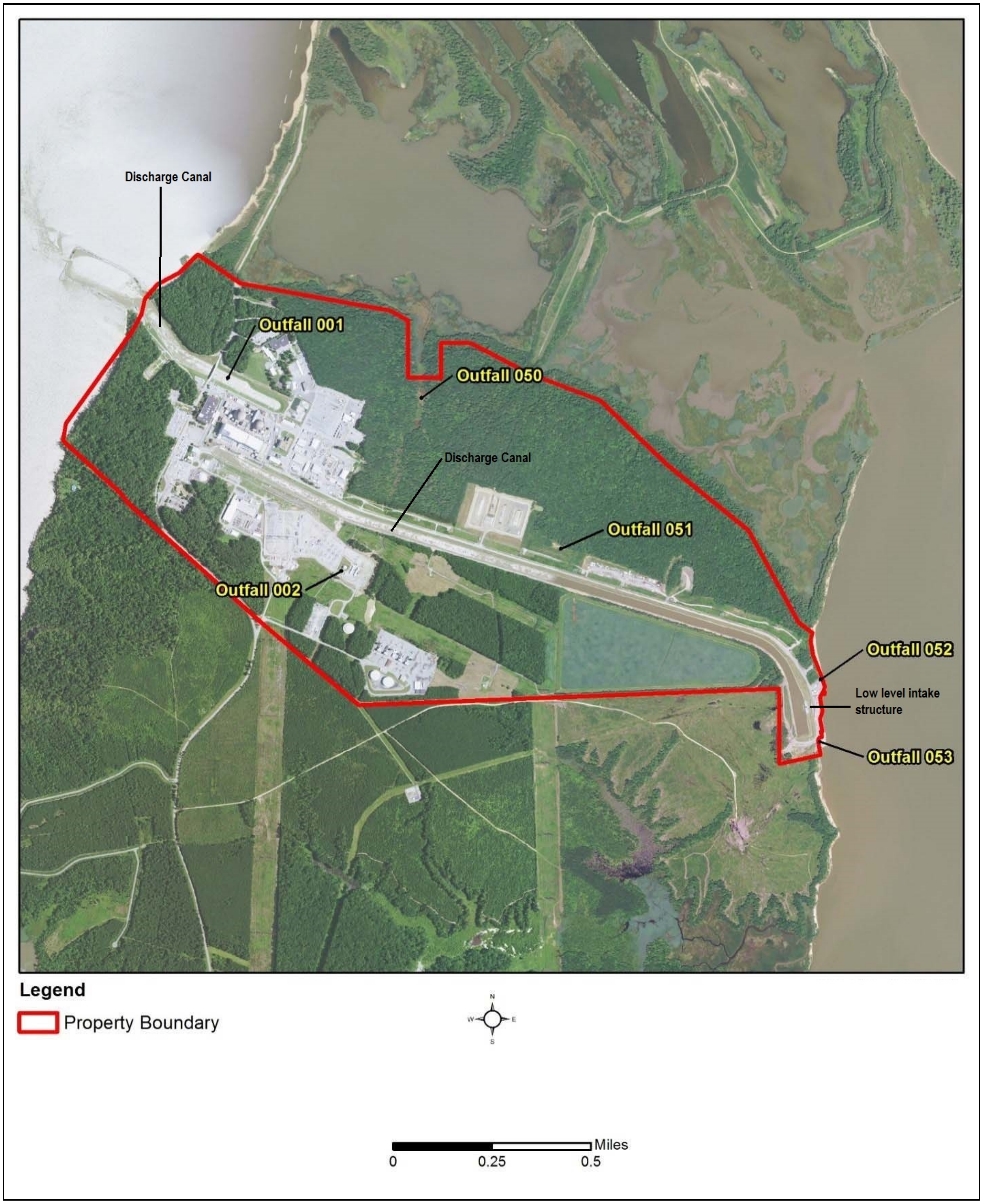
Table 3-5 Virginia Pollutant Discharge Elimination System Permitted Surry Site Outfalls

Outfall	Max flow (MGD)	Description
001	2,300	External outfall. Condenser cooling water and internal Outfalls 101 through 122. Discharge is to the James River. VPDES permit specifies heat rejection, total residual chlorine, and pH limits. Additionally, monitoring of flow, total suspended solids, and total thallium is required.
101	0.0382	Internal outfall. Sewage treatment plant. The onsite plant treats domestic wastewater from Surry sanitary drains. VPDES permit specifies pH, biochemical oxygen demand, total suspended solids, enterococci, and fecal coliform limits. Additionally, flow, total phosphorus, total kjeldahl nitrogen, nitrite and nitrate, and total nitrogen monitoring is required.
102 103 106	0.0234 0.05 0.0234	Internal outfall. Turbine sump A, B, C. Turbine sumps collect water and hydraulic oil leakage from components within the turbine building. VPDES permit specifies total suspended solids and oil and grease limits. Additionally, flow, pH, total phosphorus, total kjeldahl nitrogen, nitrite and nitrate, and total nitrogen monitoring are required.
104	0.0216	Internal outfall. Well water is treated by reverse osmosis. VPDES specifies total suspended solids and oil and grease limits. Additionally, flow, pH, total phosphorus, total kjeldahl nitrogen, nitrite and nitrate, and total nitrogen monitoring is required.
109	0.0181	Internal outfall. Radwaste facility radioactive liquid waste. VPDES specifies total suspended solids and oil and grease limits. Additionally, flow, pH, total phosphorus, total kjeldahl nitrogen, nitrite and nitrate, and total nitrogen monitoring is required.
110 111 112 113	0.0216 0.0279 0.0279 0.0279	Internal outfalls. Units 1 and 2 neutralization sumps collect and treat non-neutral pH wastewater produced during operation of the condensate polishing system. VPDES specifies total suspended solids and oil and grease limits. Additionally, flow, pH, total phosphorus, total kjeldahl nitrogen, nitrite and nitrate, and total nitrogen monitoring is required.

Outfall	Max flow (MGD)	Description
120	0.038	Internal outfall. Sump collects and treat wastewater with neutral pH from the condensate polishing system. VPDES specifies total suspended solids and oil and grease limits. Additionally, flow, pH, total phosphorus, total kjeldahl nitrogen, nitrite and nitrate, and total nitrogen monitoring is required.
107	0.0031	Internal outfall. Auxiliary boiler wastewater. VPDES specifies total suspended solids and oil and grease limits. Additionally, flow, pH, total phosphorus, total kjeldahl nitrogen, nitrite and nitrate, and total nitrogen monitoring.
114 115	0.0429 0.0429	Internal outfalls. Steam generator blowdown. VPDES specifies total suspended solids and oil and grease limits. Additionally, flow, pH, total phosphorus, total kjeldahl nitrogen, nitrite and nitrate, and total nitrogen monitoring is required.
118 119	0.09 0.09	Internal outfalls. Units 1 and 2 condenser hotwell drain. VPDES specifies total suspended solids and oil and grease limits. Additionally, flow, pH, total phosphorus nitrogen, total kjeldahl, nitrite and nitrate, and total nitrogen monitoring is required.
121 122	0.0005 0.1025	Internal outfalls. Unit 1 and 2 water used to clean steam generators via water blasting. VPDES specifies total suspended solids and oil and grease limits. Additionally, flow, pH, total phosphorus, total kjeldahl nitrogen, nitrite and nitrate, and total nitrogen monitoring is required.
105	0.05891	Internal outfall. Stormwater collected within the oil storage tank dike from oil tank that serves Surry auxiliary boiler and emergency diesel generators. VPDES permit specifies total suspended solids and oil & grease limits. Additionally, flow, pH, total phosphorus, total kjeldahl nitrogen, nitrite and nitrogen, and total nitrogen monitoring is required.
108	0.049318	Internal outfall. Intermittent discharges from the Settling pond which receives discharges from Outfalls 110, 111, 112, 113, and 120 and the Gravel Neck oil/water separator. VPDES permit specifies total suspended solids, total organic carbon, and oil and grease limits. Additionally, flow, pH, total phosphorus, total kjeldahl nitrogen, nitrite and nitrogen, and total nitrogen monitoring is required.
116 117	0.023 0.023	Internal outfall. Intermittent discharges from the Unit 1 and 2 Recirculation Spray Heat Exchangers. VPDES permit specifies total suspended solids and oil and grease limits. Additionally, flow and pH monitoring is required.
002	0.02127	External outfall. Stormwater collected within the Gravel Neck Gas Turbine Containment dike. Receiving water is an intermittent stream to the James River. VDPES permit requires monitoring of flow, copper, zinc, total organic carbon, total phosphorus, total kjeldahl nitrogen, total nitrogen, nitrite and nitrate, total nitrogen, and total suspended solids
050	Varies	External outfall. Stormwater runoff from approximately 272 acres of drainage area located in the central portion of the site. Receiving water is an intermittent stream to the James River. VDPES permit requires monitoring of flow, iron, total phosphorus, total kjeldahl nitrogen, nitrite and nitrate, total nitrogen, and total suspended solids

Outfall	Max flow (MGD)	Description
051	Varies	External outfall. Storm water runoff from approximately 84 acres of drainage area adjacent to the drainage area contributing to Outfall 050. Receiving water is an intermittent stream to Hog Island Creek. VDPES permit requires monitoring of flow, iron, total phosphorus, total kjeldahl nitrogen, nitrite and nitrate, total nitrogen, and total suspended solids
052	Varies	External outfall. Storm water runoff from approximately 10 acres of drainage area located adjacent to and north of the high level intake structure. Receiving water is the James River. VDPES permit requires monitoring of flow, iron, total phosphorus, total kjeldahl nitrogen, nitrite and nitrate, total nitrogen, and total suspended solids
053	Varies	External outfall. Storm water runoff from approximately 10 acres of drainage area located adjacent to and south of the high level intake structure. Receiving water is the James River. VDPES permit requires monitoring of flow, iron, total phosphorus, total kjeldahl nitrogen, nitrite and nitrate, total nitrogen, and total suspended solids

Source: VDEQ undated and VDEQ 2016



Source: Modified from Dominion 2018b

Figure 3-14 Surry External Outfalls

The VDPES permit limits heat rejected to the James River to 12.6×10^9 BTU/hr from Outfall 001. Monthly Discharge Monitoring Reports, from January 2016 through January 2019, show that Surry has been in compliance with this limit. Over this period, the maximum heat rejected from Surry to the James River ranged from 10.04×10^9 to 12.04×0^9 BTU/hr (EPA 2019c). Heat rejection limit are based on the results of Section 316(a) of the CWA demonstration study submitted to the State Water Control Board in 1977 (VDEQ 2019 undated; VEPC 1977). Post-operational studies conducted pursuant to Section 316(a) of the Clean Water Act recorded water temperature measurements between June and September 1975 (Fang and Parker 1976). Water temperature measurements recorded during this period within the discharge canal ranged between 81.7-99.9 °F (27.6-37.7 °C). The highest discharge temperature of 99.9 °F (37.7 °C) measured during this study occurred in August 1975. The study found that effluent temperatures in the James River from the discharge canal decrease as distance from the discharge canal increases, a decrease of 1-2 °F with every 1,000 ft (394 m) from the mouth of the discharge canal. Recent measurements taken between June through October 2018 by Dominion found that the maximum water temperature in the discharge canal was 91.4 °F (33 °F) (Dominion 2019c). Dominion is in the process of updating its Clean Water Section 316(a) demonstration for Surry; this update will include thermal modeling to evaluate the thermal mixing zone. The CWA Section 316(a) update report will be provided to VDEQ with the application for reissuance of the site VPDES permit by September 2020 (Dominion 2019c).

As noted in Table 3-5, Dominion is authorized to discharge stormwater runoff from external Outfalls 002, 050, 051, 052, and 053. Either directly or indirectly via local drainage channels, all stormwater is discharged to the James River. Dominion maintains a stormwater pollution prevention plan (SWPP) that identifies the sources of pollution to comply with the stormwater management conditions of Surry's VPDES permit (Dominion 2018b). The SWPP is intended to identify sources of stormwater pollution and document control measures, including BMPs to eliminate or reduce the pollutant in all stormwater discharges from the facility and that meet effluent limitations (Dominion 2018b).

Dominion operates an onsite sewage treatment plant for the disposal of Surry sanitary waste. After sanitary wastewater is collected and treated, it ultimately discharges to the James River via Outfall 001. Wastewater treatment includes a number of processes, including flow equalization, settling, grinding, activated sludge, chlorine disinfection, and aerobic digestion (VDEQ 2019 undated). Sewage sludge generated by the treatment plant is disposed of offsite (VDEQ 2019 undated).

Dominion submits discharge monitoring reports (DMRs) to the VDEQ in accordance with the reporting schedule specified in Surry's VQDES permit. Dominion reports that it has not received State notices of violation between 2013 and 2018 associated with Surry's VPDES permit (Dominion 2018b, Dominion 2019c). The NRC staff's review of EPA's Enforcement and Compliance History Online system 3-year compliance history (January 2016 through January 2019) revealed no notices of violation during this timeframe (EPA 2019d). However, there have been effluent limit exceedances. For the July 1, 2016, through August 31, 2016, monitoring period, biochemical oxygen demand measurements taken from Outfall 101 (sewage treatment plant) exceeded VPDES limits (Dominion 2018b). In response to biochemical oxygen demand measurement exceedances, Dominion monitored the effluent and conducted subsequent sampling measurements from Outfall 101; subsequent sampling measurements indicated that this was a temporary condition and that levels had returned to less than the limit. (Dominion 2018 ER). In January 2017, Enterococci bacteria samples from the site's sewage treatment plant discharge (Outfall 101) exceeded the VPDES permit limit. A cause evaluation determined that the likely reason for permit exceedance was due to contamination during sample collection. Dominion revised its sampling guidance to minimize sample contamination. Additionally, between 2012 and 2018, an inadvertent release of hydraulic fluid occurred in March 2017. During the cleaning of the Surry Unit 2 circulating water intake bay, approximately 8 gallons of glycol-based hydraulic fluid was released into the bay and assumed to discharge into the James River (Dominion 2019c). Dominion notified VDEQ and implemented corrective actions to minimize potential future spills (Dominion 2019c).

Other Surface Water Resources Permits and Approvals

An applicant (in this case, Dominion) 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 Section 401 of the CWA to provide the licensing agency (in this case, the NRC) with water quality certification from the state (in this case, the Commonwealth of Virginia). This certification implies 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 waived the requirement. The NRC recognizes that some NPDES-delegated states explicitly integrate their 401 certification process with NPDES permit issuance. However, Surry's VDPES permit does not explicitly convey water quality certification under CWA Section 401. Dominion is currently in discussions with VDEQ regarding permitting requirements for Surry (Dominion 2019c). Pursuant to §62.1-44.15:20(D) of the Code of Virginia, issuance of a Virginia Water Protection Permit constitutes the certification required under Section 401 of the CWA. As discussed in Section 3.5.1.2 of this SEIS, Dominion has stated that, because Surry was in operation prior to July 1, 1989, it is exempt from obtaining a Virginia Water Protection Permit. Dominion is engaged in ongoing communication and discussions with the Virginia Department of Environmental Quality regarding an exemption from State Section 401 certification requirements (Dominion 2019c). At the time of publication of this SEIS, the Virginia Department of Environmental Quality has not provided documentation to Dominion that Surry remains exempt from Virginia Water Protection/Section 401 certification requirements or provided Section 401 certification.

Dominion conducts periodic maintenance dredging of the intake channel in the James River every 3-4 years and would continue to do so if Surry were to continue operating under the proposed license renewal (Dominion 2018b; USACE 2016). The intake channel is approximately 5,700-ft (1,737-m) long; however, Dominion only dredges a 2,000 ft (609 m) long section (Dominion 2019c). Dominion has historically dredged the channel to a depth of -12 ft (3.7 m) mean lower low water (i.e., average height of the lowest tide recorded at a tide station each day) with volumes ranging from 65,000 to 150,000 cubic yards per dredge cycle (Dominion 2019c; USACE 2018b). Dredge material has been placed at an onsite dredge material management area (DMMA) adjacent to the intake structure via temporarily installed high-density polyethylene pipes (Dominion 2018b; Dominion 2019c). Dominion was authorized to conduct dredging of the intake channel in the James River and disposal onsite under a USACE regional permit, Permit Number NAO-2008-01451 (USACE 2016). In 2016, Dominion conducted geotechnical studies of the onsite DMMA and determined that it was reaching full capacity and would not support a full dredge (USACE 2018b; Dominion 2019c). Construction of a new 58-ac (23-ha) offsite DMMA, approximately 4 mi (6.4 km) south of Surry, began in February 2019, and is anticipated to be completed by November 2019.

Dominion submitted a joint application to the USACE in December 2017 to perform maintenance dredging within the existing intake channel in the James River and to place the material in the new offsite DMMA. Dredged material from the intake channel will be sluiced to the DMMA via a pipe submerged in Lawnes Creek (see Figure 3-3). The pipe will run from the intake channel to the DMMA and will be temporarily placed in Lawnes Creek only during dredging cycles and removed once dredging is complete (USACE 2018b). Additionally, during active dredging, effluent from the DMMA will be discharged to Lawnes Creek via a pipe (USACE 2018b; Dominion 2019c). Stormwater from the DMMA will be discharged to an unnamed tributary located to the north of the DMMA. Dominion obtained or is in the process of submitting applications to obtain the permits required for construction and operation of the offsite DMMA, including a Virginia Water Protection Permit, construction stormwater discharge permit, and industrial stormwater discharge permit (Dominion 2019a).

Additionally, Dominion is authorized to conduct debris removal of the low-level intake structure under USACE Nationwide Permit Number 3, NAO-2018-00103 (Dominion 2018b). Debris (aquatic vegetation, logs, sediments, trash, plastics, and metals) from the low-level intake structure is removed as part of preventive maintenance activities on a set frequency or as needed. Once removed, debris is placed in dumpsters and then transported to an offsite facility for disposal (Dominion 2019c; USACE 2017).

3.5.2 Groundwater Resources

This section describes the groundwater flow systems and water quality in and around Surry. Aquifers are underground bodies that (1) contain sufficient permeable materials, such as sand and gravel, (2) are filled with water, and (3) can supply useful quantities of water to a well or spring. Confining units are underground bodies of low permeability material that impedes the vertical movement of groundwater.

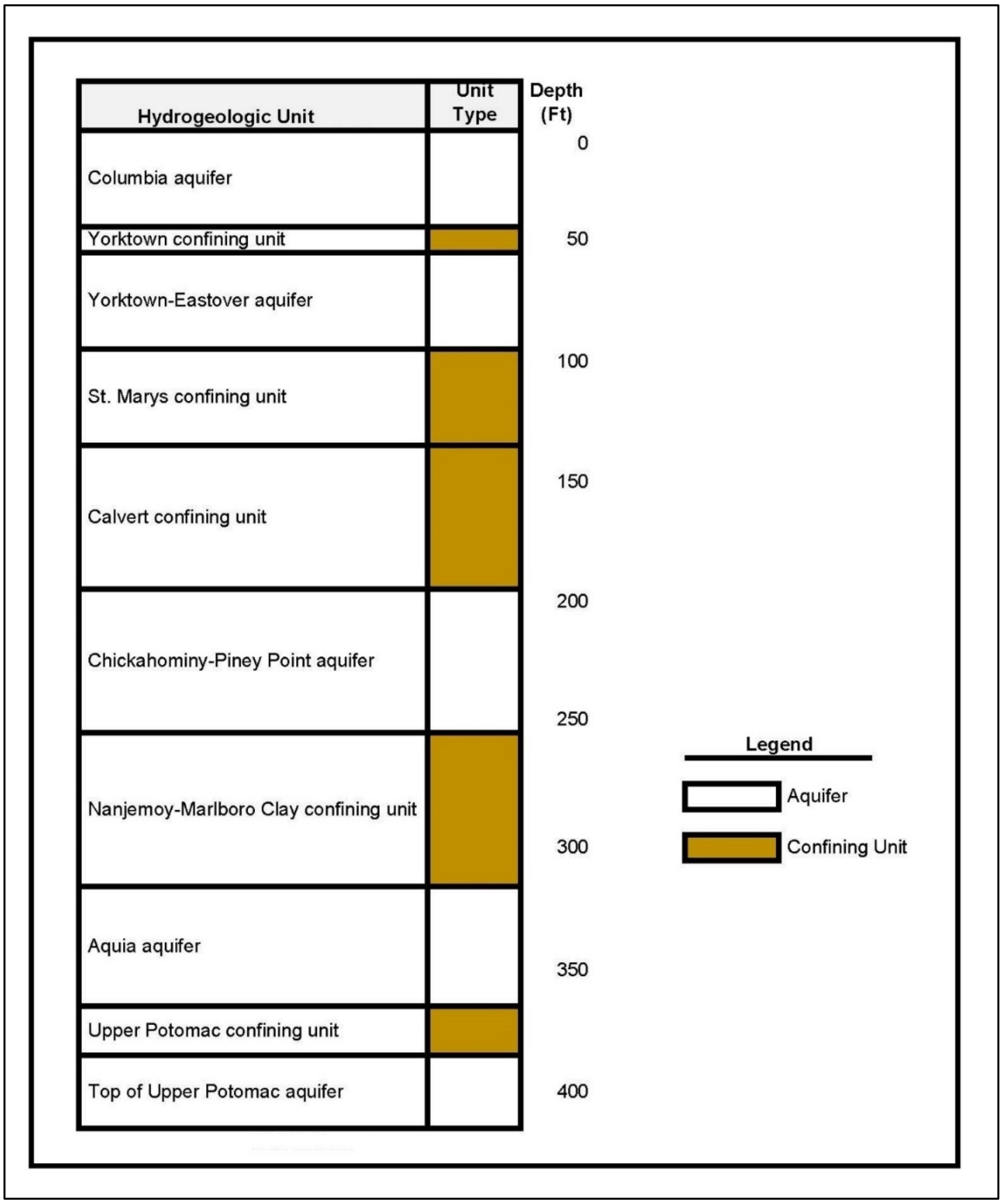
3.5.2.1 Local and Regional Groundwater Resources

As previously described in Section 3.4.1 ("Physiography and Geology") the Virginia Coastal Plain Physiographic Province is underlain by unconsolidated sedimentary layers that generally thicken and dip eastward. The alternating sand and clay layers form a series of aquifers and confining units. The aquifers consist mainly of sand, or interbedded sand and clay, while confining units consist mainly of silt and clay. Moving in an eastward direction, both aquifers and confining units thicken and are found at greater depths (USGS 1988a, 1988b) (Figure 3-16).

However, as discussed in Section 3.4.1 ("Physiography and Geology") the formation of the Chesapeake Bay Impact Crater changed this geology. Formation of the crater created new sediments, eliminated some sediments, and disrupted the eastward dip of some sediments (Figures 3-9 and 3-10). This also changed the hydrologic properties of the aquifers and confining units both within and nearby the crater. In some areas they became less permeable, in other areas they became more permeable, while in other areas they were destroyed altogether. In addition, fractures and structural changes created interconnections between aquifers and connections with post-impact sediments deposited into the crater (USGS 2000, 2006, 2010, 2013b, 2019f).

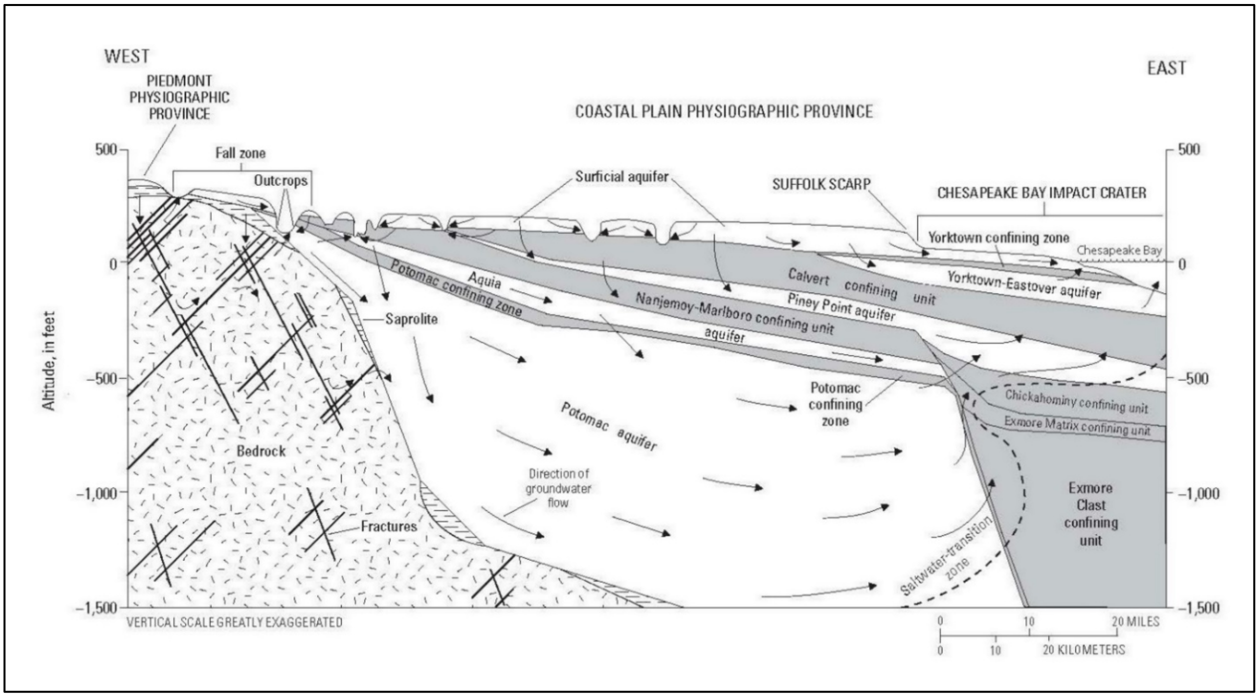
Aquifers and confining units that lie beneath Surry were not structurally affected by the creation of the impact crater. The aquifers and confining units beneath Surry are shown in Figure 3-15. Five aquifers separated by confining units are found beneath the site. In order of increasing depth, they are the (1) Columbia aquifer, (2) the Yorktown-Eastover aquifer, (3) the Chickahominy-Piney Point aquifer, (4) the Aquia aquifer, and (5) the Potomac Aquifer (USGS 1988b, 2006). Beneath the site, the Columbia aquifer forms the surface materials. It is an unconfined aquifer. Depending on its location, it is likely that the Yorktown-Eastover aquifer which underlies the Columbia aquifer may be either confined or unconfined. All deeper aquifers are confined aquifers.

Groundwater in the Columbia and the Yorktown-Eastover aquifers are recharged by local precipitation or from streams and rivers. Moving westward within the Virginia Coastal Plain Physiographic Province, aquifers are found at shallower depths until the contact between the Virginia Coastal Plain and Piedmont Plateau physiographic provinces is reached. This contact is identified as the fall line in Figures 3-7, 3-8, and 3-16. Aquifers that underlie the Columbia and the Yorktown-Eastover aquifers are recharged in the area of the fall line from precipitation and from rivers and streams (USGS 2010).



Derived from USGS 1988b

Figure 3-15 Aquifers and Confining Units Beneath Surry From the Land Surface to the Top of the Upper Potomac Aquifer



Modified from USGS 2013b

Figure 3-16 Westward Movement of Groundwater Within the Coastal Plain Physiographic Province from the Fall Zone Toward the Chesapeake Bay Impact Crater

Surry is located on a meander of the James River. It can be visualized as a peninsula that is surrounded by the river on three sides. The direction of groundwater flow in the Columbia aquifer and the Yorktown-Eastover aquifers are likely influenced by (1) the water levels of the James River, (2) precipitation, and (3) the operation of the Surry intake and discharge canals. Depending on these influences, groundwater flow in the Columbia and Yorktown-Eastover aquifers is either into or from the James River. (Dominion 2018b).

The regional direction of groundwater flow in the deeper underlying confined aquifers is eastward away from their recharge areas and toward the Atlantic Ocean (Dominion 2018b; USGS 1990, 2009, 2010). However, in some confined aquifers, the direction of flow may be influenced by groundwater pumping (USGS 2009).

In the Virginia Coastal Plain Physiographic Province, the two aquifers most widely used as a source of groundwater are the Yorktown-Eastover aquifer and the Potomac aquifer (Dominion 2018b; USGS 2009; VDEQ 2015b). Of the two aquifers, the Potomac aquifer is the major supplier of groundwater in the region. It lies on top of the crystalline rock which underlies all the sediments in the Coastal Plain Physiographic Province (Dominion 2018b). It is found beneath the entire region, except where both it and overlying aquifers were removed by the formation of the Chesapeake Bay Impact Crater (Figures 3-16 and 3-17) (USGS 2000, 2006, 2009).

As groundwater flowing in the Potomac aquifer or in overlying aquifers encounters the rim of the impact crater, it flows around the crater rim and continues toward the Atlantic Ocean. This is because after the impact crater was formed, it filled with low permeability tsunami-generated breccia, and later by other low permeability sediments (USGS 2009, 2010). Groundwater flows from areas of high heads to low heads, which in groundwater can often be expressed as water levels measured in wells. Figure 3-18 shows the water levels in the Potomac aquifer before pumping from the aquifer began. In this figure, the direction of groundwater flow is around the impact crater and toward the Atlantic Ocean. Figure 3-19 shows the impact of pumping on water levels within the Columbia aquifer and, therefore, also on the direction of groundwater flow. In this figure, most of the groundwater is flowing toward the two regional pumping centers in Franklin and West Point.

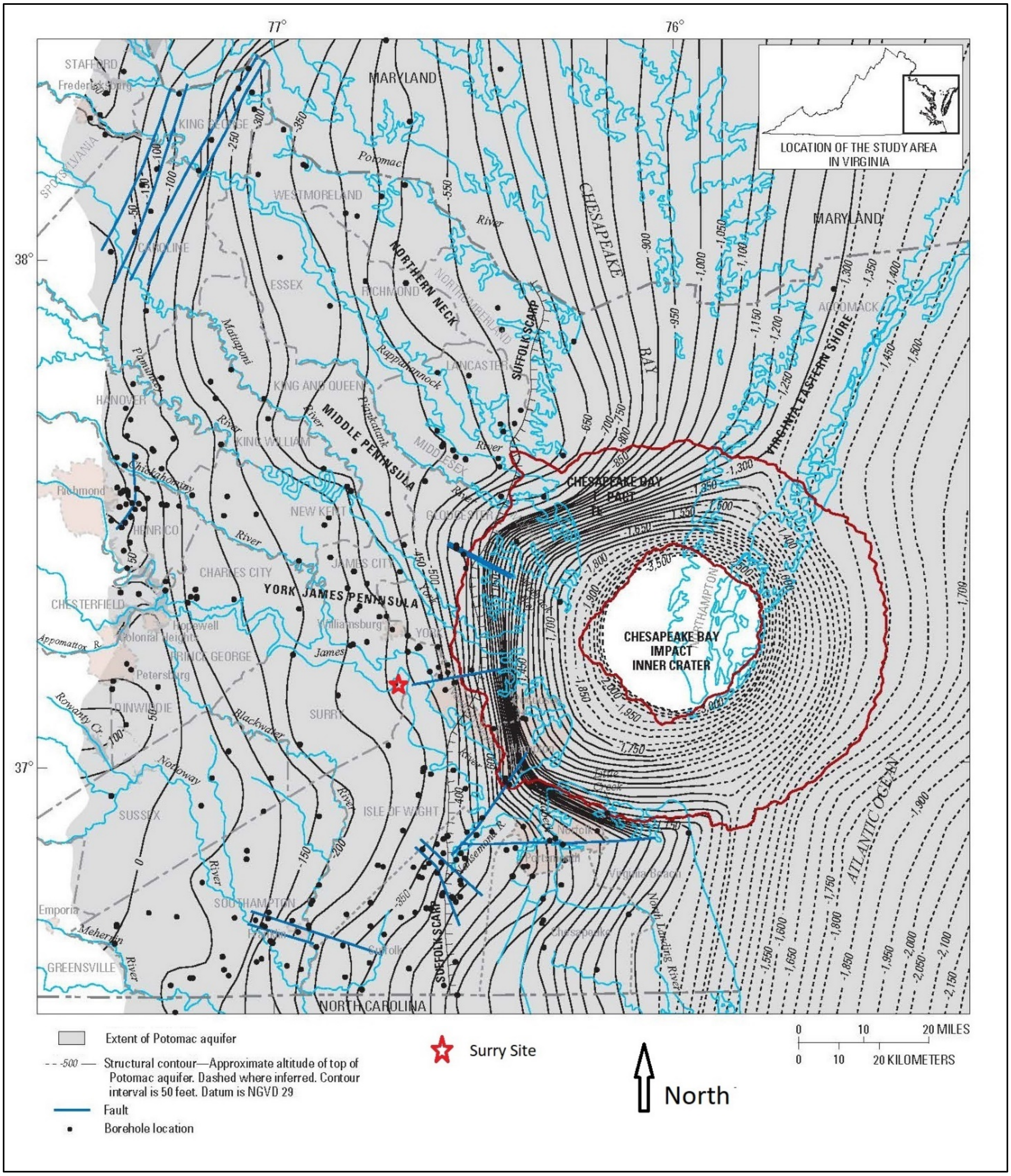
The Potomac aquifer is commonly characterized as having three distinct zones. These zones are separated from each other by confining units. From the bottom up, these zones are the Lower Potomac aquifer, the Middle Potomac aquifer, and the Upper Potomac aquifer. Together, they comprise the Columbia aquifer. Beneath Surry, the aquifer is approximately 911 ft (278 m) thick (USGS 2013b). In the Coastal Plain Physiographic Province, much of the water consumed is derived from the Upper Potomac aquifer (USGS 2008b; VDEQ 2012, VDEQ 2015b). The Surry facility also obtains its water from the Upper Potomac aquifer (Dominion 2018b).

3.5.2.2 Local and Regional Water Consumption

In the Coastal Plain Physiographic Province, the over-pumping of groundwater from the Potomac aquifer has caused water levels within the aquifer to fall over a broad area, including beneath the Surry site (VDEQ 2015b; USGS 2008c 2019h). The confined aquifers of the Virginia Coastal Plain Physiographic Province have historically yielded high rates of groundwater. However, large withdrawals from these aquifers to satisfy industrial, commercial, municipal, and agricultural needs have resulted in declining water levels within the Potomac aquifer. Water level observations of the Potomac aquifer have been collected for decades. These data indicate that in the Potomac aquifer, water levels have been falling at a rate of about 2 ft/yr (0.6 m/yr) (VDEQ 2012) (Figure 3-20).

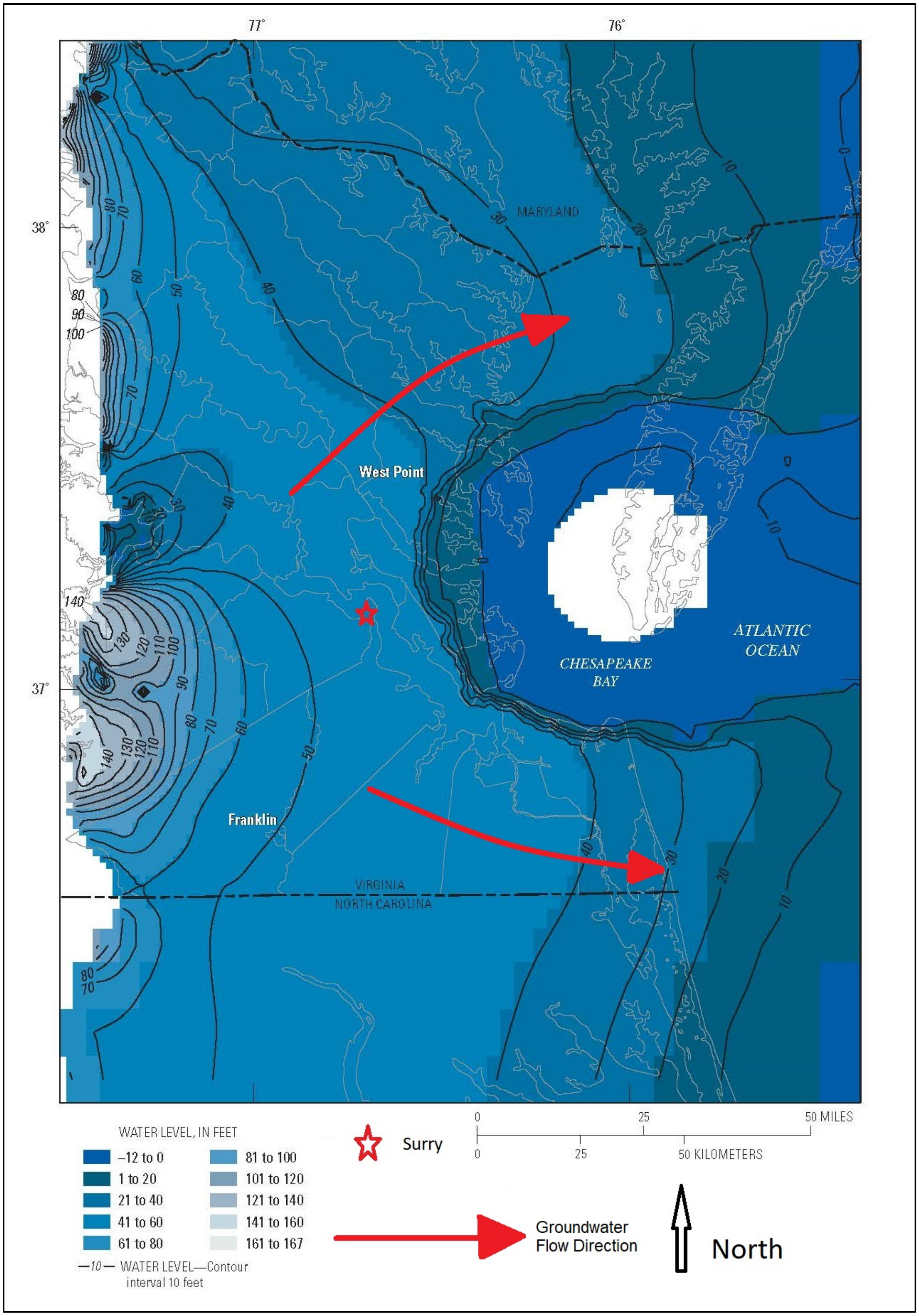
The regional drop in Potomac aquifer water levels is reflected in data collected from a USGS Potomac Aquifer monitor well located close to Surry at the tip of Hog Island. Since 1979, the water levels in this well have declined by 36.6 ft (11.2 m) (USGS 2019a).

As previously discussed in Section 3.4.4, land subsidence is ongoing in the region around Surry. Two areas on the Virginia coastal plan, with high land surface subsidence rates roughly coincide with the two groundwater pumping centers at Franklin and West Point, Virginia (Figure 3-21). Over-pumping of groundwater can cause a decrease in well water levels and the heads within an aquifer. Too much of a reduction in heads within an aquifer can also cause some sediments within the aquifer to compact. Unfortunately, even if the heads in the aquifer were to recover at a future date, this subsidence is unlikely to be reversed. This means subsidence can cause a permanent loss in the volume of water that can be stored within the aquifer along with a permanent lowering of the land surface.



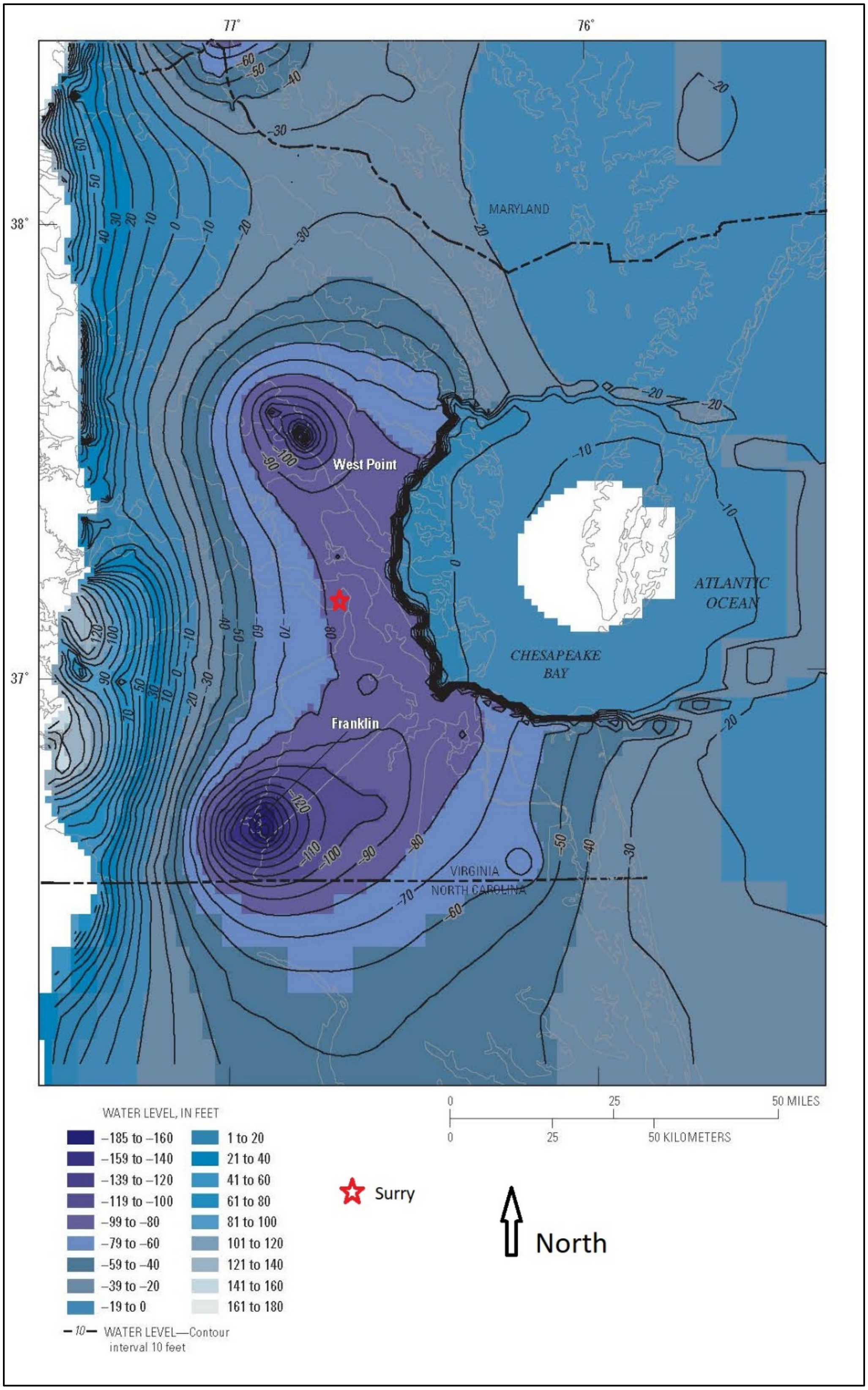
Source: Modified from USGS 2006

Figure 3-17 Top of Potomac Aquifer Elevations



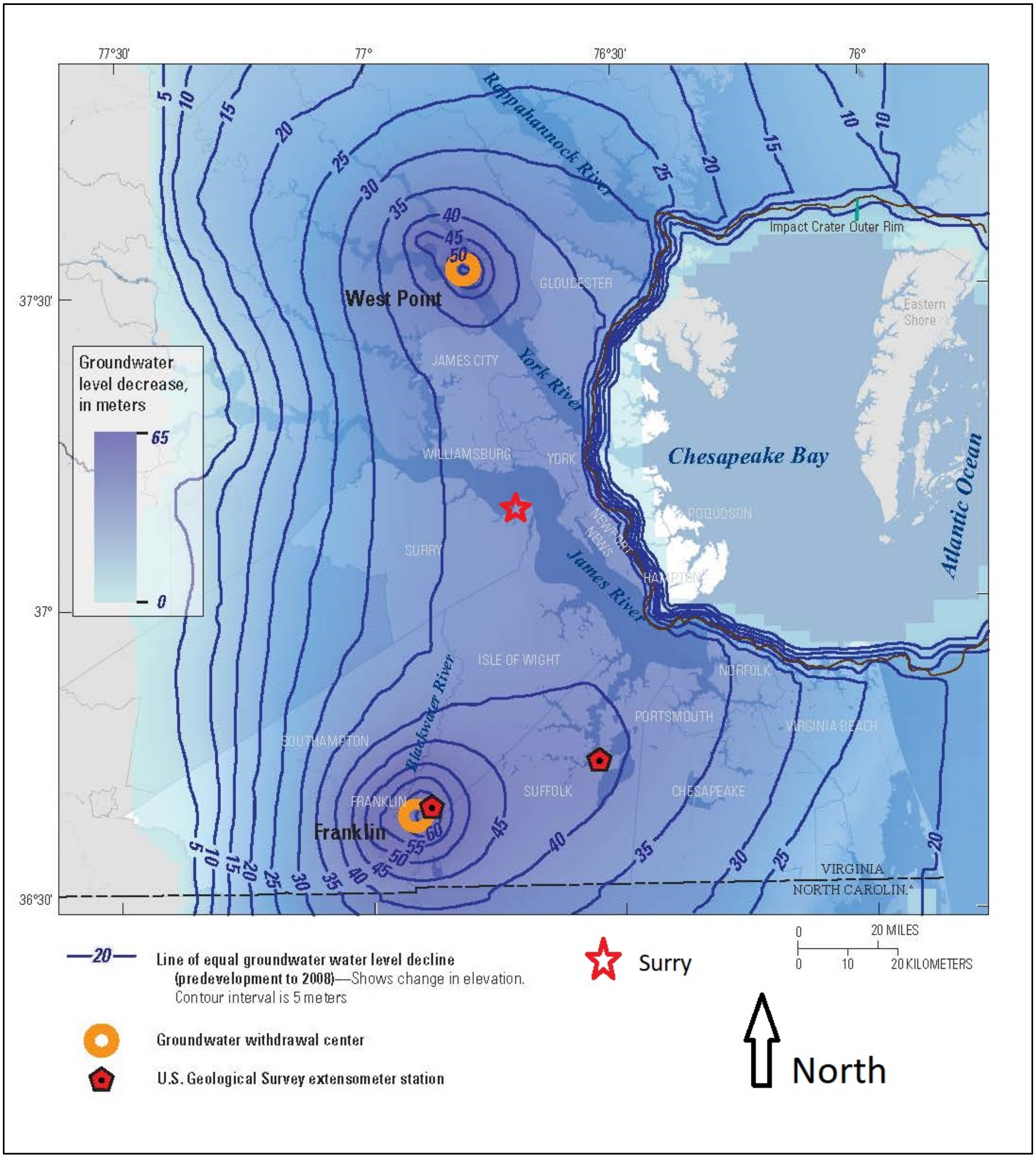
1 Source: Modified from USGS 2009

2 **Figure 3-18 Simulated Pre-Pumping Groundwater Levels Within the Potomac Aquifer**



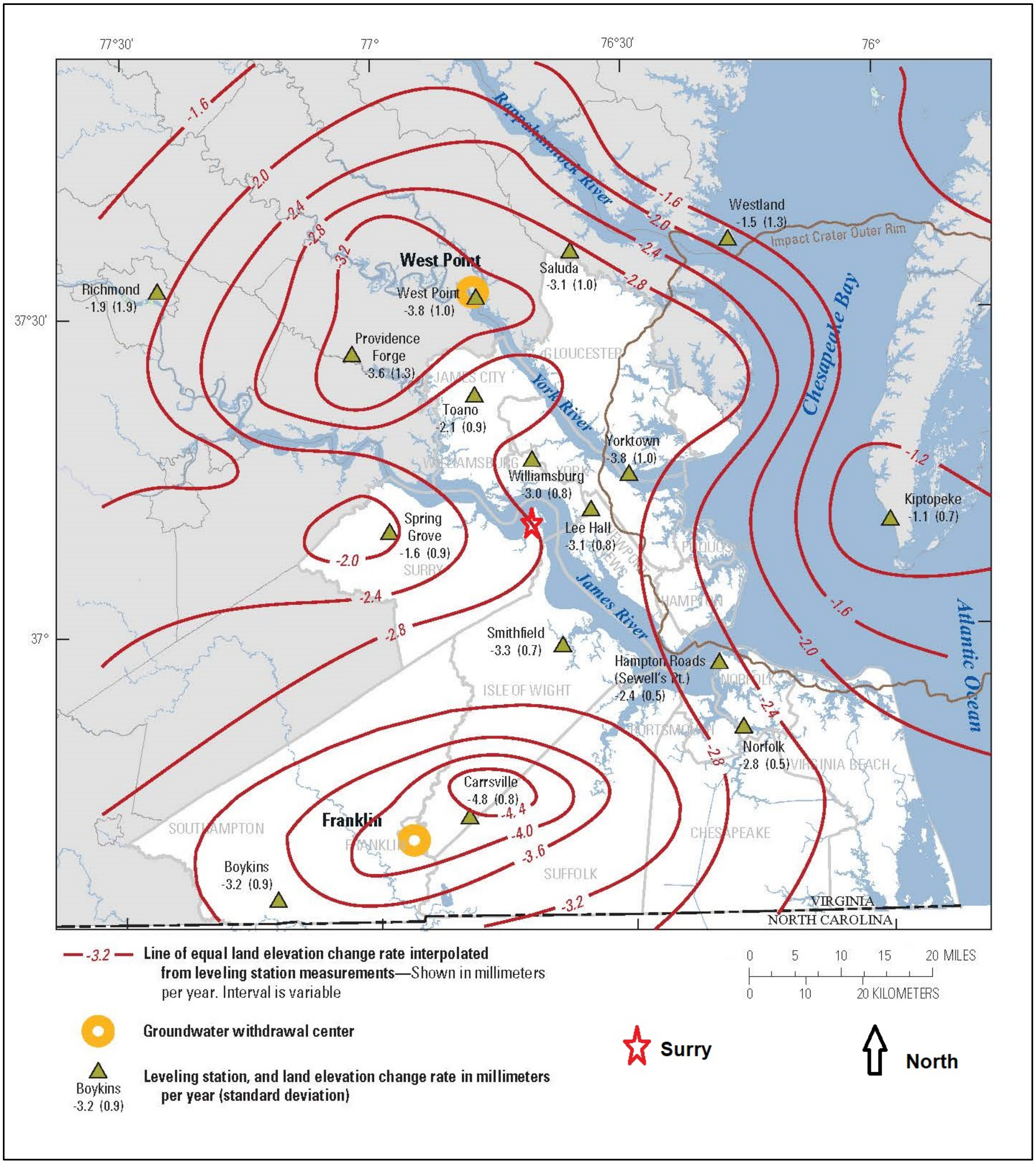
Source: Modified from USGS 2009

Figure 3-19 Simulated 2003 Groundwater Levels Within the Potomac Aquifer



Source: Modified from USGS 2013a

Figure 3-20 Groundwater Water Level Decreases Within the Potomac Aquifer from 1900 to 2008



Source: Modified from USGS 2013a

Figure 3-21 Land Elevation Change Rates from 1940 through 1971 (contours indicate lines of equal land elevation change rate in mm/year; negative elevation rates indicate subsidence)

Surry is in the Virginia Eastern Groundwater Management Area. In this area, Groundwater Withdrawal Permits are required from the Virginia Department of Environmental Quality to withdraw more than 300,000 gallons (1.1 million liters (L)) in any month. Permit applications for new groundwater withdrawals or for increases to existing groundwater withdrawals are evaluated for sustainability by considering the combined impacts from all existing lawful withdrawals. Virginia contractors and staff use groundwater models to conduct evaluations of impacts and resource sustainability (VDEQ 2012).

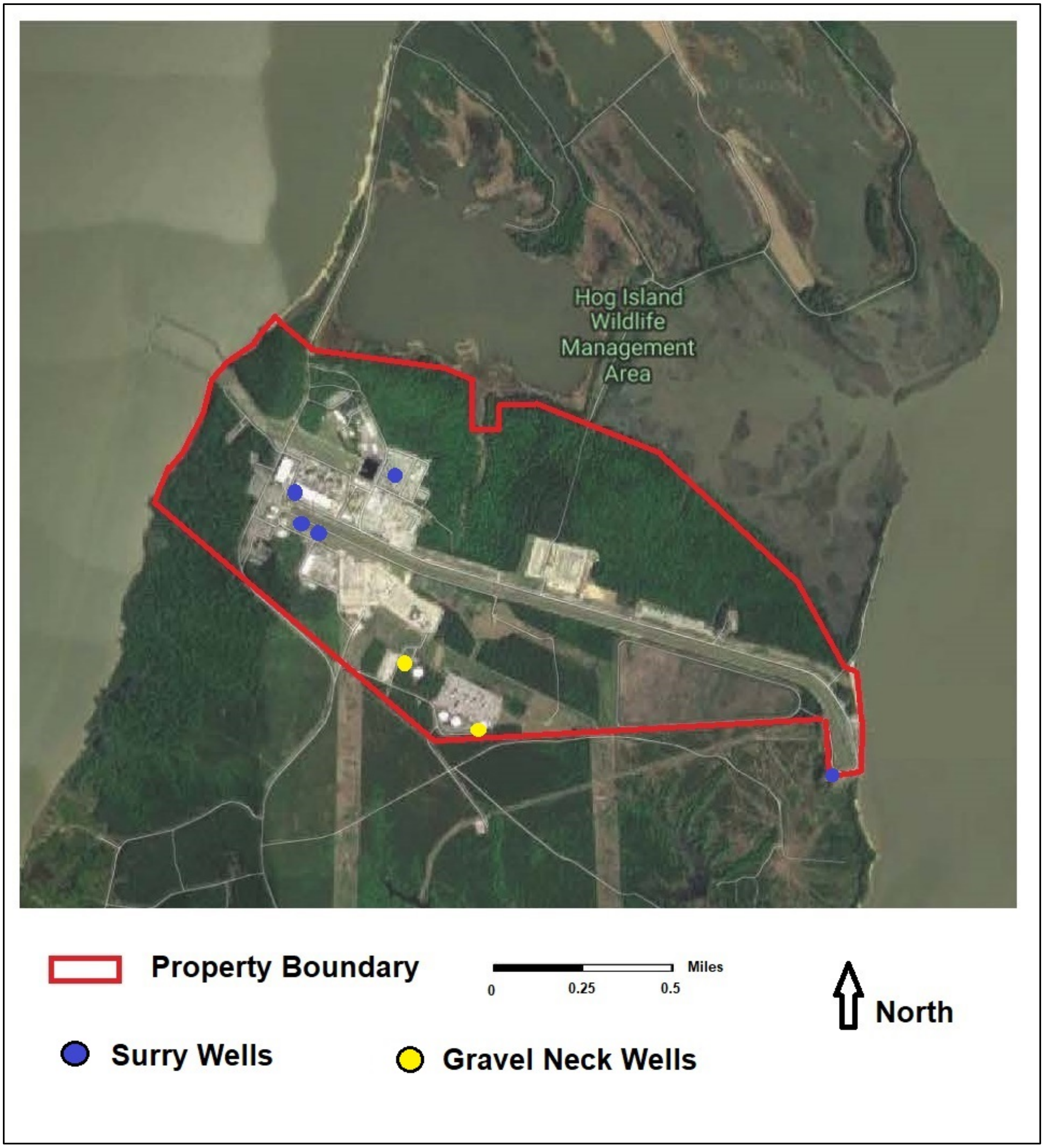
Within the Surry site, five wells supply water to the Surry facility and two wells supply water to the Gravel Neck Combustion Turbines Station (Figure 3-22). All the wells produce water from the Upper Potomac aquifer. The water is used for facility operations and as a source of potable water. There are no registered water wells within 1 mile (1.6 km) of the site boundary. The nearest water supply well is located approximately 1.5 mi (2.4 km) north of the site boundary at the tip of Hog Island. This well also obtains its water from the Upper Potomac aquifer (Dominion 2018b).

All of the Surry water supply wells are permitted by the Commonwealth of Virginia under Virginia Department of Water Quality permit number GW0003901. As part of the permitting process, groundwater modeling of the Potomac aquifer and overlying Aquia aquifer was conducted by the Commonwealth of Virginia to evaluate the impacts on water levels and on other lawful consumers of groundwater from the water supply wells at Surry (Dominion 2018b). The permitting process concluded that water-level drawdown impacts were acceptable.

Between 2013 and 2017, the wells supplying the Surry facility and the Gravel Neck Combustion Turbines Station consumed an average of 121 mgy (458 mLy) (Dominion 2018b). This is less than the 154.7 mgy (586 mLy) that the site has been permitted to consume.

3.5.2.3 Groundwater Quality

A sole source aquifer is an aquifer that supplies at least 50 percent of the drinking water for its service area. It is also an aquifer where no reasonably available alternative drinking water sources exist should the aquifer become contaminated (EPA 2019i). The Surry site is not located over a sole source aquifer and Surry water supply wells are not withdrawing any water from a sole source aquifer (Dominion 2018b; EPA 2019e).



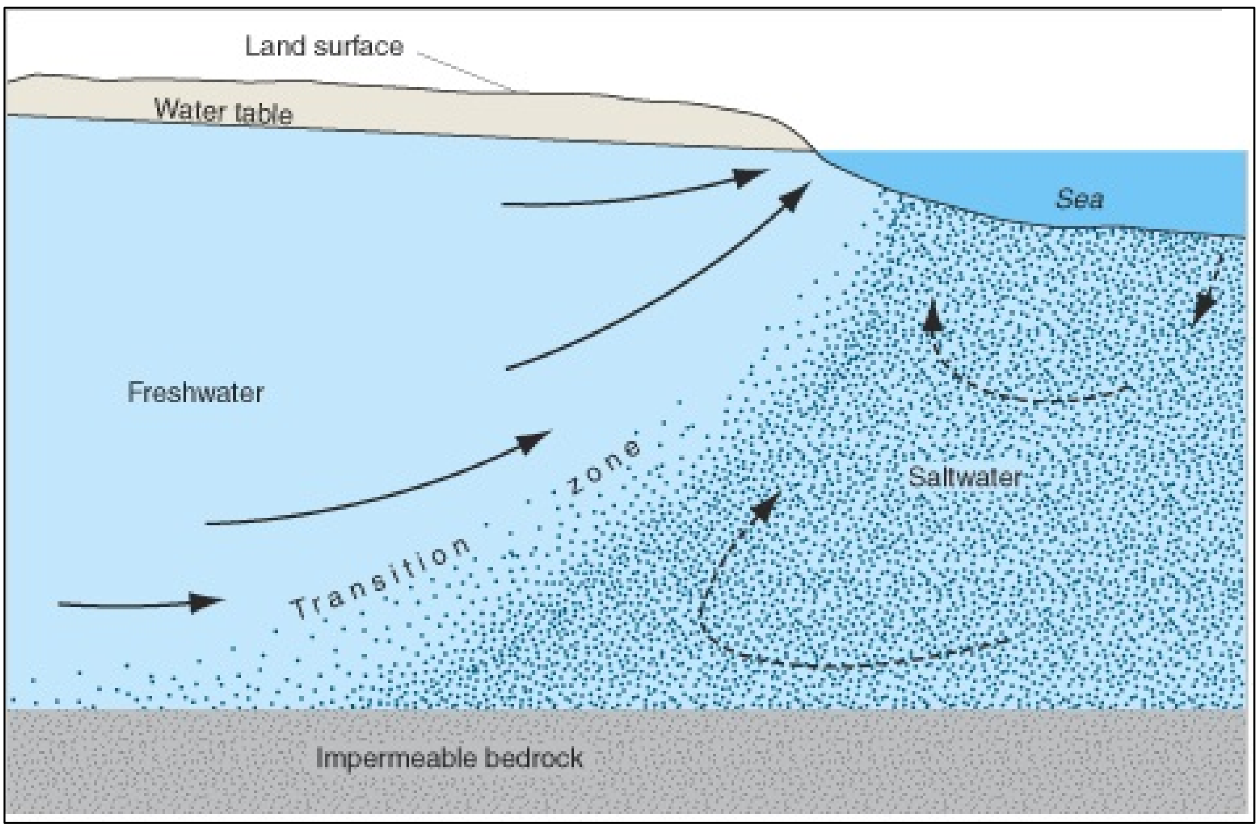
Source: Derived from Dominion 2018b

Figure 3-22 Water Supply Wells Within the Property Boundary

As groundwater in the confined aquifers of the Virginia Coastal Plain Physiographic Province moves eastward, it eventually encounters saltwater from the Atlantic Ocean. The location of this saltwater interface is a function of the height of the freshwater head versus the increased density of the saltwater and the head in the saltwater part of the aquifer. West of this interface, the aquifers contain freshwater and east of this interface, the aquifers contain saltwater (Figures 3-23 and 3-24). Reducing the head in the freshwater aquifer can cause this interface to move inland, converting freshwater aquifers into saltwater aquifers. Regional pumping of groundwater has caused the freshwater interface in the Potomac aquifer to move inland (USGS 2003, 2010, 2015a).

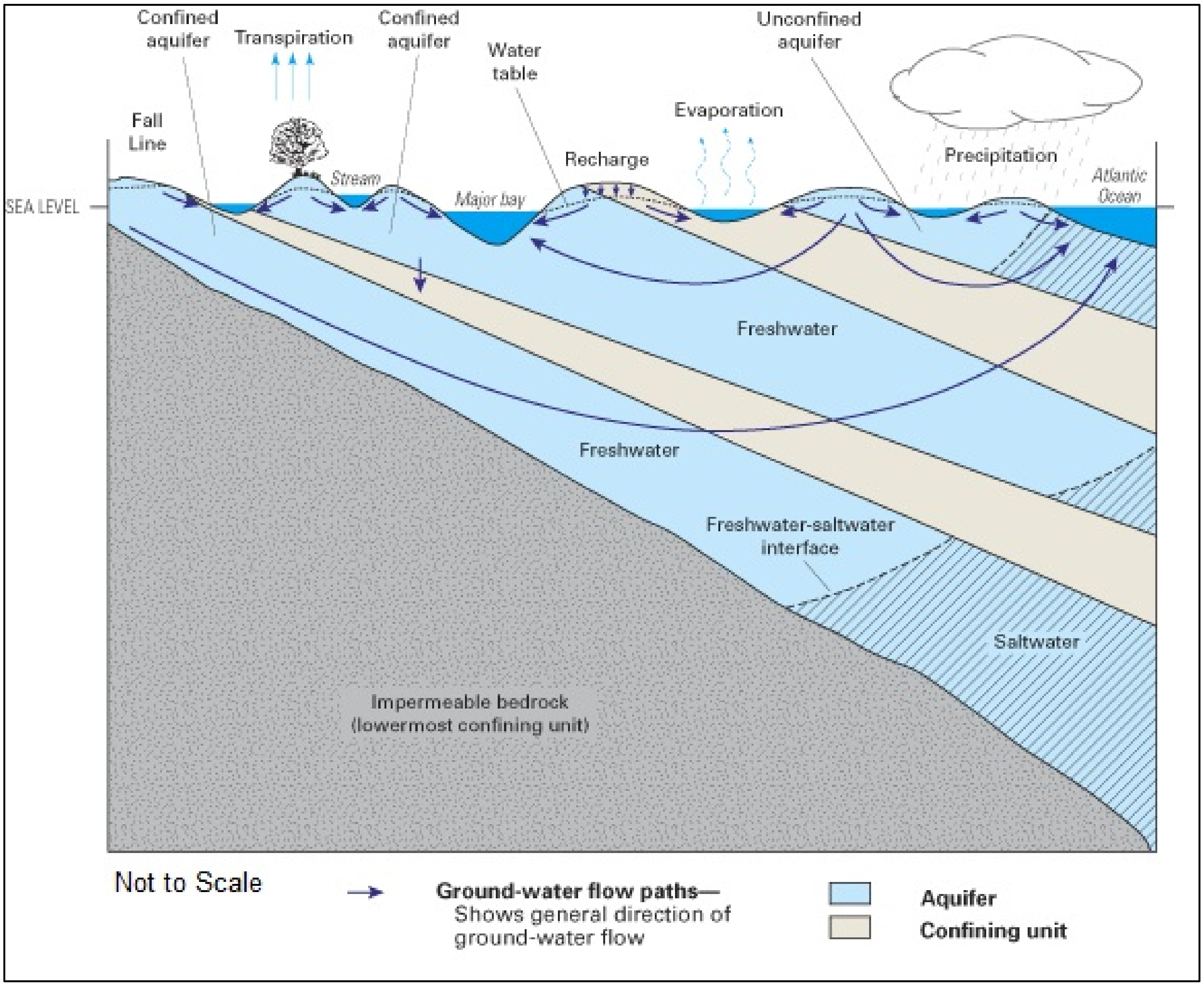
Salty groundwater associated with the sediments in the Chesapeake Bay Impact Crater has moved the saltwater freshwater interface inland relative to those areas that are not near the impact structure (USGS 2009, 2010, 2013b) (Figure 3-25). The Potomac Aquifer and the other confined aquifers beneath the Surry site contain freshwater (Dominion 2018b; USGS 2010).

The water quality of the confined aquifers located beneath Surry, but above the Potomac Aquifer are likely acceptable as sources of water (USGS 2010). The water quality of the Columbia aquifer may also be useable, but near the James River its water quality may be degraded by brackish water from the James River. Regionally, water from the Upper Potomac aquifer is considered to have the best quality (Dominion 2018b; USGS 2010).



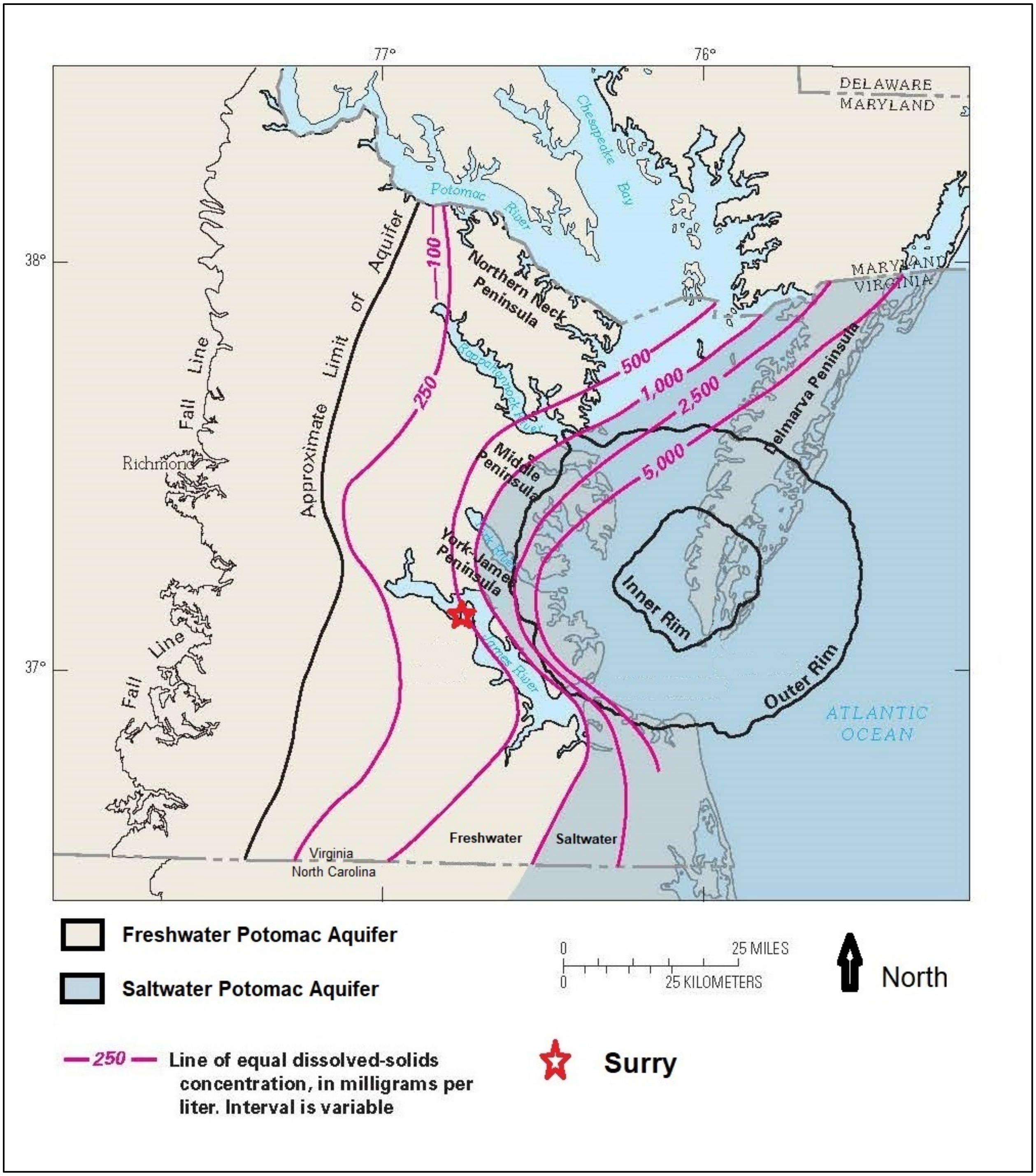
Source: Modified from USGS 2003

Figure 3-23 Illustrative Groundwater Freshwater/Saltwater Interface



1 Source: Modified from USGS 2003

2 **Figure 3-24 Virginia Coastal Plain Physiographic Province Illustrative**
3 **Freshwater/Saltwater Interface**



Source: Modified from USGS 2003

Figure 3-25 Approximate Location of Virginia's Freshwater/Saltwater Interface Within the Potomac Aquifer

Non-Radiological Spills

Between 2012 and 2017, one small liquid spill of nonradiological fluids occurred. While cleaning a service water intake bay, approximately 8 gallons of glycol-based hydraulic fluid was spilled. The release was reported to the Virginia Department of Environmental Quality (Dominion 2018b).

Radiological Spills

Three spills into groundwater have occurred near Surry Units 1 and 2. All of the spills occurred in 2012 and contained tritium. These spills were reported to county and state officials and the NRC. The concentration of tritium in each spill was below the EPA established maximum contaminant level for drinking water of 20,000 pCi/L.

Tritium is a hydrogen atom with an atomic mass of three instead of one (NRC 2019a); like any other hydrogen atom, it usually binds with oxygen to form a water molecule. A water molecule that contains hydrogen in the form of tritium will behave in the environment just like a water molecule that does not contain tritium.

Tritium emits a weak form of radiation in the form of a low-energy beta particle, which is like an electron. This radiation does not travel very far in air and cannot penetrate the skin. If tritium enters the body, it disperses quickly and is uniformly distributed throughout the soft tissues. Tritium decays into a nonradioactive form of helium and has a half-life of 12.3 years. This means that after 12.3 years, half of the tritium will be gone, and will have decayed into a form that is no longer radioactive.

However, if ingested, the human body excretes half of the tritium ingested within approximately 10 days (NRC 2019a). For tritium in drinking water, the EPA has established a maximum contaminant level of 20,000 pCi/L (EPA 2002; NRC 2019a). Each spill was estimated to be larger than 100 gal (379 L).

The following contains a description of the three spills in 2012.

- On August 8th, a damaged storm drain was discovered to have a 6-inch hole in it. Water from a sump that discharges to this storm drain was found to contain a tritium concentration of 1,250 pCi/L. The sump discharge was redirected to prevent any future releases through the damaged storm drain line (Dominion 2018b).
- On September 17th and on September 23rd, a tank associated with the Unit 2 turbine building overflowed and spilled water through the previously mentioned damaged storm drain. Water in the tank was found to contain tritium at a concentration of 1,450 pCi/L (Dominion 2018b).

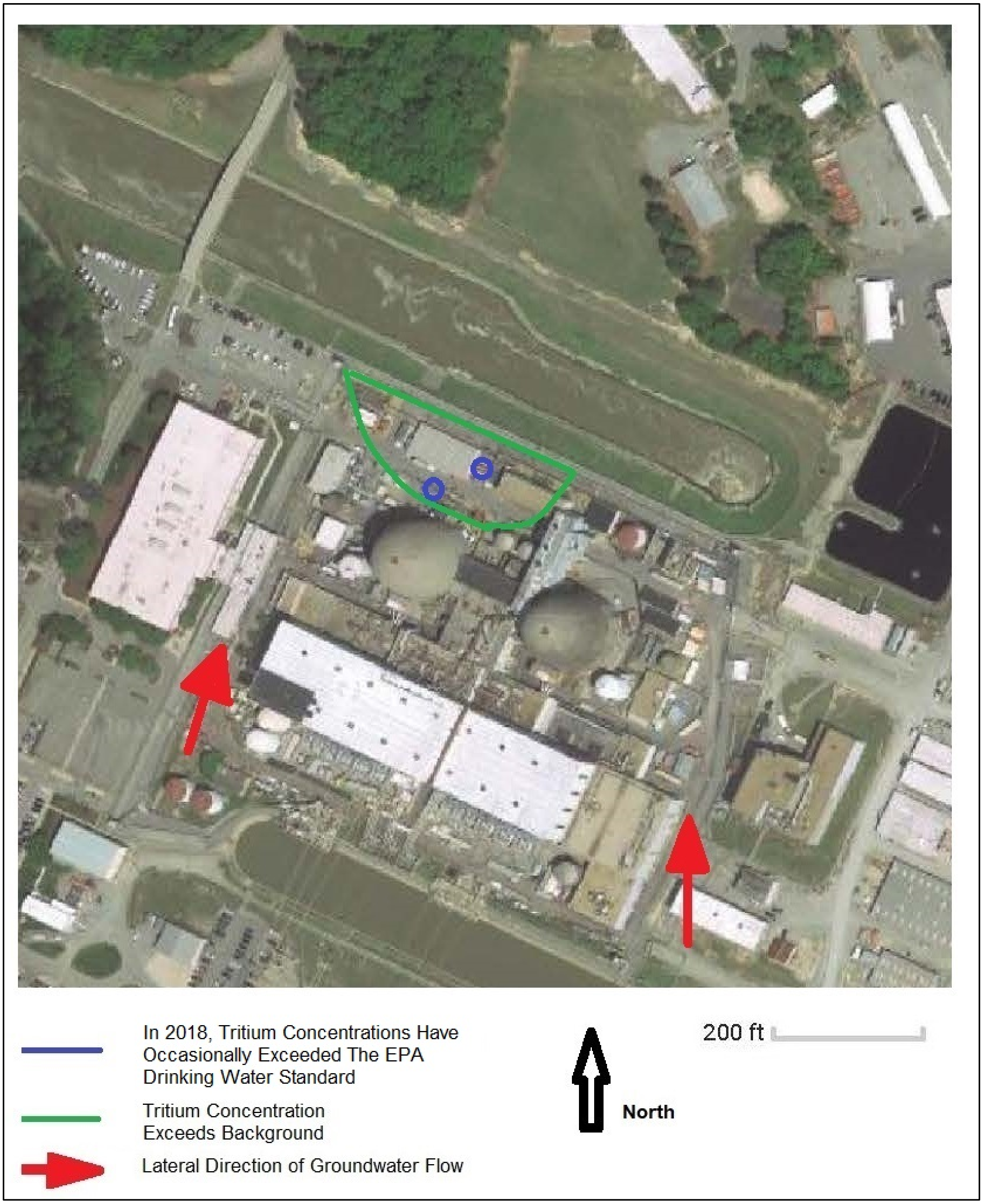
Tritium in Groundwater

A small area of groundwater tritium contamination has been detected in fill material and the Columbia and Yorktown-Eastover aquifers between the Surry Units 1 and 2 power block area and the discharge canal (Figure 3-26). Radionuclide concentrations above background values have not been detected in groundwater off the site or outside of this area. Except for tritium, no other radionuclides above background concentrations have been detected in the groundwater. At the end of 2018, tritium concentrations in the area of contamination were all below the EPA established maximum contaminant level for drinking water of 20,000 pCi/L for tritium. Outside the area of contamination, tritium concentrations are all below background concentrations (Dominion 2018b; VEPC 2019b; VEPC 2019c).

When the power block was constructed, the buildings were built within a man-made excavation. After the buildings were constructed, engineered fill was placed between and around the buildings.

Some of the structures in the power block area either penetrate or were excavated into the Yorktown-Eastover aquifer. The discharge canal was constructed through the Columbia aquifer and lies very close to if not on top of the Yorktown-Eastover aquifer. The fuel building was constructed on top of numerous vertical piles, which penetrated through the Columbia and Yorktown-Eastover aquifers and into the top of the underlying St. Mary's confining unit. A subsurface coffer dam that limits the lateral movement of groundwater was constructed in the power block area and was excavated into the Yorktown-Eastover aquifer. The containment structures for Surry Units 1 and 2 were excavated into the Yorktown-Eastover aquifer. Some of these structures are in the area where the groundwater contains tritium and could function as vertical pathways for groundwater containing tritium to move from the Columbia aquifer into the underlying Yorktown-Eastover aquifer (VEPC 2019d).

Sumps were installed around the bottom of the containment structures for Surry Units 1 and 2. These sumps are pumped to remove the groundwater that collects around the bottom of the containment structures. These sumps remove groundwater from the Yorktown-Eastover aquifer and may help to remove some groundwater containing tritium (Dominion 2018b; EPA 2019e).



Source: Derived from Dominion 2018b

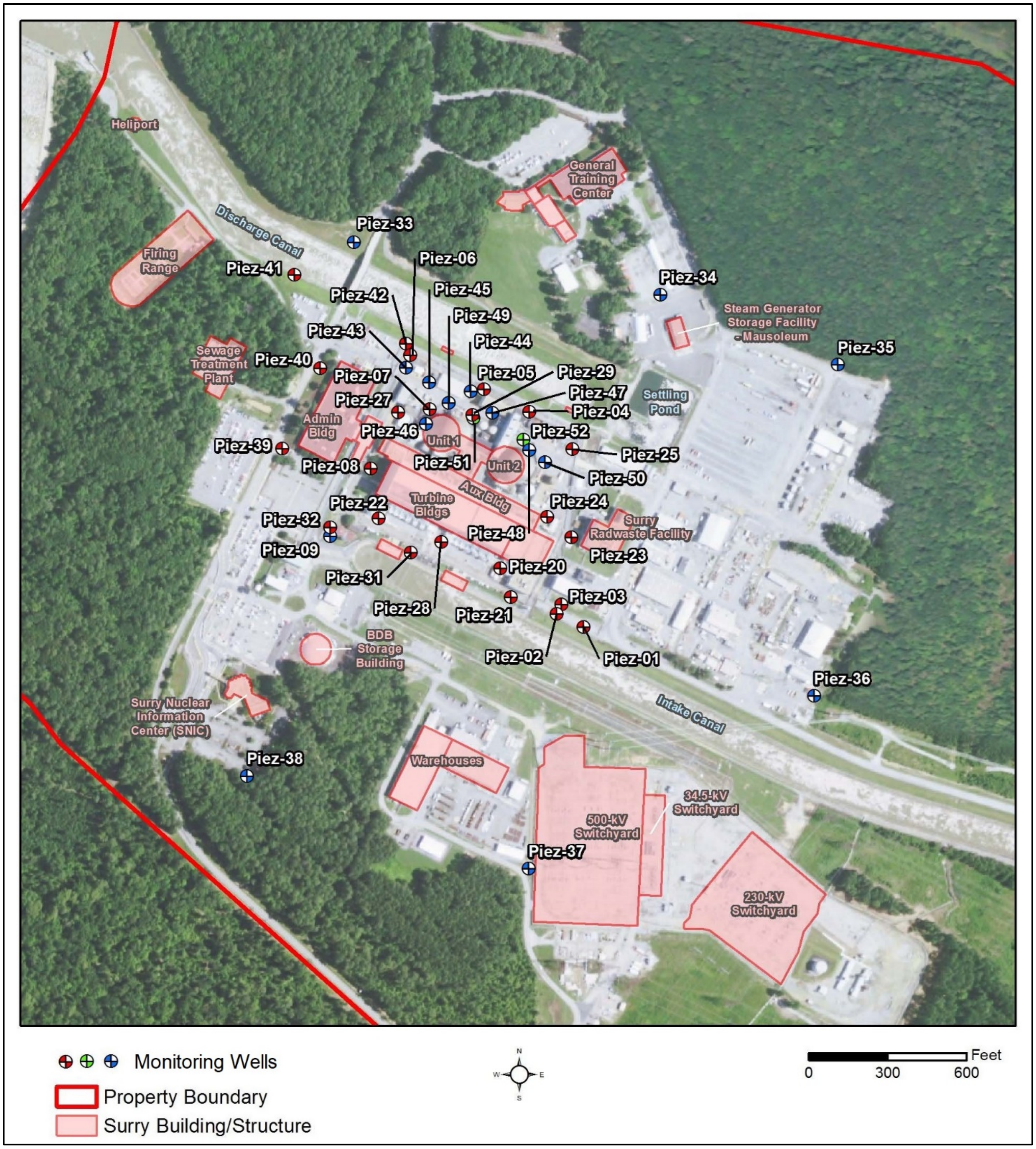
Figure 3-26 Approximate Areas of 2018 Tritium Groundwater Contamination and General Direction of Groundwater Flow

To quickly detect potential spills of radionuclides into the groundwater, monitor wells have been placed close to, within, and around the power block area. Monitor well installation began in 2007 (VEPC 2008a). In 2008, the site contained 26 monitor wells (VEPC 2009a). Over time, more monitor wells were added. In 2017, there were a total of 40 monitor wells at the site (Dominion 2018b). In general, the wells are monitoring an interval from 37 to 60 ft (11 to 18 m) in depth. Depending on their location, the wells either monitor a vertical interval that includes the Columbia and the Yorktown-Eastover aquifers, or an interval that includes the Columbia and Yorktown-Eastover aquifers along with the engineered fill. In the power block area, the bottom of the monitored interval is about 17.5 ft (5.3 m) lower than the bottom of the discharge canal (Dominion 2018b; VEPC 2019d).

Water quality samples from the monitor wells reflect a mixture of water from the intervals being monitored (Dominion 2018b; VEPC 2019d). In addition to water quality, the wells monitor water levels. As previously explained for water quality, these water levels reflect the combined heads found in the interval being monitored. The well water levels indicate that laterally in the power block area, the general direction of groundwater flow within the Columbia aquifer, Yorktown-Eastover aquifer, and fill materials is from the intake canal toward the discharge canal (Dominion 2018b; VEPC 2019d). The location of the monitor wells is shown in Figure 3-27.

Water samples are analyzed for gross gamma, iron-55, nickel-63, strontium-90, tritium, and transuranics (alpha-emitting radionuclides of atomic number greater than 92). Sample results are reported annually to the NRC in radioactive effluent release reports (Dominion 2018b).

In 2008, except for three wells, all sampled parameters were below laboratory detection limits or background values. In these three wells, tritium values exceeded background concentrations but were below the EPA established drinking water maximum contaminant level of 20,000 pCi/L (Dominion 2018b; VEPC 2009a, VEPC 2018a]. In order of decreasing concentration, the three wells were Piez-05, Piez-29, and Piez-06. For 2008, tritium values in monitor well Piez-05 averaged16,600 pCi/L and tritium values in monitor well Piez-29 averaged 9,993 pCi/L. Piez-06 had the lowest tritium values. In this monitor well, tritium values averaged 2,307 pCi/L (VEPC 2009a).



Source: Modified from Dominion 2018b

Figure 3-27 Surry Groundwater Monitor Wells

From 2008 to 2017, tritium concentrations in monitor wells Piez-05 and Piez-29 slowly declined, while tritium concentrations in Piez-06 stayed about the same. In 2017, tritium values in monitor well Piez-05 averaged 5,267 pCi/L, tritium values in monitor well Piez-29 averaged 5,667 pCi/L, and tritium values in monitor well Piez-06 averaged 2,043 pCi/L (VEPC 2009a, VEPC 2010a, VEPC 2011a, VEPC 2012a, VEPC 2013a, VEPC 2014b, VEPC 2015a, VEPC 2016a, VEPC 2017a, VEPC 2018a).

The three liquid spills containing tritium that occurred in 2012 are unlikely to be the source of the tritium values measured in wells Piez-05, Piez-29, and Piez-06. From 2008 through 2018, the concentrations of tritium in these wells have exceeded the concentration of tritium in the spills. This suggests that the source of the tritium in the groundwater at these locations goes back to 2008 and perhaps longer. It is also possible that there may be an ongoing leak of tritium into the groundwater.

In 2017, ten new monitor wells were installed at the site. Five of the new monitor wells detected tritium concentrations that exceeded background concentrations but were below the EPA established maximum contaminant level for drinking water of 20,000 pCi/L for tritium. However, one of the new monitor wells exceeded this standard. Tritium concentrations in monitor well Piez-44 ranged from 39,700 to 59,300 pCi/L (VEPC 2017a, VEPC 2018a).

At the beginning of 2018, two wells (Piez-44 and Piez-49) exceeded the EPA maximum contaminant level for tritium of 20,000 pCi/L. Monitor well Piez-44 began 2018 at a concentration of 78,000 pCi/L and Piez-49 began 2018 at a concentration of 25,000 pCi/L. However, at the end of the year, tritium concentrations in these wells were below the EPA drinking water standard. At the end of 2018, tritium concentrations in Piez-44 were 8,960 pCi/L and in Piez-49 they were 6,670 pCi/L (VEPC 2019b). At the end of 2018, tritium concentrations measured in wells within the area of contamination were all below the EPA drinking water standard (VEPC 2019b).

Groundwater quality monitoring data indicate that groundwater contamination has not moved offsite. It appears to be restricted to the fill material and the Columbia and Yorktown-Eastover aquifers on the northside of the power block (VEPC 2019d). As the Yorktown-Eastover aquifer is underlain by approximately 100ft (30.5 m) (Figure 3-15) of confining units, it is unlikely that tritium contamination has moved into any deeper underlying aquifers. The area of contamination appears to be bounded by the discharge canal, as tritium concentrations above background have not been observed in monitor wells Piez-33 or Piez-34, which are located on the opposite side of the discharge canal (Figure 3-27). Figure 3-26 illustrates the lateral extent of tritium contamination above background levels. It is possible that groundwater containing some or all of the tritium flows into the discharge canal and from there moves into the James River, where it would be greatly diluted in concentration (VEPC 2009a, 2010a, 2011a, 2012a, 2013a, 2014b, 2015a, 2016a, 2017a, 2018a, 2019b).

In addition to water quality samples from onsite monitor wells, water supplied to the Surry facility from the water supply wells is routinely sampled for radionuclides. As previously described, this water is obtained from the Upper Potomac aquifer. Samples of groundwater are also obtained from a well located at the tip of Hog Island. This well also obtains water from the Upper Potomac aquifer. Sampling results are reported to the NRC in an annual radiological environmental operating report.

An inspection of annual radiological environmental operating reports between 2005 and 2018 confirm that man-made isotopes have not been detected in water supplied to the Surry facility from the onsite wells or from the offsite Potomac aquifer well located at the tip of Hog Island. Tritium concentrations have been below laboratory detection limits (VEPC 2006, 2007, 2008b, 2009b, 2010b, 2011b, 2012b, 2013b, 2014c, 2015b, 2016b, 2017b, 2018b, 2019c).

The hydrogeology of the site should prevent tritium from reaching the Potomac aquifer. For tritium to reach the Upper Potomac aquifer, it would have to move through the confining materials that overlie the Potomac aquifer. Of the approximately 350 ft (107 m) of rock between the fill and the top of the Potomac aquifer, there is approximately 205 ft (63 m) of confining material between the fill and the top of the Potomac aquifer. There are no known faults or open fractures beneath the Surry facility that would provide pathways for tritium to move down to the Potomac aquifer over this vertical distance. (USGS 1988b, 2006) (Figure 3-15).

The deep water-supply wells at Surry should not provide a pathway for tritium to reach the Upper Potomac Aquifer because they are not in or near the area of contamination. Furthermore, the deep wells that supply water to Surry are all upgradient from the direction of groundwater flow in the fill material or the Columbia and Yorktown-Eastover aquifers. Therefore, their locations prevent tritium-contaminated groundwater from reaching them.

Corrective Actions

Dominion has taken the following actions to prevent the release of radionuclides into the groundwater, to further define the extent of contamination, and to actively reduce tritium concentrations within the groundwater.

- Concrete sumps exposed to radioactive fluids have been coated or lined with stainless steel to eliminate potential leakage.
- Direct buried cast iron drain pipes exposed to radioactive fluids have been cleaned and coated to eliminate potential leakage.
- Corrugated metal storm-drain lines have been cleaned, replaced as necessary, and coated to eliminate potential leakage.
- Building floor drain piping exposed to radioactive material has been cleaned and coated to eliminate potential leakage.
- Shake spaces have been sealed within buildings containing components transporting radioactive fluids.
- Components located outside buildings (e.g., valves), which transport radioactive fluids and have a history of being difficult to detect leakage from, have been redesigned to easily detect leakage and prevent leakage from reaching soil.
- The liquid release process has been improved by reducing concentrations prior to release into the discharge canal.
- Credible leakage mechanisms to groundwater continue to be explored.
- Geoprobes are being used to refine the extent of groundwater contamination within the power block area and to plan active restoration activities.
- Some monitor wells within the power block are being pumped to lower tritium concentrations in the area of groundwater contamination. Active pumping is removing 14,300 gpd (54,131Lpd) (VEPC 2019d).

3.6 <u>Terrestrial Resources</u>

This section describes the terrestrial resources of the affected environment, including the surrounding ecoregion, species, and vegetative communities present on the Surry site, and important species and habitats potentially present on or near the site.

3.6.1 Ecoregion

The Surry site is situated in the middle Atlantic coastal plain ecoregion (Dominion 2018b). The U.S. Environmental Protection Agency (EPA) (1999b) characterizes this ecoregion (Level III Ecoregion 63) as a low, nearly flat plain with many swampy or marshy areas that extend northeastward from Georgia to New Jersey. Forest cover consists predominantly of loblolly-shortleaf pine forest with patches of oak, gum, and cypress forest near major streams. Poorly drained soils are common in the ecoregion, especially in the lowest areas. Elevations range from 0 to 100 ft (30 m) above sea level, and local relief can be nearly level. The landscape contains low terraces, marshes, dunes, beach ridges, barrier beaches, and beaches, which support natural vegetation of Appalachian oak forest, northern cordgrass prairie, southern floodplain forest, live oak-sea oats vegetation, and oak-hickory-pine forest (Dominion 2018b).

Dominion's ER (Dominion 2018b) includes descriptions of several regional ecosystems in the landscape near the Surry site, including:

- Coastal Plain Calcareous Seepage Swamp
- Coastal Plain Depression Wetland
- Coastal Plain/Outer Piedmont Basic Mesic Forest
- Northern Coastal Plain/Piedmont Mesic Mixed Hardwood Forest
- Coastal Plain Dry Calcareous Forest
- Bald Cypress-Water Tupelo Brownwater Swamp
- Tidal Bald Cypress Woodland (Shoreline Sedge Type)

The descriptions, presented on pages E-3-117 through E-3-124 of the Surry ER (Dominion 2018|ER) characterize the tree canopy, shrub, and herbaceous strata of each plant community relying on information from the Virginia Department of Conservation and Recreation (VDCR) (VDCR 2016|2016b in ER) and are incorporated here by reference.

Tidal and non-tidal wetlands are common features in the landscape surrounding the Surry site. Wetlands are defined by the U.S. Army Corps of Engineers (USACE) as areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas (33 CFR 328.3(c)(4)). Dominion (Dominion 2018b) identified approximately 37,445 ac (15,153 ha) of wetlands and deepwater habitats within a 6-mi radius of the Surry site using the U.S. Fish & Wildlife Service (USFWS) National Wetland Inventory (NWI) maps, including estuarine and marine deepwater habitat (19,344 ac) (7,828 ha), estuarine and marine wetlands (2,182 ac) (883 ha), freshwater emergent wetlands (2,611 ac) (1,057 ha), freshwater forested/scrub shrub wetlands (2,338 ac) (946 ha), freshwater pond (304 ac) (123 ha), lake waters (541 ac) (219 ha), and riverine waters (10,124 ac) (4,097 ha).

Dominion presented a map of NWI features in the landscape surrounding the Surry site as Figure E3.7-1 of the ER, which is incorporated herein by reference (Dominion 2018b). The map indicates that most of the marine and estuarine deepwater features are situated in the James

River and tidal tributaries east of the Surry site, and that most of the riverine features are situated in the James River west of the site as well as in other river channels in the landscape. The map depicts most of the marine and estuarine wetlands (tidal marshes and flats) in tidal tributaries to the James River, with many of the largest on Hog Island directly north of the Surry site and along tidal tributaries to the southeast. The map indicates that most freshwater emergent and forested wetlands, which may be tidal or non-tidal, are situated in numerous stream valleys and in other low areas within the landscape.

3.6.2 Surry Site

The Surry property is roughly rectangular in shape and is bounded by the James River on the eastern and western boundaries (Dominion 2018 | ER). According to Dominion, most of the site consists of generation and maintenance facilities, laydown areas, parking lots, roads, and mowed grass. Terrestrial habitats on the Surry site consist of remnants of mixed pine-hardwood forests interspersed with early successional fields and developed areas (Dominion 2018 | ER, p. E-3-126). Informal observations by NRC staff ecologists while present on the Surry site in March 2019, suggest that Dominion's characterization in the ER of the terrestrial habitats on the site is correct. The remnants of mixed pine-hardwood forest remaining after development of Surry were used for timber production prior to acquisition by Dominion (Dominion 2018 | ER, p. E-3-116), as reportedly was the entire site (USAEC, 1972 | Final ES, p. 4).

A key consideration in preserving and managing forest cover near the Chesapeake Bay is maintaining habitat for forest-interior bird species preferring large, contiguous tracts of mature forest cover (Maryland Critical Area Commission 2000). Many such bird species have experienced substantial population declines since the mid-20th Century (Maryland Critical Area Commission 2000). Aerial photographs included in the ER (Dominion 2018 | ER) and available on Google Earth indicate that the remaining forest cover on the Surry site is heavily fragmented by developed areas and clearings associated with Surry facilities. The largest remaining unfragmented area of forest cover on the Surry site is an irregularly shaped patch of mixed pine-hardwood forest on the northern perimeter, north of the intake canal and ISFSI and west of the reactors. Using an area measurement tool on Google Earth, the NRC staff estimates that the area of this forest patch is approximately 275 ac (111 ha). The Maryland Critical Area Commission (2000) recognizes forest cover that is more than 300 ft (91 m) interior from the edge, and contained within patches larger than 50 contiguous acres (20 ha), as potentially providing habitat for forest-interior bird species. Based on this criterion, the northern part of the Surry site may provide habitat for forest-interior birds, but the other forest on the site is too fragmented for those species.

Dominion (Dominion 2018 | ER) identifies the following wetlands and other surface water features on the Surry site: estuarine and marine wetlands (0.46 ac) (0.19 ha), freshwater emergent wetlands (6.07 ac) (2.46 ha), freshwater forested wetlands (2.66 ac) (1.08 ha), freshwater pond (3.03 ac) (1.23 ha), lake waters (22.6 ac) (9.15 ha), and riverine waters (12.93 ac) (5.23 ha). Figure E3.7-2 of the ER shows the location of NWI wetlands on the Surry site and is incorporated by reference. The lake and riverine features are limited to the man-made channels leading into the water intake structure and away from the water discharge structure. The map depicts wetlands on the site as limited to small, narrow areas in swales and other low areas within undeveloped lands.

Dominion states that wildlife on the Surry site is found primarily in the remaining forested areas and is typical of the upland forests in coastal Virginia (Dominion 2018 | ER, p. E-3-126).

Dominion presents lists of terrestrial wildlife species likely to be observed in habitats near the Surry site in Table E3.7-3 of the ER, which are herein incorporated by reference. The table reports species of amphibian, bird, insect, mammal, and reptile species reported for a 6-mi (10-km) radius from the Surry site in the Virginia Department of Game and Inland Fisheries Fish & Wildlife Information System, as accessed in November 2016. Dominion does not indicate that any of the species in the table are unusual for the region. Dominion notes that the Surry site is situated in the Atlantic flyway, a major route for migratory birds during the fall and spring (Dominion 2018│ER, p. E-3-126). Forests, wetlands, and other natural habitats within flyways can help facilitate the seasonal migration of large numbers of birds over long distances separating wintering areas from summer breeding areas.

According to Dominion (2019│RAI Response Letter dated May 10), it is building a new DMMA on an offsite tract of approximately 400 ac (162 ha) situated south of the site. Dominion indicates that most of the new facility will be built within agricultural land, but that approximately 3 ac (1 ha) of forest clearing will be necessary. Dominion also indicates that building a discharge pipe from the new DMMA to Lawnes Creek will require the permanent loss of approximately 4,200 ft^2 (390 m^2) of non-tidal forested wetlands. Dominion states that DMMA construction will be completed by the end of November 2019. The completed DMMA will therefore be considered part of the baseline conditions for purposes of evaluating impacts from the subsequent license renewal (SLR) action on terrestrial resources. Aerial photographs that Dominion provided indicate that the remainder of the 400-ac (162-ha) tract outside of the new DMMA facility comprises wetlands and other naturally vegetated lands.

3.6.3 Important Species and Habitats

State-Listed species

Based on a review of Virginia Department of Game and Inland Fisheries (VDGIF) and Virginia Natural Heritage Program (VNHP) databases, Dominion identified 28 State-listed species known to occur or potentially occur in Surry County or its adjoining counties (Dominion 2018│ER, p. E-3-163), of which 25 are terrestrial. The table of federally and State-listed species provided by Dominion in Table E3.7-4 on pages E-3-198 and E-3-199 of the ER is incorporated by reference. Thirteen of the State-listed species are also federally listed and are addressed below in Section 3.8.1 of this SEIS. The descriptions of the following species on pages E-3-163 through E-3-176 in Dominion's ER are herein incorporated by reference:

- barking treefrog (*Hyla gratiosa*) (amphibian)
- eastern tiger salamander (*Ambystoma tigrinum*) (amphibian)
- Mabee's salamander (*Ambystoma mabeei*) (amphibian)
- Bachman's sparrow (*Peucaea aestivalis*) (bird)
- black rail (*Laterallus jamaicensis*) (bird)
- Henslow's sparrow (*Ammodramus henslowii*) (bird)
- loggerhead shrike (*Lanius ludovicianus*) (bird)
- little brown bat (*Myotis lucifugus lucifugus*) (mammal)
- Rafinesque's eastern big-eared bat (*Corynorhinus rafinesquii macrotis*) (mammal)
- tricolored bat (*Perimyotis subflavus*) (mammal)
- canebreak rattlesnake (*Crotalus horridus*) (reptile)
- eastern chicken turtle (*Deirochelys reticularia reticularia*) (reptile)

- northern diamond-backed terrapin (*Malaclemys terrapin terrapin*) (reptile)
- spotted turtle (*Clemmys guttata*) (reptile)

Most of the species noted above favor wetlands or specialized natural habitats that do not occur within or immediately adjacent to the developed areas of the Surry site. Such habitats may be present in undeveloped shorelines and forested areas on the Surry site, and many such habitats are present on Hog Island directly to the north. It is possible that the three State-listed bat species (as well as the federally listed northern long-eared bat) may forage in the remaining forested areas on the Surry site and perhaps may nest in the less fragmented forest cover on the fringes of the site. The loggerhead shrike is tolerant of some disturbed habitat but is unlikely to visit developed areas of an active power generation facility.

Species Protected under the Bald and Golden Eagle Protection Act

The Bald and Golden Eagle Protection Act (16 U.S.C. 668-668c) extends regulatory protections to the bald eagle and golden eagle. As noted by Dominion (Dominion 2018│ER, p. E-3-175), the Act prohibits anyone, without a permit from the Secretary of the Interior, from “taking” bald eagles (or golden eagles), including their parts, nests, or eggs. According to Dominion (Dominion 2018│ER, p. E-3-141), data from the Center for Conservation Biology at the College of William and Mary (CCB 2016) indicate that there are three bald eagle nests on the Surry site. All were active in 2017 (Dominion 2018│ER, p. E-3-141). The abundance of forested shorelines abutting open water in undeveloped areas of the Surry site and the surrounding landscape provides widespread bald eagle nesting opportunities.

Species Protected under the Migratory Bird Treaty Act

As noted by Dominion (Dominion 2018b, p. E-3-163), 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. Dominion maintains a depredation permit (Dominion 2018b) authorizing it to take a maximum of 70 black vultures, 20 turkey vultures, and 40 Canada geese at all Dominion power generation locations. The 2017 permit expired on March 31, 2018. Dominion states that because it submitted an application for renewal before the expiration date, depredation permit activities are authorized until a new permit is issued (Dominion 2018b, p. E-3-176).

Invasive Species

Invasive species are defined as alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health (EO 13112, Section 1(f)). Executive Order (EO) 13112 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). Dominion (Dominion 2018│ER, p. E-3-131) notes that VDCR maintains an inventory of invasive species for Virginia (VDCR 2014). Dominion maintains guidance documents with policies and procedures for invasive species management (Dominion 2016│2016l in ER). Specific terrestrial invasive plant species identified by Dominion as important species include phragmites (*Phragmites australis*), kudzu (*Pueraria montana*), and Japanese stiltgrass (*Microstegium vimineum*). Descriptions of phragmites on page E-3-133 of the ER and of kudzu and Japanese stiltgrass on pages E-3-134 and E-3-135 of the ER are incorporated herein by reference.

Dominion reports that the invasive grass Phragmites occurs in wetlands on the Surry site (Dominion 2019 │RAI Response Letter dated May 10).

Important Habitats

Important habitats on and around the Surry site include wetlands, discussed above in Section 3.6.1, and the Hog Island Wildlife Management Area (HIWMA). The HIWMA comprises two parcels of land occupying much of the remainder of the Gravel Neck Peninsula that contains the Surry site. The Hog Island tract comprises approximately 2,900 ac (1174 ha) in the northern part of the Gravel Neck Peninsula and adjacent to the northern boundary of the Surry site. It consists primarily of tidal marshes and diked impoundments interspersed with pine forests, and it reportedly provides habitat for numerous amphibians, reptiles, mammals, waterfowl, and upland game birds (Dominion 2018│ER, p. E-3-131) (NRC 2002│2002a in ER). The Carlisle and Stewart tracts together comprise approximately 1,000 ac (405 ha) southeast of the Surry site, in the southeastern part of the Gravel Neck Peninsula, that contain upland forested areas and tidal marshes (Dominion 2018│ER, p. E-3-131; NRC 2002│2002a in ER).

3.7 Aquatic Resources

This section describes the aquatic resources of the affected environment, including the James River, its major tributaries (the Appomattox and Chickahominy Rivers), and the Chesapeake Bay into which these rivers flow.

3.7.1 James River

The Surry site lies on Gravel Neck Peninsula along the southern shore of the James River, approximately 30 river miles (RM) (48 river kilometers (RKM)) upstream of the river's confluence with the Chesapeake Bay. The James River is relevant to the NRC staff's environmental review because Surry's once-through cooling system withdraws water from and discharges heated effluent to this waterbody.

The James River begins in the Allegheny Mountains from the confluence of the Cowpasture and Jackson Rivers near the Virginia-West Virginia border. It flows southeasterly for 340 mi (550 km) to Hampton Roads, Virginia, where it enters the Chesapeake Bay (FWS 2015a). The river crosses portions of the Blue Ridge, Valley and Ridge, Piedmont, and Coastal Plain physiographic provinces and drains 10,265 mi^2 (26,586 km^2) or approximately 24 percent of Virginia's land surface (FWS 2015a). Cobham Bay, which lies just west and upriver of the Surry site, represents the approximate upstream limit of saltwater incursion such that upstream of the Surry site, the James River is a tidally influenced freshwater river, and downstream of the site, it is a brackish water estuary. The river in this region is approximately 2.5 mi (4 km) wide, and the shoreline is comprised primarily of wetland and marsh habitats.

The lower James River is a partially mixed estuary. This type of estuary has low river flows and moderate tidal flows that mix within the water column. The current-induced turbulence causes mixing of the whole water column such that salinity varies more longitudinally than vertically. This leads to moderately stratified conditions. Stratification is typically most distinct at the bottom of the water column where salinities are greatest. Near Surry, the James River varies from 0 to 17 ppt at the cooling water intake structure, whereas salinities near the discharge canal, which lies 6 RM (10 RKM) upstream, range from 0 to 9.2 ppt (NRC 2002b). Salinity has occasionally trended higher; pre-operational studies have reported salinities as high as 21.1 ppt at water depths of 26 ft (8 m) just east of the Surry intake (VEPC 1980).

The U.S. Army Corps of Engineers maintains navigation channels, which extend 90.8 mi (146 km) from the mouth of the James River at Hampton Roads upstream to Richmond, Virginia. From the mouth of the river to Hopewell, Virginia, the main channel is maintained to be 25 ft (40 km) deep and 300 ft (482 km) wide (USACE 2019). This channel is called the Tribell Shoal Channel, and it includes the portion of the river that interacts with Surry's cooling water intake system. Upriver, the main channel is maintained at shallower depths, narrower widths, or both. As a result of the channelized river bottom and steep bank elevation, the river's littoral zone (the nearshore area from the high-water mark to the point of permanent submersion) is narrow in the vicinity of Surry. The river bed in this region includes soft mud, clay, sand, and pebbles with no single predominant substrate type (VEPC 1980). Mean tide level at Hog Point is +1.0 ft (+0.3 m); mean tidal range is 2.1 ft (0.64 m); and mean spring tidal range is 2.5 ft (0.76 m) (VEPC 1980).

The local biological community consists of resident species that can tolerate the fluctuating tidal conditions and seasonal migrants or transients from upstream or downstream that occupy the immediate area for short periods when river conditions are optimal. The lower James River supports nationally recognized largemouth bass (*Micropterus salmoides*), striped bass (*Morone axatilis*), and blue catfish (*Ictalurus furcatus*) fisheries. Common recreational and sportfish species include black crappie (*Poxomis nigromaculatus*), channel catfish (*Ictalurus punctatus*), flathead catfish (*Pylodictis olivaris*), shad (American, *Alosa sapidissima*, and hickory, *A. mediocris*), white perch (*Morone americana*), bluegill (*Lepomis macrochirus*), and common carp (*Cyprinus carpio*). Fish and other aquatic biota are described in more detail below in Section 3.7.5, "Aquatic Community of the Lower James River."

3.7.2 Appomattox and Chickahominy Rivers

Two James River tributaries are of interest to the affected environment: the Appomattox and Chickahominy Rivers, both of which enter the James River between Richmond, Virginia, and Hampton Roads, Virginia. Striped bass and walleye (*Sander vitreus*), which run out of Lake Chesdin, a major man-made impoundment on the river just west of Petersburg, Virginia, provide a seasonal fishery in the Appomattox River (VDGIF 2019a). Largemouth and smallmouth bass, redbreast sunfish (*Lepomis auritus*), bluegill, flier (*Centrarchus macropterus*), black crappie, pickerel (*Esox* species), fallfish (*Semotilus corporalis*), and chub (*Semotilus* species) are also important recreational species within the Appomattox (VDGIF 2019a). The Chickahominy River contains broad expanses of open marsh and cypress groves along its shoreline and typically boasts the highest largemouth bass catch in the State (VDGIF 2019b). White and yellow (*Perca flavescens*) perch, black crappie, and blue catfish are also important recreational species within the Chickahominy (VDGIF 2019b). This river also supports an important spring run of river herring (blueback herring, *Alosa aestivalis*, and alewife, *A. pseudoharengus*).

3.7.3 Chesapeake Bay

The Chesapeake Bay, into which the James River flows, is the largest estuary in North America. The bay lies between the mainland to the west and the Delmarva Peninsula to the east along the coasts of Maryland and Virginia. Roughly half of the bay's water originates from the Atlantic Ocean. The other half drains into the bay from a watershed that encompasses parts of six states—Delaware, Maryland, New York, Pennsylvania, Virginia, and West Virginia—and the District of Columbia. The watershed drains an area of roughly 64,000 mi^2 (103,000 km^2) and includes thousands of streams, creeks, and rivers that eventually flow into the bay.

The Chesapeake Bay's salinity gradually increases from north to south, and this mixture of fresh and saltwater, along with the bay's diversity of habitats, supports a complex aquatic ecosystem. Typical habitats include shallow waters, open waters, marshes and wetlands, oyster reefs, mud flats, and sandy beaches. Shallow waters extend from the shore to about 10 ft (3 m) in depth. Shallow waters support submerged aquatic vegetation and provide shelter for young fish, blue crabs (*Callinectues sapidus*), and sharks. The bay's open waters include channels up to 100 ft (30 ft) in depth. Open water provides a haven for migratory fish, such as striped bass, bluefish (*Urophycis chuss*), weakfish (*Cynoscion regalis*), American shad, blueback herring, alewife, bay anchovy (*Anchoa mitchilli*), Atlantic menhaden (*Brevoortia tyrannus*), cobia (*Rachycentron canadum*), and mackerels (family Scombridae). These migratory fish occupy the Bay in the summer to feed on menhaden (*Brevoortia* species), anchovies (family Engraulidae), and other small fish and invertebrates. Plankton, which forms the base of the food web, also inhabit open waters.

The bay's marshes and wetlands support a wide array of wildlife. These habitats are nursery grounds for critical life stages of many species of fish, shellfish, and amphibians. Worms, periwinkles, and many aquatic insects also require wetland habitats. Oyster reefs are the largest source of hard bottom surface in the bay. Reefs provide habitat for oyster larvae, sponges, barnacles, other crustaceans and invertebrates, and early life stages of fish. Reefs support feeding and sheltering of larger species as well, such as white perch, striped bass, and blue crabs (NPS 2018). In addition to the bay itself, tributaries support hundreds of species of fish and shellfish, many of which are commercially important. Tributaries are spawning ground for anadromous fish, including striped bass, blueback herring, alewife, American shad, hickory shad, and Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*).

3.7.4 Environmental Changes in the Lower James River and Chesapeake Bay

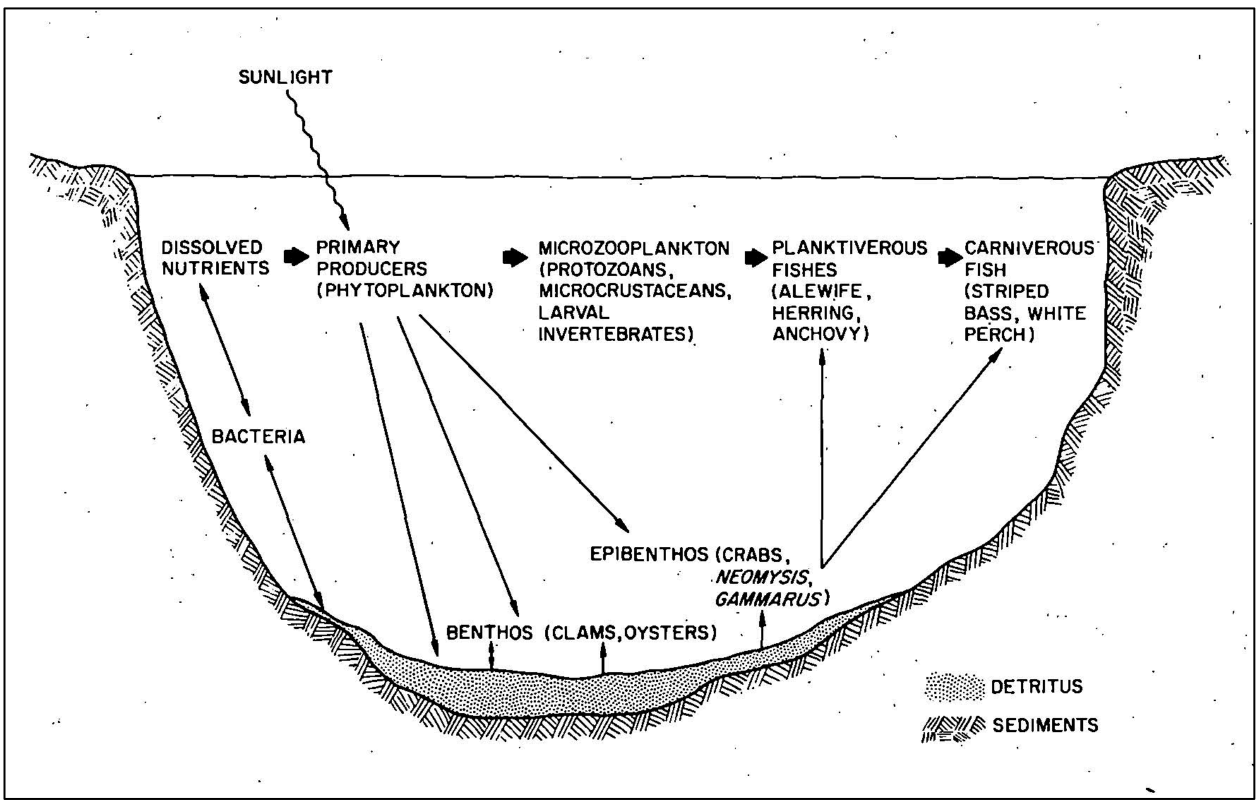
The Chesapeake Bay watershed has experienced significant environmental degradation over the past century. Symptoms of this degradation include declines in fish and shellfish populations, reduced densities and health of sea grass beds, seasonal dissolved oxygen depletions, and increased sediment load. Many of these changes are the result of human-induced ecological stresses relating to land use change. Land use within the watershed has largely shifted from forests, wetlands, and other natural habitats to agricultural lands, and more recently, to industrial, residential, and other urban-use lands. Excess nitrogen, phosphorus, and sediments in the bay and its tributaries have caused many sections of the watershed to be listed as impaired under Section 404 of the Clean Water Act. Native oysters, which play important ecological roles in filtering excess nutrients and in offering food and habitat to other animals, have significantly declined, exacerbating nutrient loading within the watershed. Non-native and invasive species have also noticeably altered the aquatic ecosystem. Predatory fish, including blue catfish and northern snakehead (*Channa argus*), have disrupted the aquatic food chain and contributed to declines in menhaden and blue crab abundance.

Climate changes have also noticeably altered the watershed. For example, over the past century, the Chesapeake Bay's waters have risen about a foot, and water levels are predicted to rise an additional 1.3 to 5.2 ft (0.4 to 1.6 m) over the next century (CBP 2019c). Between 1960 and 2010, the U.S. Geological Survey observed an increase in the region's air temperature of 1.98 °F (1.1 °C), and the U.S. Environmental Protection Agency reported an increase of 1.2 °F (0.66 °C) in the region's stream temperatures (CBP 2019c). Rainfall and storm severity have also intensified over the same period.

In 2014, the Chesapeake Bay Commission, six states (Delaware, Maryland, Pennsylvania, New York, Virginia, and West Virginia), and the District of Columbia signed the Chesapeake Watershed Agreement, an agreement that fosters partnership among the parties and the parties' shared restoration goals. The agreement's goals include protection, restoration, and enhancement of fish and shellfish populations and habitats. Specific goals include increasing blue crab abundance, fostering increases in native oyster populations, and improving the quality of important fish habitats.

3.7.5 Aquatic Community of the Lower James River

The estuarine environment near Surry consists of a complex community of primary producers and decomposers (i.e., plankton, bacteria, fungi, and aquatic plants); primary consumers (i.e., benthic invertebrates and early life stages of aquatic organisms); planktiverous fish (e.g., river herring and anchovies); and carnivorous fish (e.g., striped bass and white perch). This section reviews and summarizes past aquatic studies and surveys to characterize the Lower James River aquatic community. Figure 3-28 is a simplified aquatic food web from the U.S. Atomic Energy Commission's final environmental statement for operation of Surry (AEC 1972). This diagram remains a helpful depiction of the ecological interactions that occur within the lower James River.



Source: AEC 1972

Figure 3-28 Simplified Food Web of the Lower James River Aquatic Community

3.7.5.1 Plankton

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). 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.

Early after Surry began operating, Jordan et al. (1977) performed a study in 1975 and 1976 to characterize the dominant plankton in the James River over two seasons. This study remains the most comprehensive data available on the phytoplankton and zooplankton communities in the James River near Surry. During the study, researchers determined that seasonal temperatures controlled total phytoplankton densities, while local salinity fluctuations influenced community structure and variation. For instance, the diatom *Skeletonema costatum* was uniformly distributed in the study area when minimum salinity was greater than 1 ppt but was absent at lower salinities. Zooplankton presence correlated with either temperature or salinity depending on the species. The distribution of barnacle nauplii (the first larval stage) and copepod nauplii of *Eurytemora* species and *Arcartia* species more closely related to seasonal temperature patterns, while fluctuations in pelecypod, gastropod, and polychaete larvae followed the salinity curve. Overall, phytoplankton and zooplankton standing crops were low in comparison to upstream freshwater reaches of the river. Table 3-6 identifies the plankton taxa present during the study.

Table 3-6 Plankton Taxa in the James River near Surry

Species	Type
Phytoplankton	
Chroomonas sp.	cryptomonad
Coscinodiscus lacustris	diatom
Melosira subsalsa	diatom
Nitzschia kutzingiana	diatom
Katodinium rotundatum	diatom
Morone americana	dinoflagellate
Zooplankton	
Order: Cladocera	cladocerans
Acartia species	copepod
Eurytemora species	copepod
Phylum: Rotifera	rotifer
Source: Jordan et al. 1977	

3.7.5.2 Benthic Invertebrates

Benthic invertebrates inhabit the bottom of the water column and its substrates and include macroinvertebrates (clams, crabs, oysters, and other shellfish) as well as certain zooplankton, such as polychaetes (described previously). While a combination of physical, chemical, and biological factors affect the distribution and abundance of benthic organisms, salinity appears to exert the greatest influence. Within the Chesapeake Bay and its estuaries, shellfish comprise the majority of the benthic biomass. Biomass is typically low in brackish water zones and increases downstream with salinity and upstream in freshwater reaches.

In the vicinity of Surry, the Atlantic rangia (*Rangia cuneata*), a ubiquitous clam in eastern estuaries, dominates the benthic community. During eight years of pre- and post-operational sampling (1969-1976), Jordan et al. (1977) collected the Atlantic rangia on all sampling dates. Other collected taxa were rare in comparison and included dark false mussel (*Mytilopsis leucophaeata*); Asiatic clam (*Corbicula manilensis*); water snails (*Hydrobia* species); pile worm (*Alitta succinea*); various polychaetes, oligochaetes, and amphipods; and larval flies (Order Diptera). In addition to these species, the U.S. Atomic Energy Commission (AEC 1972) reported the presence of larval eastern oyster (*Crassostrea virginica*) under higher salinity conditions and the seasonal presence of blue crab. During ichthyoplankton trawl surveys from 1996 through 2000, the Virginia Institute of Marine Sciences collected various species of oysters, blue crabs, spider crabs (*Libinia emarginata*), eight species of shrimp, and five species of clams near Surry (Dominion 2001b). In a recent impingement study, HDR Engineering, Inc. (HDR 2017) collected six taxa of shellfish, including blue crabs, mud crabs (family Xantheoidae and Panopeidae), and four species of shrimp—grass shrimp (*Palaemontetes* species), brown shrimp (*Farfantepenaeus aztecus*), northern white shrimp (*Litopenaeus setiferus*), and sand shrimp (*Crangon septemspinosa*) (see Table 3-9).

3.7.5.3 Adult and Juvenile Fish and Ichthyoplankton

The fish community near Surry includes permanent residents that occur year-round and diadromous species that pass through the region seasonally during migrations to and from spawning grounds. Researchers have conducted biological sampling of the James River near Surry in connection with Surry's impingement, entrainment, and thermal studies during three time periods: 1970-1978, 2005-2006, and 2015-2017.

Ambient Fish Sampling, 1970-1978. The Virginia Institute of Marine Science, on behalf of the Virginia Electric and Power Company, conducted sampling of the James River fish community from 1970 through 1978 in connection with Clean Water Act Section 316(b) impingement and entrainment studies. Researchers performed monthly seine hauls, which target shallow water, schooling, and young-of-the-year and small adult fish, at seven sampling stations ranging from Jamestown Island to slightly downstream of the Surry cooling water intake structure. Additionally, supplemental seine hauls from 1973 through 1978 gathered information on the relative abundances of species inhabiting the shore zone between the Surry intake and discharge locations. Seine collections yielded 203,472 fish of 63 species over the study period. Atlantic menhaden, blueback herring, inland silverside (*Menidia beryllina*), bay anchovy, and spottail shiner (*Notropis hudsonius*) comprised over 75 percent of the total catch. Researchers also made otter trawl collections to target demersal, bottom-dwelling, and bottom-feeding species of larger sizes at six sampling stations. Otter trawl collections yielded 33,953 fish of 42 species. Hogchoker (*Trinectes maculatus*), spot (*Leiostomus xanthurus*), channel catfish, Atlantic croaker (*Micropogonias undulatus*), and bay anchovy comprised over 80 percent of the total. Table 3-7 lists the 10 most prevalent fish collected for each gear type across all years. (VEPC 1980).

Table 3-7 Most Prevalent Fish in Monthly Haul Seine and Otter Trawl Samples of the Lower James River, 1970–1978

Haul Seine		Otter Trawl	
Species	**Percent Composition**	**Species**	**Percent Composition**
Atlantic menhaden	26.6	hogchoker	27.6
blueback herring	14.1	spot	22.1
bay anchovy	13.2	channel catfish	13.0
tidewater silverside	13.2	bay anchovy	9.5
spottail shiner	8.4	Atlantic croaker	9.4
Atlantic silverside	5.9	white perch	5.1
spot	5.6	white catfish	4.0
alewife	2.6	spottail shiner	2.5
American shad	1.8	threadfin shad	2.2
white perch	1.8	American eel	0.7

Source: VEPC 1980

Ambient Fish Sampling, 2005–2006. From September 2005 through June 2006, EA Engineering, Science, and Technology, Inc. collected quarterly ambient fish samples by seine and otter trawl at several of the stations established during the 1970-1978 surveys as part of a larger entrainment characterization effort (EA Engineering 2006). Table 3-8 identifies the most prevalent fish collected for each gear type.

Seine collections yielded 463 fish of 16 species over four sampling efforts. Atlantic menhaden, inland silverside, and bay anchovy comprised 91.0 percent of the total catch. Seining data demonstrated high seasonal variation in the composition of the local fish community. A single species dominated the catch during each sample date. For instance, Atlantic silverside (*Menidia menidia*) comprised 97 and 79.5 percent of individuals collected in September 2005, and January 2006 (respectively), whereas bay anchovy comprised 66.7 percent of the November 2005 catch, and inland silverside comprised 91.8 percent of the June 2006 catch. The most commonly collected species typically appeared only once in large numbers. For instance, the November 2005 bay anchovy catch represented 91.8 percent of all individuals of this species collected over the course of the entire study period, and the June 2006 inland silverside catch represented 100 percent of all individuals collected during the study period.

Otter trawl collections yielded 1,236 individuals of 20 fish species and one shellfish (blue crab). Blue catfish was numerically the most abundant fish followed by spot, hogchoker, bay anchovy, and white perch. Temporal abundance variability was not as pronounced as with seine catches; two or more species typically dominated each collection rather than a single species. Of the five most dominant species, all species appeared in all collections except for the spot in January 2006.

Table 3-8 Most Prevalent Fish in Monthly Haul Seine and Otter Trawl Samples of the Lower James River, 2005–2006

Haul Seine		Otter Trawl	
Species	**Percent Composition**	**Species**	**Percent Composition**
Atlantic silverside	52.9	blue catfish	35.3
inland silverside	29.2	spot	15.5
bay anchovy	8.9	hogchoker	14.5
white perch	3.2	bay anchovy	11.7
spot	1.7	white perch	9.6
All other species comprised <1% of total seine catch.		Atlantic croaker	5.3
		Atlantic menhaden	1.5
		silver perch	1.4

Source: EA Engineering 2006

Although many of the same species appeared in 2005-2006 collections as those that were present in area in the 1970s, certain species were not as abundant in 2005-2006. For instance, Atlantic menhaden constituted the majority of the seine catch in the 1970s but was absent from seine samples in 2005-2006. A small number of Atlantic menhaden (15 individuals) appeared in trawl samples in 2005-2006, which indicates that the species remained present in the area. Inland silverside and blue catfish were not present in the 1970s but were proportionally abundant in 2005-2006. HDR Engineering (HDR 2017) attributes the appearance of blue catfish in this study to the introduction of the species as a sport fish in the James, Rappahannock, and Mattaponi Rivers from 1974 through 1989. Silver perch, which was not collected in the 1970s, was also present in low numbers in 2005-2006. In terms of species diversity, researches collected 70 species in the 1970s and only 25 species in 2005-2006. However, disparity in collection period (8 years versus 1 year) and collection effort (13 versus 6 sampling stations) may have affected much of this variability.

Impingement Sampling, 2015–2016. From August 2015 through July 2016, HDR Engineering performed monthly impingement sampling of the Surry cooling water intake structure. During the study, researchers collected 61 distinct taxa of finfish. Section 4.7 of this SEIS describes the methods and results of this study, as well as other past impingement studies, in detail as part of the NRC staff's impingement and entrainment analysis. However, the taxonomic inventory from this study is included in this section as Table 3-9 to provide a fuller picture of the juvenile and adult fish community currently present in the James River near Surry. The table also identifies the benthic invertebrates (shellfish) collected during the study.

Table 3-9 Taxa Collected in Surry Impingement Sampling, 2015‑2016

Common Name	Species	Common Name	Species
Finfish			
blueback herring	*Alosa aestivalis*	spot	*Leiostomus xanthurus*
hickory shad	*Alosa mediocris*	longnose gar	*Lepisosteus osseus*
alewife	*Alosa pseudoharengus*	pumpkinseed	*Lepomis gibbosus*
American shad	*Alosa sapidissima*	bluegill	*Lepomis macrochirus*
river herring	*Alosa* species	gray snapper	*Lutjanus griseus*
white catfish	*Ameiurus catus*	Atlantic silverside	*Menidia*
yellow bullhead	*Ameiurus natalis*	inland silverside	*Menidia beryllina*
brown bullhead	*Ameiurus nebulosus*	southern kingfish	*Menticirrhus americanus*
bay anchovy	*Anchoa mitchilli*	Atlantic croaker	*Micropogonias undulatus*
American eel	*Anguilla rostrata*	largemouth bass	*Micropterus salmoides*
fourspine stickleback	*Apeltes quadracus*	white perch	*Morone americana*
silver perch	*Bairdiella chrysoura*	striped bass	*Morone saxatilis*
Atlantic menhaden	*Brevoortia tyrannus*	striped mullet	*Mugil cephalus*
flier	*Centrarchus macropterus*	silver mullet	*Mugil curema*
Atlantic spadefish	*Chaetodipterus faber*	golden shiner	*Notemigonus crysoleucas*
striped blenny	*Chasmodes bosquianus*	bridle shiner	*Notropis bifrenatus*
grass carp	*Ctenopharyngodon idella*	spottail shiner	*Notropis hudsonius*
spotted seatrout	*Cynoscion nebulosus*	summer flounder	*Paralichthys dentatus*
gray trout	*Cynoscion regalis*	harvestfish	*Peprilus alepidotus*
sheepshead minnow	*Cyprinodon variegatus*	yellow perch	*Perca flavescens*
common carp	*Cyprinus carpio*	lake lamprey	*Petromyzon marinus*
gizzard shad	*Dorosoma cepedianum*	black drum	*Pogonias cromis*
threadfish shad	*Dorosoma pentenense*	bluefish	*Pomatomus saltatrix*
banded killifish	*Fundulus diaphanus*	black crappie	*Poxomis nigromaculatus*
mummichog	*Fundulus heteroclitus*	common searobin	*Prionotus carolinus*
Alaskan stickleback	*Gasterosteus aculeatus*	Atlantic Spanish mackerel	*Scomberomorus maculatus*
skilletfish	*Gobiesox strumosus*	Atlantic needlefish	*Strongylura marina*
naked goby	*Gobiosoma bosc*	blackcheek tonguefish	*Symphurus plagiusa*
eastern silvery minnow	*Hybognathus regius*	dusky pipefish	*Syngnathus floridae*
blue catfish	*Ictalurus furcatus*	Atlantic cutlassfish	*Trichiurus lepturus*
channel catfish	*Ictalurus punctatus*	hogchoker	*Trinectes maculatus*
unidentified catfish	*Ictalurus* species	unidentified finfish	unidentified finfish
Shellfish			
blue crab	*Callinectes sapidus*	northern white shrimp	*Litopenaeus setiferus*
sand shrimp	*Crangon septemspinosa*	grass shrimp species	*Palaemonetes* species
decapod shrimp	Decapoda shrimp species	mud crabs (Panopeidae)	Panopeidae species
brown shrimp	*Farfantepenaeus aztecus*	mud crabs (Xanthoidea)	Xanthoidea species
Source: HDR 2017, Table 4-2			

The results of entrainment and ichthyoplankton sampling summarized below provide a picture of the early life stages of fish and shellfish present in the region.

Entrainment Sampling, 1976–1978. From 1976 through 1978, researchers collected ichthyoplankton entrainment samples from the Surry intake forebay and discharge canal using paired, 0.5-m diameter, 505-μm mesh plankton nets equipped with flowmeters (VEPC 1980). Discrete samples were collected from near-bottom, mid-depth, and near-surface locations for a total of 1,080 samples over the study period. Researchers identified 39 taxa. Bay anchovy eggs and larvae and naked goby larvae accounted for the overwhelming majority (91.1 percent) of all organisms collected. Bay anchovy eggs peaked in mid-spring, and larvae of both species peaked in early to mid-summer. Other collected organisms included: larval and juvenile Atlantic croaker, spot, and Atlantic menhaden; all life stages of Atlantic silverside, inland silverside, and rough silverside (*Membras martinica*); and eggs and larvae of white perch.

Ambient Ichthyoplankton Sampling, 2005–2006. From June 2005 through May 2006, HDR Engineering performed bimonthly ambient ichthyoplankton sampling for larval fish and pelagic invertebrates in the James River upstream, downstream, and adjacent to the Surry cooling water intake structure (EA Engineering 2006). Researchers collected four mid-depth samples per sampling day with single 0.5-m diameter, 505-μm mesh plankton nets equipped with flowmeters. Only six taxa appeared in samples, which were (in order of abundance): bay anchovy eggs, naked goby larvae/eggs, bay anchovy larvae/juveniles/adults, Atlantic croaker juveniles, Atlantic silverside larvae/juvenile/adults, and blue crab megalopae (the final larval stage of decapod crustaceans).

Entrainment Sampling, 2005–2006. In conjunction with the effort described in the above paragraph, HDR Engineering researchers collected bimonthly ichthyoplankton samples in front of the Surry cooling water intake structure during the same period to estimate entrainment at the plant (EA Engineering 2006). In contrast with ambient samples, entrainment samples yielded a much higher diversity of taxa (45 total taxa over 24 samples), and invertebrates comprised 96.8 percent of all samples. Unidentified shrimp (66.5 percent) and unidentified crab zoea (the planktonic larval form of decapod crustaceans) (24 percent) were the most abundant taxa; these accounted for a collective 90.5 percent of total estimated entrainment. Finfish ichthyoplankton (3.2 percent of all samples) included bay anchovy eggs, goby (unidentified species) post-yolk sac larvae, naked goby post-yolk sac larvae, naked goby juveniles, Atlantic croaker juveniles, and Atlantic croaker post-yolk sac larvae.

3.7.6 Important Aquatic Species and Habitats

The Commonwealth of Virginia enacted the Virginia Endangered Plant and Insect Species Act (Va. Code § 3.2-1000 et seq.) in 1979 to protect Virginia-endemic species from possible extinction throughout all or a significant part of those species' native ranges. Under the authority of this act, the Virginia Department of Game and Inland Fisheries lists 23 fish, 41 mollusks, 4 freshwater crustaceans, and 7 marine mammals as State-endangered or threatened. Additionally, under the Virginia Wildlife Action Plan (VDGIF 2015), the Department 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.

The Virginia Department of Game and Inland Fisheries' Virginia Fish and Wildlife Information Service database identifies four aquatic species with designated State or Federal status with the potential to occur in Surry County (Roble 2016; VDGIF 2019f). These species are:

- Atlantic sturgeon
- blackbanded sunfish (*Enneacanthus chaetodon*)
- bridle shiner (*Notropis bifrenatus*)
- yellow lance (*Elliptio lanceolata*)

The Atlantic sturgeon is endangered within Virginia. It is also federally listed as endangered under the Endangered Species Act. This species and its critical habitat occur in the James River in the immediate vicinity of the Surry site. Section 3.8.1.3, "Endangered Species Act: Species and Habitats under National Marine Fisheries Service Jurisdiction," of this SEIS describes this species in detail.

The blackbanded sunfish is endangered within Virginia. It is a small, short-lived sunfish that inhabits acidic, shallow, dark-water swamps, creeks, ponds, and small to medium rivers (NatureServe 2019). Individuals prefer areas of thick vegetation, low turbidity, and sand and mud substrates. Adults eat zooplankton, midge larvae, other aquatic insects, and crustaceans (NatureServe 2019). The species likely does not occur in the immediate vicinity of the Surry site because the area lacks suitable habitat. Although the Virginia Department of Game and Inland Fisheries (VDGIF 2019d) recognizes it as known or likely to occur in Surry County, the State has no specific records for the James River. Additionally, the species has not been collected in any of the aquatic surveys or studies associated with Surry that the NRC staff reviewed during preparation of this SEIS.

The bridle shiner is a Tier I ("Critical Conservation Need") species in the Virginia Wildlife Action Plan (VDGIF 2015), but the State has not given it any formal protective status. The bridle shiner is a small member of the minnow family found in eastern North America from eastern Lake Ontario, Canada, east to Maine, and south to South Carolina. Adults are straw-colored with green-blue iridescence and silvery-white on the dorsal and ventral sides. Bridle shiners inhabit quiet areas of streams and lakes with dense aquatic vegetation and silty to sandy substrates. Adults eat zooplankton and aquatic insect larvae. Although researchers have historically collected the species in James River marshes, the State's most recent records are from the late 1970s (VDGIF 2019e). The species has not been collected in any of the aquatic surveys or studies associated with Surry that the NRC staff reviewed during preparation of this SEIS.

The yellow lance is federally listed as threatened under the Endangered Species Act (83 FR 14189). The State has not given the species any formal protective status at the State level to date (Roble 2016; VDGIF 2019f). Yellow lance is a bright yellow elongate freshwater mussel found in eight Atlantic Slope drainages from the upper Chesapeake River Basin in Maryland to the Neuse River Basin in North Carolina (FWS 2019d). The species relies on host fish, including white shiner (*Luxilus albeolus*) and pinewoods shiner (*Lythrurus matuntinus*), for reproduction (FWS 2019d). It inhabits sandy areas of clean, moderate flowing river waters with high dissolved oxygen content (FWS 2019d). The James River population of yellow lance consists of the Johns Creek Management Unit in western Virginia bordering West Virginia (FWS 2019c, 2019d). The species was last observed in this region in 2009 (FWS 2019d). The FWS (2019c, 2019d) reports no occurrences of the species, either historically or currently, within the James River or in Surry County.

With respect to important aquatic habitats, the National Marine Fisheries Service (NMFS) has designated the James River near the Surry site as critical habitat for the Atlantic sturgeon under the Endangered Species Act. Section 3.8.1.3, "Endangered Species Act: Species and Habitats under National Marine Fisheries Service Jurisdiction," of this SEIS describes the critical habitat in detail.

3.7.7 Non-Native and Invasive Aquatic Species

Non-native 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 those non-native species whose introduction does or is likely to cause economic or environmental harm or harm to human health (64 FR 6183).

The Center for Invasive Species and Ecosystem Health identifies 213 invasive species in Surry County (CISEH 2019). The Virginia Invasive Species Management Plan (VISAC 2018) names the northern snakehead (*Channa argus*) and Zebra mussel (*Dreissena polymorpha*) to be the two aquatic invasive species of particular concern. The northern snakehead is a 4-ft (1.2-m)-long predatory fish from Asia that can drastically alter freshwater ecosystems through its predation on fish, frogs, crustaceans, and aquatic insects, and its ability to readily outcompete predatory native fish for food and resources. The species is also able to survive in low-oxygen waters. The zebra mussel is a 2-inch (5-cm) freshwater bivalve from Russia that forms dense colonies on any hard surface, living or inanimate. Individuals will attach to boats, pipes, piers, docks, plants, clams, and even other mussels. Zebra mussels can cause significant biofouling of industrial intake pipes at power and water facilities.

The primary aquatic invasive species of concern near Surry is the Asian clam (*Corbicula fluminea*). This species is capable of surviving in relatively cold waters, reproduces rapidly, and competes with native species for limited resources. 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. Dominion (VEPC 2019a) reports the Asian clam from the Surry site, although the species' presence has not necessitated Dominion to take specific management actions beyond normal intake pipe cleaning and maintenance practices.

The non-native blue catfish (*Ictalurus furcatus*) and common carp (*Cyprinus carpio*) also inhabit the James River near the Surry site (VEPC 2019a).

3.8 Special Status Species and Habitats

This section addresses species and habitats that are federally protected under the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.), and the Magnuson–Stevens Fishery Conservation and Management Reauthorization Act, as amended (16 U.S.C. 1801-1884). Prior to taking a Federal action, such as the issuance of the proposed renewed licenses for Surry, the NRC has direct responsibilities under these statutes. Sections 3.6, "Terrestrial Resources," and 3.7, "Aquatic Resources," of this SEIS address species and habitats protected by other Federal statutes and the Commonwealth of Virginia under which the NRC does not have such responsibilities.

3.8.1 Endangered Species Act: Federally Listed Species and Critical Habitats

The U.S. Fish and Wildlife Service (FWS) and the NMFS jointly administer the Endangered Species Act. The FWS manages the protection of, and recovery effort for, listed terrestrial and freshwater species, and the NMFS manages the protection of, and recovery effort for, listed marine and anadromous species. The following sections describe the Surry action area and the species and habitats that may occur in the action area under the FWS's and the NMFS's jurisdictions.

3.8.1.1 Endangered Species Act: Action Area

The implementing regulations for Section 7(a)(2) of the Endangered Species Act 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, "Definitions"). 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 Surry license renewal on federally listed species, the NRC staff considers the action area to consist of the following.

Surry Site: The terrestrial region of the action area consists of the 840-ac (340-ha) Surry site, located on Gravel Neck Peninsula, in Surry County, Virginia. Forests cover 48 percent (approximately 403 ac (163 ha)) of the site and consist of deciduous forest (23.7 percent), evergreen forest (12.6 percent), and mixed forest (11.3 percent). Section 3.2, "Land Use and Visual Resources," and Section 3.6, "Terrestrial Resources," of this SEIS describe the developed and natural features of the site and the characteristic vegetation and habitats.

James River: The aquatic region of the action area includes the James River from the Surry cooling water intakes (Virginia Pollutant Discharge Elimination System (VPDES) Permit Outfalls 52 and 53) at RM 29 (47 RKM) upstream to the thermal effluent discharge point (VPDES permit Outfall 001) at RM 37 (60 RKM). The action area also encompasses the region of the river that experiences heightened temperatures from Surry's thermal plume. The area affected by the plume varies depending on season, tides, and other conditions. During slack tides, the plume pools in the immediate vicinity of the outfall. During flood and ebb tides, the plume remains close to the shore and extends farther downstream. Based on the available information, measurable increased water temperatures may extend up to 2,000 ft (610 m) downstream from the discharge outfall and 6 ft (1.8 m) below the water's surface under these conditions (Dominion 2012; Fang and Parker 1976). Increased water temperatures extend no more than half the width of the river at its narrowest point under all conditions and scenarios (Dominion 2012; Fang and Parker 1976). The NMFS determined this region of the river to be the appropriate action area for continued Surry operations during a 2012 consultation with the NRC (NMFS 2012).

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. Similarly, certain fish could swim through the action area seasonally on their way to or from spawning grounds. 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 whether the life history and habitat requirements of each species makes it likely to occur in the action area where it could be affected by the proposed license renewal. The following sections first discuss listed species and critical habitats under the FWS's jurisdiction followed by those under the NMFS's jurisdiction.

3.8.1.2 Endangered Species Act: Federally Listed Species and Critical Habitats under U.S. Fish and Wildlife Service Jurisdiction

One species under the FWS's jurisdiction that may be present in the Surry action area: the northern long-eared bat (*Myotis septentrionalis*) (FWS 2019a). The FWS listed this species under the Endangered Species Act after the NRC completed its environmental review for the 2003 license renewal. The sections below describe the habitat requirements, life history, and regional occurrence of this species.

During the NRC's environmental review for the license renewal in 2003, the NRC (NRC 2002b) considered potential impacts on the bald eagle (*Haliaeetus leucocephalus*) and determined that license renewal would not affect this species. The FWS subsequently delisted this species due to recovery. The bald eagle remains federally protected under the Bald and Golden Eagle Protection Act, which is discussed in Section 3.6.4, "Important Species and Habitats," of this SEIS. No candidate species, proposed species, or critical habitats (proposed or designated) occur within the Surry action area (FWS 2019a).

<u>Northern Long-eared Bat (*Myotis septentrionalis*)</u>

The FWS listed the northern long-eared bat as threatened throughout its range in 2015 (80 FR 17974). In 2016, the FWS determined that designating critical habitat for the species was not prudent because such designation would increase threats to the species resulting from vandalism and disturbance and could potentially increase the spread of white-nose syndrome (81 FR 24707). Information in this section is organized according to the description of the species in the FWS's *Federal Register* notice associated with the final rule to list the species (80 FR 17974) and draws from this source unless otherwise cited.

Taxonomy and Species Description

Although there have been few genetic studies on the northern long-eared bat, the FWS describes it as a monotypic species (i.e., having no subspecies). This species has been recognized by different common names, including Keen's bat, northern Myotis, and the northern bat.

The northern long-eared bat is a medium-sized bat that is distinguished from other *Myotis* species by its long ears, which average 0.7 inch (17 mm) in length. Adults weigh 5 to 8 g (0.2 to 0.3 oz), and females tend to be slightly larger than males. Individuals are medium to dark brown on the back, dark brown on the ears and wing membranes, and tawny to pale brown on the ventral side. Within its range, the northern long-eared bat can be confused with the little brown bat (*Myotis lucifugus*) or the western long-eared myotis (*M. evotis*).

Distribution and Relative Abundance

<u>Species Range</u>. The northern long-eared bat is found across much of the eastern and north-central United States and all Canadian provinces from the Atlantic coast west to the southern Northwest Territories and eastern British Columbia. Its range includes 37 U.S. states. The species is widely distributed within the eastern portion of its range, which includes Delaware, Connecticut, Maine, Maryland, Massachusetts, New Hampshire, New Jersey,

Pennsylvania, Vermont, Virginia, West Virginia, New York, Rhode Island, and the District of Columbia. Prior to documentation of white-nose syndrome, northern long-eared bats were consistently captured during summer mist-net and acoustic surveys within this region. However, as white-nose syndrome has spread, growing gaps exist within the eastern region where bats are no longer being captured or detected. In other areas, occurrences are sparse. Frick et al. (2015) documented the local extinction of northern long-eared bats from 69 percent of 468 sites where white nose syndrome has been present for at least 4 years in Vermont, New York, Pennsylvania, Maryland, West Virginia, and Virginia, which was by far the highest extinction rate among six species of North American hibernating bats considered during the study.

Status Within Virginia. As of 2016, the FWS (2016) reports 11 known northern long-eared bat hibernacula and 12 known occupied maternity roost trees in Virginia. Historically, the species has been captured in both summer and winter surveys within the State. However, since the appearance of white-nose syndrome in Virginia (2008–2009), winter and summer survey captures have sharply declined. In a 2015 environmental assessment associated with the northern long-eared bat final rule under Section 4(d) of the Endangered Species Act Section, the FWS (FWS 2015c) made the following estimates of Virginia's northern long-eared bat population:

- 277,920 total adults
- 138,960 total pups
- 6,948 maternity colonies of an average size of 20 individuals
- 48.3 percent occupancy of Virginia's available forested habitat
- 7.29 percent use of Virginia's available forested habitat as maternity roost areas

Habitat

Winter Habitat. Northern long-eared bats predominantly overwinter in hibernacula of various sizes that include underground caves and abandoned mines. Preferred hibernacula have relatively constant, cool temperatures with very high humidity and no air currents. Individuals most often roost in small crevices or cracks in cave or mine walls or ceilings but are also infrequently observed hanging in the open. Less commonly, northern long-eared bats overwinter in abandoned railroad tunnels, storm sewers, aqueducts, attics, and other non-cave or mine hibernacula with temperature, humidity, and air flow conditions resembling suitable caves and mines.

Summer Habitat. In summer, northern long-eared bats typically roost individually or in colonies underneath bark or in cavities or crevices of both live trees and snags. Males and nonreproductive females may also roost in cooler locations, including caves and mines. Individuals have also been observed roosting in colonies in buildings, barns, on utility poles, and in other man-made structures. The species has been documented to roost in many species of trees, including black oak, northern red oak, silver maple (*Acer saccharinum*), black locust (*Robinia pseudoacacia*), American beech (*Fagus grandifolia*), sugar maple (*A. saccharum*), sourwood (*Oxydendrum arboreum*), and shortleaf pine (*Pinus echinata*). Foster and Kurta (1999) found that rather than being dependent on particular tree species, northern long-eared bats are likely to use a variety of trees as long as they form suitable cavities or retain bark. Owen et al. (2002) found that tree-roosting maternal colonies chose roosting sites in larger trees that were taller than the surrounding stand and in areas with abundant snags. Carter and Feldhamer (2005) indicate that resource availability drives roost tree selection more than the actual tree species. However, several studies have shown that the species more often roosts in shade-tolerant deciduous trees rather than conifers. Additionally, the FWS concludes in its final listing that the tendency for northern long-eared bats to use healthy live trees for roosting is low.

Northern long-eared bats actively form colonies in the summer, but such colonies are often in flux because members will frequently depart to be solitary or to form smaller groups and later return to the main unit. This behavior is described as "fission-fusion," and it also results in individuals often switching tree roosts (typically every 2 to 3 days). Roost trees are often close to one another within the species' summer range with various studies documenting distances between roost trees ranging from 20 ft (6.1 m) to 2.4 mi (3.9 km).

Spring Staging. Spring staging is the period between winter hibernation and spring migration to summer habitat when bats begin to gradually emerge from hibernation. Individuals will exit the hibernacula to feed but re-enter the same or alternative hibernacula to resume periods of physical inactivity. The spring staging period is believed to be short for the northern long-eared bat and may last from mid-March through early May with variations in timing and duration based on latitude and weather.

Fall Swarming. Fall swarming is the period between the summer and winter seasons and includes behaviors such as copulation, introduction of juveniles to hibernacula, and stop-overs at sites between summer and winter regions. Both males and females are present together at swarming sites, and other bat species are often present as well. For northern long-eared bats, the swarming period may occur between July and early October, depending on latitude within the species' range. Northern long-eared bats may use caves and mines during swarming. Little is known about roost tree selection during this period, but some studies suggest that a wider variation in tree selection may occur during swarming than during the summer.

Roost Trees. Northern long-eared bats roost in cavities, crevices, hollows, or under the bark of live and dead trees and snags of greater than 3-inch (8-cm) diameter at breast height. Isolated trees may be considered suitable habitat when they exhibit these characteristics and are less than 1,000 ft (300 m) from the next nearest suitable roost tree within a wooded area. Northern long-eared bats appear to choose roost trees based on structural suitability rather than exhibiting a preference for specific species of trees.

Biology

Hibernation. Northern long-eared bats hibernate during winter months. Individuals arrive at hibernacula in August or September, enter hibernation in October and November, and emerge from hibernacula in March or April. The species has shown a high degree of repeated hibernaculum use, although individuals may not return to the same hibernacula in successive seasons. Northern long-eared bats often inhabit hibernacula in small numbers with other bat species, including little brown bats, big brown bats (*Eptesicus fuscus*), eastern small-footed bats (*Myotis leibii*), tri-colored bats (*Perimyotis subflavus*), and Indiana bats (*M. sodalis*). Northern long-eared bats have been observed moving among hibernacula during the winter hibernation period, but individuals do not feed during this time, and the function of this behavior is not well understood.

Migration and Homing. Northern long-eared bats migrate relatively short distances (between 56 and 89 km (35 and 55 mi)) from summer roosts and winter hibernacula. The spring migration period typically occurs from mid-March to mid-May, and fall migration typically occurs between mid-August and mid-October.

Reproduction. Northern long-eared bats mate from late July in northern regions to early October in southern regions. Hibernating females store sperm until spring, and ovulation takes place when females emerge from hibernacula. Gestation is estimated to be 60 days, after which time females give birth to a single pup in late May or early June. Females raise their young in maternity colonies, which generally consist of 30 to 60 individuals (females and young). Roost tree selection changes depending on reproductive stage with lactating females roosting higher in tall trees with less canopy cover. Young are capable of flight as early as 3 weeks following birth. Maximum lifespan for northern long-eared bats is estimated to be up to 18.5 years, and the highest rate of mortality occurs during the juvenile stage.

Foraging Behavior. Northern long-eared bats are nocturnal foragers that use hawking and gleaning in conjunction with passive acoustic cues to collect prey. The species' diet includes moths, flies, leafhoppers, caddisflies, beetles, and arachnids. Individuals forage 1 to 3 m (3 to 10 ft) above the ground between the understory and canopy of forested hillsides and ridges with peak foraging activity occurring within 5 hours after sunset.

Home Range. Northern long-eared bats exhibit site fidelity to their summer home range, during which time individuals roost and forage in forests. Studies indicate a variety of home range sizes—from as little as 8.6 ha (21.3 ac) to as large as 172 ha (425 ac). Some studies indicate differences in ranges between sexes, while others find no significant differences.

Factors Affecting the Species

The FWS identifies white nose syndrome, a disease caused by the fungus *Pseudogymnoascus destructans*, to be the predominant threat to the northern long-eared bat's continued existence. Other factors include human disturbance of hibernacula and loss of summer habitat due to forest conversion and forest management.

Occurrence Within the Action Area

The Surry action area falls within the range of the northern long-eared bat. No bat surveys have been conducted within the action area, nor have any assessments been undertaken to specifically determine habitat suitability or quality for bats. However, no hibernacula or roost trees occur within the action area according to Virginia Department of Game and Inland Fisheries records (VDGIF 2019c). Because of this, northern long-eared bats would not be present in the action area in winter. The NRC staff conservatively assumes that forests within the action area, which cover 403 ac (163 ha), could support foraging, mating, and sheltering in the spring, summer, and fall. If present during these seasons, individuals would only occur in the action area occasionally and in low numbers.

Summary of Potential Species Occurrence in the Action Area

Table 3-10 below summarizes the potential for each federally listed species to occur in the action area.

Table 3-10 Occurrences of Federally Listed Species in the Action Area under U.S. Fish and Wildlife Jurisdiction

Species	Type of occurrence in Virginia	Period of occurrence in Virginia (if present)	Likelihood of occurrence in action area
Northern long-eared bat	resident	Spring, summer, and fall	Occasional presence in low numbers possible in action area forests of sufficient size to support foraging, mating, and sheltering.

3.8.1.3 Endangered Species Act: Federally Listed Species and Critical Habitats under National Marine Fisheries Service Jurisdiction

With respect to federally listed species under the NMFS's jurisdiction, in communications between the NMFS and the NRC staff, the agencies determined that two species, the shortnose sturgeon (*Acipenser brevirostrum*) and Atlantic sturgeon (*A. oxyrinchus oxyrinchus*), occur in the Surry action area. The NMFS has also designated critical habitat for the Atlantic sturgeon in the James River. The sections below describe the two sturgeons and the characteristics of the designated critical habitat.

Shortnose Sturgeon (*Acipenser brevirostrum*)

The FWS listed the shortnose sturgeon as an "endangered species threatened with extinction" in 1967 under the Endangered Species Preservation Act. The species was added to the initial list of endangered species following promulgation of the Endangered Species Act in 1973, and currently remains listed as endangered wherever found. The NMFS has not designated critical habitat for this species. Information in this section is derived from the Shortnose Sturgeon Status Review Team's 2010 species assessment (SSSRT 2010) and the NMFS's biological opinion for continued operation of Salem Nuclear Generating Station, Units 1 and 2, and Hope Creek Generating Station, Unit 1 (NMFS 2014) unless otherwise cited.

Taxonomy and Species Description

Shortnose sturgeon are primitive benthic bony fish with cylindrical bodies that taper at the head and a protective armor of bony plates called "scutes" extending longitudinally from the base of the skull to the caudal peduncle. Sturgeon lack scales but have minute denticles, which are tiny tooth-like projections present in the skin of cartilaginous fishes. The dorsal, pelvic, and anal fins are located far back on the body; the pectoral fins are positioned low; and the pelvic fins are in the abdominal position. The shortnose sturgeon is the smallest of the three North American sturgeon species.

Distribution and Relative Abundance

Shortnose sturgeon are amphidromous fish that inhabit a great diversity of habitats, including coastal rivers, estuaries, nearshore marine waters, and offshore marine waters along the continental shelf. Shortnose sturgeon occur in most major river systems along the U.S. eastern seaboard. In the Mid-Atlantic portion of its range, the species is found in the Delaware River in Delaware, New Jersey, and Pennsylvania, and the Chesapeake Bay in Maryland and Virginia. The species was also recently collected from the James River in Virginia, as described below under "Occurrence Within the Action Area."

Biology

Reproduction. Shortnose sturgeon are long-lived; females can live up to 67 years, whereas males seldom exceed 30 years of age. Adults mature at 17 to 22 inches (45 to 55 cm) fork length throughout their range with sturgeon in southern rivers maturing at a younger age due to accelerated growth rates. Females spawn every 3 to 5 years, while males spawn every 2 years. The spawning period begins from late winter/early spring when freshwater temperatures increase to 46.4-48.2 °F (8-9 °C) and lasts from a few days to several weeks. Females spawn at discrete sites within their natal river, but individual females do not spawn every year. Annual egg production estimates are, therefore, difficult to calculate and may range greatly from 27,000 to 208,000 eggs per female. At hatching, shortnose sturgeon are blackish in color, 0.3-0.4 inch (7-11 mm) in length. The yolk sac is absorbed in 9 to 12 days, and larvae begin downstream migrations at about 0.8 inch (20 mm) total length. Larvae transform into juveniles at around 2.2 inches (57 mm) total length and an age of 40 days.

Diet. Shortnose sturgeon are benthic invertivores that feed throughout their lifecycle on benthic and epibenthic insects, crustaceans (e.g., amphipods, chironomids, and isopods), mollusks, and polychaetes. Females may seasonally suspend feeding prior to spawning by as much as 8 months, and both sexes may slow their feeding rates in winter.

Habitat

Shortnose sturgeon occupy both fresh and marine waters throughout the year, and habitat requirements for each life stage appear to correlate with increased salinity tolerance as the life cycle progresses.

Spawning. In undammed rivers, adults often travel to the farthest accessible upstream reaches of the river to spawn in the spring. In dammed rivers, adults will spawn near the base of the dam. Spawning sites typically exhibit moderate river flow with average bottom velocities of 1.3–2.6 fps (0.4–0.8 m/s). Substrate is typically course and may include gravel, rubble, or cobble or bedrock within deeper, moderate-flowing water.

Foraging. Juvenile and adult shortnose sturgeon forage in river and estuary reaches with sandy to muddy bottoms that support benthic invertebrates. Sturgeon may occupy foraging areas year-round in the mid-Atlantic, although individuals tend to seek refuge in cooler, deeper areas of rivers during the hotter summer months.

Overwintering. In northern rivers, shortnose sturgeon tend to form tight aggregations in specific fresh or saline reaches of rivers with little movement, whereas sturgeon in southern rivers tend to occupy the fresh/saltwater interface. Sub-adults and adults occupy similar habitat in winter, although the two age classes may overwinter in different areas. Young-of-the-year typically overwinter in freshwater channels upstream of the salt wedge.

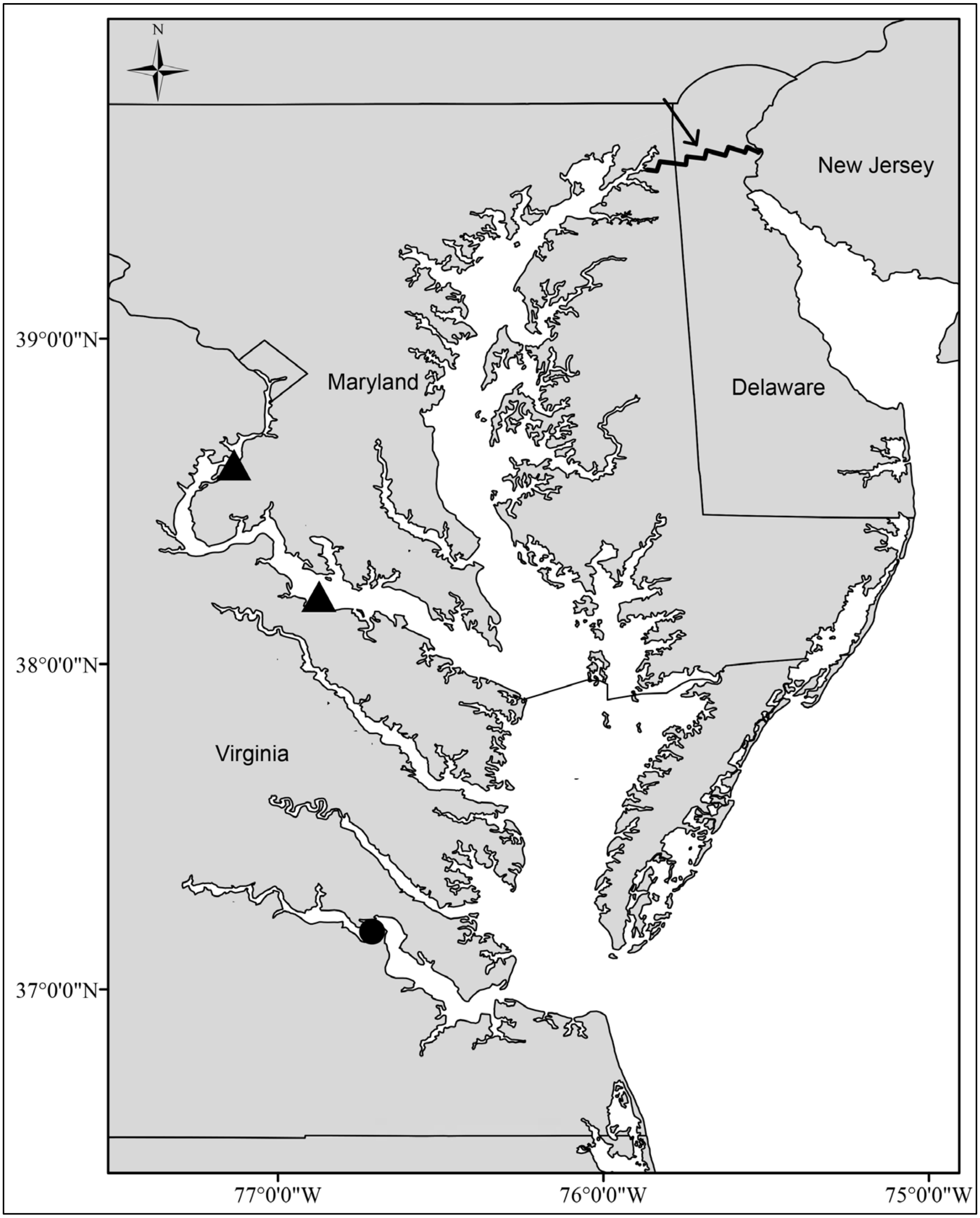
Factors Affecting the Species

Many factors have contributed to the decline of shortnose sturgeon. These factors include dam construction, pollution of many large northeastern river systems, habitat alterations related to water intake and discharge structures, dredging or disposal of material into rivers, and shoreline development effects on the habitat quality of estuarine and riverine mudflats and marshes (NMFS 2019c).

Occurrence Within the Action Area

Although the Chesapeake Bay lies in the middle of the shortnose sturgeon's geographic range, the species is relatively scarce in the bay, and regional research has been extremely limited. During 1996–2006, collection efforts in the bay focused on the Atlantic sturgeon; researchers reported incidental captures of shortnose sturgeon from several studies (Mangold 2007; Spells 1998; Welsh et al. 2002). In Maryland, 72 individuals were captured during the period, although some of these individuals may have been recaptures as only a third of captured shortnose sturgeon were tagged prior to release. Only one shortnose sturgeon was collected in Virginia waters: a single individual in the lower reach of the Rappahannock River within the marine waters of the Chesapeake Bay estuary.

Within the freshwaters of the Chesapeake Bay's tributaries, only three shortnose sturgeon have been documented in recent years from two studies. In 2008, Kynard et al. (2009) captured and telemetry-tagged two adult females in the Potomac River in Maryland. Over the course of a season, the tagged individuals used a 77-mi (124-km) stretch of the river. The sturgeon foraged and wintered in saltwater/freshwater reaches of the river between RM 63 and 88 (RKM 63 and 141), and one of the two females spawned at RM 116 (RKM 187) in Washington, DC. These observations support the idea that a natal population once lived in the Potomac River. The third documented shortnose sturgeon in Chesapeake Bay freshwaters is from the James River in Virginia. In March 2016, researchers collected an approximately 30-inch (75-cm) fork length shortnose sturgeon in a gillnet set for juvenile Atlantic sturgeon at RM 30 (RKM 48) (Balazik 2017). The collection location was within the Surry action area approximately 1 RM (1.6 RKM) upstream of Surry's cooling water intakes. Although researchers took photos of the individual, no formal measurements were taken and the sex was not determined. This collection is the first verified occurrence of a shortnose sturgeon inhabiting the James River. Figure 3-29 depicts the collection locations of these three shortnose sturgeon on a map. The black triangles indicate the initial capture locations of the two adult females in the Potomac River, and the black circle indicates the capture location of the shortnose sturgeon in the James River. Based on this information, the NMFS (NMFS 2018b) believes that shortnose sturgeon may occur in the James River up to Boshers Dam (RM 113.3 (RKM 182.3)), although the species' range has yet to be confirmed.



Source: Balazik 2017

Figure 3-29 Collection Locations of Shortnose Sturgeon in Freshwaters of the Chesapeake Bay Watershed

Based on the available information, the NRC staff concludes that adult shortnose sturgeon occur within the Surry action area, although such occurrences are rare. The NRC staff also assumes that subadults may also be present. The NRC staff assumes that adults and subadults may occur in the action area throughout the year and that occurrences are most likely during the mid-Atlantic migratory period from April through May. These assumptions are consistent with observations of shortnose sturgeon in the tidally influenced portions of other mid-Atlantic rivers. Other age classes do not occur in the action area. No shortnose sturgeon spawning grounds have been identified in the James River, and if present, spawning grounds would be well upstream of the action area within freshwater reaches of the river. Sturgeon eggs are adhesive and demersal and occur only on spawning grounds, and larvae would not be expected to travel as far downstream as the Surry action area before progressing to a more advanced life stage.

Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*)

The NMFS listed five distinct population segments (DPSs) of the Atlantic sturgeon as threatened or endangered in 2012 (77 FR 5880; 77 FR 5914). In 2017, the NMFS designated critical habitat for the Atlantic sturgeon, which is described in a separate section below. Information in this section is derived from the NMFS's background and status review of the species contained in the proposed rule to list the three northeast DPSs (75 FR 61872) unless otherwise cited.

Taxonomy and Species Description

Atlantic sturgeon is a subspecies of *Acipenser oxyrinchus* that occurs along the eastern coast of North America. It is a long-lived, estuarine-dependent, anadromous species. The species is distinguished by five rows of scutes and long snout with a ventrally located protruding mouth and four slender, soft tissue projects called barbels. The Atlantic sturgeon is the largest of the three North American sturgeon species.

Distribution and Relative Abundance

Atlantic sturgeon inhabit the eastern coast of North America from Hamilton Inlet, Labrador, Canada, to Cape Canaveral, Florida. Historically, the species occurred within 38 rivers in the United States from St. Croix, Maine, to Saint Johns River, Florida, 35 of which supported spawning. Current data indicate that the species occurs in 36 rivers in the United State and Canada, and spawns in at least 18 of these. In the Mid-Atlantic portion of its range, the species spawns in the Delaware River in New Jersey, Delaware, and Pennsylvania, and the James River in Virginia. Atlantic sturgeon may also spawn in the York River in Virginia and Neuse River in North Carolina, although confirmatory data or observations are not currently available. Although the five DPSs of Atlantic sturgeon originate from different river systems, individuals from different DPSs may co-occur within estuaries and marine waters as sub-adults and adults during non-spawning seasons.

Atlantic sturgeon that spawn in the James River are part of the Chesapeake Bay DPS. This DPS includes all Atlantic sturgeon whose range occurs in watersheds that drain into the Chesapeake Bay and into coastal waters from the Delaware-Maryland border on Fenwick Island to Cape Henry, Virginia, as well as wherever sturgeon from this DPS occur in coastal bays, estuaries, and marine waters from the Bay of Fundy, Canada, to the Saint Johns River, Florida. Within this range, researchers have documented Atlantic sturgeon from the James, York, Potomac, Rappahannock, Pocomoke, Choptank, Little Choptank, Patapsco, Nanticoke, Honga, and South Rivers as well as the Susquehanna Flats. Upon listing, the NMFS believed the James River to be the only spawning location for this DPS. However, more recent data indicate that the species also spawns in the Pamunkey River of the York River system in Virginia and Marshyhope Creek of the Nanticoke River system on the Delmarva Peninsula (NMFS 2017). Additionally, recent genetic evidence suggests that the James River spring and fall spawning Atlantic sturgeon are separate subpopulations (Balazik and Musick 2015).

Biology

Reproduction. Atlantic sturgeon are long-lived; individuals live 25 to 30 years in the southeast and up to 60 years in Canada. Southern populations typically grow faster and reach sexual maturity earlier than northern populations. For instance, individuals mature at 5 to 19 years of age in South Carolina rivers, at 11 to 21 years in the Hudson River in New York, and at 22 to 34 years in the St. Lawrence River in Canada. Females spawn every 2 to 5 years, while males spawn every 1 to 5 years. Females produce 400,000 to 8 million eggs depending on age and body size. In the mid-Atlantic, the spawning migration period extends from April to May. In Chesapeake Bay tributary rivers, Atlantic sturgeon may also spawn in late summer and fall. Females tend to rapidly migrate upstream, spawn, and then depart. Males tend to arrive at spawning grounds before females and will stay until the last female has spawned. Spawning occurs between the salt front of estuaries and the fall line of large rivers in waters with cobble or other hard substrate, with temperatures of 68-70 °F (20-21 °C), depths of 36-89 ft (11-27 m), and a flow of 1.5-2.5 fps (0.46-0.76 m/s). Eggs are highly adhesive; once deposited, they sink to the bottom of the water column where they attach to the substrate and incubate for 94 to 140 hours. Upon hatching, larvae are demersal. The yolksac larval stage lasts 8 to 12 days, during which time, larvae move downstream to rearing grounds. Larvae develop a tolerance for salinity as they move downstream and develop into the juvenile phase. Juveniles reside in estuarine waters for months to years before emigrating to open ocean as subadults.

Diet. Atlantic sturgeon are benthic omnivores that filter large quantities of mud along with their food. Adults consume mollusks, gastropods, amphipods, isopods, and fish. Juveniles consume aquatic insects and other invertebrates.

Habitat

Atlantic sturgeon occupy both fresh and marine waters throughout the year, and habitat requirements for each life stage appear to correlate with increased salinity tolerance as the life cycle progresses.

Spawning. Like shortnose sturgeon, Atlantic sturgeon adults will travel to the farthest accessible upstream reaches of the river to spawn in the spring. In dammed rivers, adults will spawn near the base of the dam. Spawning sites typically exhibit fast flow, temperatures of 55.4 to 78.8 °F (13 to 26 °C), and dissolved oxygen of 6 ppm (6 mg/L) or more (82 FR 39160). Substrate is typically coarse and may include gravel, rubble, or cobble or bedrock within deeper, moderate-flowing water. Spawning may occur from the salt front to the fall line.

Foraging. Juvenile and adult Atlantic sturgeon forage in river and estuary reaches with soft bottoms that support benthic invertebrates. Sturgeon may occupy foraging areas throughout the year in the mid-Atlantic, although individuals tend to seek refuge in cooler, deeper areas of rivers during the hotter summer months. Adults may also forage in marine waters.

Overwintering. Atlantic sturgeon overwinter in bays, estuaries, and marine waters off of estuaries (82 FR 39160). Available data are lacking on particular movement patterns and regional or population-specific overwintering habitat selection.

Factors Affecting the Species

Many factors have contributed to the decline of the Atlantic sturgeon. These factors include dam construction, pollution of freshwater river systems, habitat alteration, and overfishing. The primary factors that continue to threaten the species include artificial barriers to passage (i.e., dams and tidal turbines), dredging, and poor water quality (e.g., dissolved oxygen levels, water temperature, and contaminants).

Occurrence Within the Action Area

The marine range of all five DPSs of Atlantic sturgeon extends along the Atlantic coast from Canada to Cape Canaveral, Florida. Atlantic sturgeon originating from any of the five DPSs could occur in the James River and may be present in the Surry action area (NMFS 2012). In a tagging effort that extended from spring and fall 2012 through spring 2014, researchers collected 239 adult-sized Atlantic sturgeon in the James River (NMFS 2018c). The NMFS (NMFS 2018c) considers this to be a minimum count of the adult number of the species present in the river during the period because capture efforts did not occur in all areas or at all times when Atlantic sturgeon are known to be present in the river. In a 2017 stock assessment of the species, the Atlantic States Marine Fisheries Commission determined that the coastwide Atlantic sturgeon population is stable to slowly increasing (ASMFC 2017a). The assessment noted that researchers have tagged and released over 600 unique adults in the James River since 2009. Finally, in fall 2018 trawl surveys of the tidal James River, researchers associated with the Virginia Commonwealth University Rice River Center collected nearly 150 age-0 Atlantic sturgeon (VCU 2018). Except for two age-1 individuals in 2016, this was the first collection of juvenile sturgeon since the university's sampling effort began 9 years ago. These collections confirm that the James River supports a spawning population of the species.

Based on the available information, the NRC staff concludes that yearling, subadult, and adult Atlantic sturgeon occur within the Surry action area. Adults and subadults may occur in the action area from late August through November as they migrate to and from freshwater spawning grounds upriver (NMFS 2012). No eggs or larvae occur in the action area because spawning grounds are well upstream of the action area (NMFS 2012). Sturgeon eggs are adhesive and demersal and occur only on spawning grounds, and larvae would not be expected to travel as far downstream as the Surry action area before progressing to a more advanced life stage.

Designated Critical Habitat of the Atlantic Sturgeon

Critical habitat represents the habitat that contains the physical or biological features (PBFs) essential to conservation of the listed species and that may require special management considerations or protection (78 FR 53058). Critical habitat may also include areas outside the geographical area occupied by the species if the NMFS determines that the area itself is essential for conservation.

With respect to the Atlantic sturgeon, the NMFS designated critical habitat for all five DPSs in 2017 (82 FR 39160). In the associated final rule, the NMFS identifies four PBFs that support successful sturgeon reproduction and recruitment (see Table 3-11). PBFs are those features that support the life-history needs of the species, including, but not limited to, water characteristics, soil type, geological features, sites, prey, vegetation, symbiotic species, or other features (81 FR 7413). A feature may be a single habitat characteristic or a more complex combination of habitat characteristics (81 FR 7413).

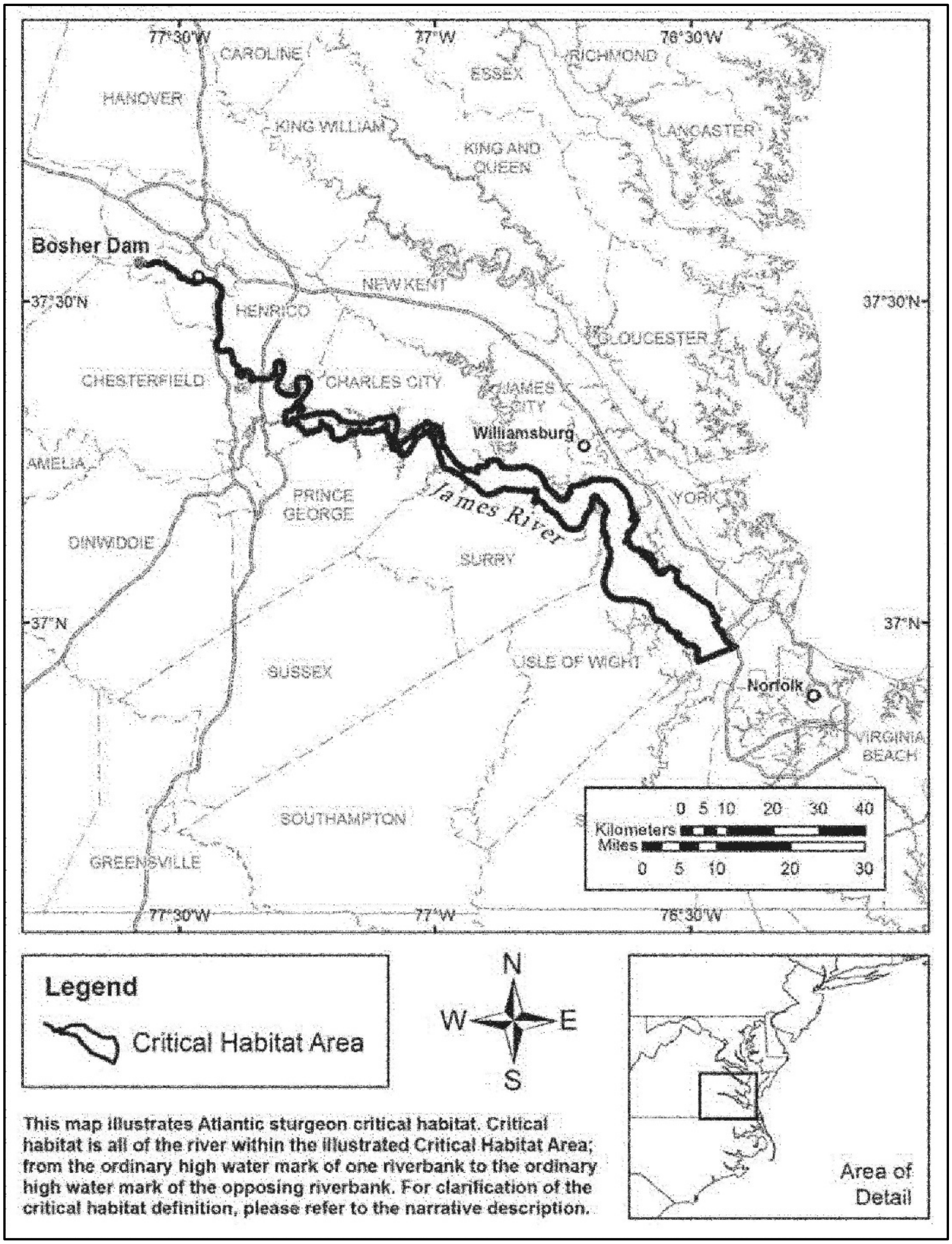
Table 3-11 Physical or Biological Features of Atlantic Sturgeon Critical Habitat

PBF[(a)]	Description
PBF 1	Hard bottom substrate (e.g., rock, cobble, gravel, limestone, boulder) in low salinity waters (i.e., 0.0-0.5 parts per thousand range) for settlement of fertilized eggs, refuge, growth, and development of early life stages.
PBF 2	Aquatic habitat with a gradual downstream salinity gradient of 0.5 up to as high as 30 parts per thousand and soft substrate (e.g., sand, mud) between the river mouth and spawning sites for juvenile foraging and physiological development.
PBF 3	Water of appropriate depth and absent physical barriers to passage (e.g., locks, dams, thermal plumes, turbidity, sound, reservoirs, gear) between the river mouth and spawning sites necessary to support: (i) Unimpeded movement of adults to and from spawning sites; (ii) Seasonal and physiologically dependent movement of juvenile Atlantic sturgeon to appropriate salinity zones within the river estuary; and (iii) Staging, resting, or holding of subadults or spawning condition adults. Water depths in main river channels must also be deep enough (e.g., at least 1.2 meters) to ensure continuous flow in the main channel at all times when any sturgeon life stage would be in the river.
PBF 4	Water, between the river mouth and spawning sites, especially in the bottom meter of the water column, with the temperature, salinity, and oxygen values that, combined, support: (i) Spawning; (ii) Annual and interannual adult, subadult, larval, and juvenile survival; and (iii) Larval, juvenile, and subadult growth, development, and recruitment (e.g., 13 to 26 °C for spawning habitat and no more than 30 °C for juvenile rearing habitat, and 6 milligrams per liter (mg/L) or greater dissolved oxygen for juvenile rearing habitat).

[(a)] The physical or biological features (PBFs) identified in this table are specific to the Chesapeake Bay, New York Bight, and Gulf of Maine DPSs of Atlantic sturgeon.

Source: 82 FR 39160

Within the James River, the NMFS designated critical habitat for the Chesapeake Bay DPS of Atlantic sturgeon from Boshers Dam (RM 113.3 (RKM 182.3)) downstream to where the main stem river discharges at its mouth into the Chesapeake Bay at Hampton Roads (RM 0 (RKM 0)) (82 FR 39160) (Figure 3-30). This region is designated as Chesapeake Bay Critical Habitat Unit 5. The unit includes all of the river from the ordinary high-water mark of one riverbank to the ordinary high-water mark of the opposing riverbank (50 CFR 226.225). Accordingly, the entirety of the James River within the Surry action area is designated critical habitat.



Source: 50 CFR 226.225, Map 13

Figure 3-30 Atlantic Sturgeon Chesapeake Bay DPS Critical Habitat Unit 5 in the James River

The Surry site lies along the James River at the transition between the tidally influenced freshwater river upstream and the saline estuary downstream. The waters within the action area exhibit varying salinity levels depending on river discharge. The river typically varies from 0 to 17 ppt at the cooling water intake structure and from 0 to 9.2 ppt near the discharge canal, which lies 6 RM (10 RKM) upstream (NRC 2002b). The entirety of the river within the action area is subject to tidal influence. The characteristics of the river are described in more detail in Section 3.5, "Surface Water Resources," and 3.7, "Aquatic Resources," of this SEIS.

With respect to the PBFs of the critical habitat (see Table 3-11), the Surry action area does not contain the appropriate environmental conditions to support spawning. Current literature reports that Atlantic sturgeon spawning in the James River takes place from RM 56-59 (RKM 90-95) in the spring (Balazik and Musick 2015) and from RM 65 (RKM 105) and the fall line near Richmond, VA, at RM 96 (RKM 155) in the fall (Balazik et al. 2012). The action area is likely to contain habitat supporting summer and fall staging, which is reported to take place from RM 14 (RKM 22) (downstream of the action area) and through RM 66.5 (RKM 107) (well upstream of the action area) (Balazik et al. 2012; Balazik and Musick 2015). The action area also likely supports habitat for rearing of juveniles and subadults and foraging of juveniles, subadults, and adults (NMFS 2018a).

Summary of Potential Species Occurrence and Critical Habitat in the Action Area

Table 3-12 below summarizes the potential for each of the federally listed species to occur in the action area. The table also identifies designated critical habitat within the action area.

Table 3-12 Occurrences of Federally Listed Species and Critical Habitats in the Action Area Under National Marine Fisheries Service Jurisdiction

Species	Type of occurrence in Virginia	Period of occurrence in Virginia (if present)	Likelihood of occurrence in action area
shortnose sturgeon	resident and seasonal migrant	Year-round with higher probability of occurrence in April and May	Aquatic surveys have confirmed presence of the species in the action area. Subadults and adults may occasionally occur, but the species is rare overall. Other age classes do not occur in the action area.
Atlantic sturgeon	seasonal migrant	late August through November	Aquatic surveys have confirmed presence of the species in the action area. Juveniles, subadults, and adults occur seasonally during migration. Other age classes do not occur in the action area.
Critical habitat			
Atlantic sturgeon	The entirety of the James River within the action area is designated as Critical Habitat Unit 5 for the Chesapeake Bay DPS.		

3.8.1.4 Magnuson–Stevens Act: Essential Fish Habitat

Under the provisions of the Magnuson–Stevens Act, the Fishery Management Councils and the NMFS have designated essential fish habitat (EFH) for certain federally managed species. EFH is defined as the waters and substrate necessary for spawning, breeding, feeding, or growth to maturity (16 U.S.C. 1802(10)). For each federally managed species (herein referred to as "EFH species"), the Fishery Management Councils and the NMFS designate and describe EFH by life stage (i.e., egg, larva, juvenile, adult).

To determine the relevant EFH species for the NRC staff's license renewal review, the NRC staff queried the NMFS's EFH Mapper, an online mapping application. The EFH Mapper identified 10 species that may have EFH within the James River near the Surry site (NMFS 2019a). The NRC staff compared each species and life stage with habitat characteristics documented in scientific literature and the descriptions of EFH designated by the Fishery Management Councils and the NMFS in relevant fishery management plans and other regulatory documents. Finally, the NRC staff considered whether the prey of each EFH species and life stages would be relevant to the NRC staff's EFH analysis. For instance, if a given species with designated EFH downstream of Surry in the Chesapeake Bay consumes diadromous fish that occur in the James River, effects of the proposed action on those prey fish would be relevant to the NRC staff's EFH analysis. Table 3-13 summarizes the results of this review. Habitat characteristics, descriptions of designated EFH, and diet summaries for each of the relevant EFH species and life stages follow the table.

Table 3-13 Summary of EFH Species and Life Stages Relevant to Proposed Surry Subsequent License Renewal

Species	Common Name	EFH Mapper Results[(a)(b)]	Relevant Life Stages for EFH Analysis[(a)]
Centropristis striata	black sea bass	J, A	—
Clupea harengus	Atlantic herring	J, A	—
Leucoraja erinacea	little skate	A	(P)
Leucoraja ocellata	winter skate	A	(P)
Paralichthys dentatus	summer flounder	L, J, A	L, J, A
Peprilus triacanthus	Atlantic butterfish	J, A	J, A
Pomatomus saltatrix	bluefish	J, A	J
Raja eglanteria	clearnose skate	J, A	—
Scopthalmus aquosus	windowpane flounder	J	J, A
Urophycis chuss	red hake	E, L, J, A	—

(a) E = eggs; L = larvae; J = juveniles; A = adults; (P) = prey of EFH species.

(b) See NMFS 2019a.

<u>Black Sea Bass (*Centropristis striata*) – Juveniles, Adults</u>

Habitat Characteristics

Juvenile and adult black sea bass inhabit demersal waters over the continental shelf from the Gulf of Maine to Cape Hatteras, North Carolina; inshore waters of oceanic salinities; and estuary mixing zones. Both life stages generally occupy waters warmer than 43 °F (6.1 °C) with salinities greater than 18 ppt. Juveniles inhabit estuaries and coastal areas between Virginia and Massachusetts in spring and summer, whereas adults inhabit these areas spring through mid-fall (October). Adults move into offshore waters, south of New York to North Carolina, from November through April. Both life stages are typically associated with rough bottoms, shellfish and eelgrass beds, man-made structures in sandy shelly areas, offshore clam beds, and shell patches. Juveniles commonly occupy depths of less than 33 ft (10 m), and adults most commonly occupy depths of 66-197 ft (20-60 m). (Drohan et al. 2007; MAFMC and NMFS 1998).

Designated Essential Fish Habitat

EFH for juvenile and adult black sea bass includes the mixing and seawater zones of all major estuaries where the species was identified as being present in the NOAA's Estuarine Living Marine Resources Database (NMFS 2019b; NOAA 2019d). This includes the Chesapeake Bay estuary for both life stages. However, salinity requirements for this species are not present in the James River near Surry and, therefore, this species will not be considered any further in the NRC staff's EFH analysis for the proposed action.

Diet

Juvenile black sea bass prey on benthic and epibenthic crustaceans (e.g., isopods, amphipods, small crabs, sand shrimp, copepods, and mysids) and small fish (Drohan et al. 2007). Adults are generalist carnivores that feed on a variety of infaunal and epibenthic invertebrates, especially juvenile American lobster (*Homarus americanus*), crabs, shrimp, and other crustaceans, as well as small fish and squid (Drohan et al. 2007). Fish prey include sand lance (*Ammodytes dubius*), scup (*Stenotomus chrysops*), sheepshead minnow (*Cyprinodon variegates*) (Drohan et al. 2007). Because black sea bass do not consume diadromous fish, the potential effects of the proposed action on black sea bass prey is not relevant to the NRC staff's EFH analysis.

<u>Atlantic herring (*Clupea harengus*) – Juveniles, Adults</u>

Habitat Characteristics

Juvenile and adult Atlantic herring occupy intertidal and subtidal pelagic habitats to 984 ft (300 m), including bays and estuaries. Young juveniles form large schools and make limited seasonal inshore-offshore migrations. Adults migrate extensively between summer and fall spawning grounds on Georges Bank and the Gulf of Maine and overwintering areas in southern New England and the Mid-Atlantic. Juveniles inhabit waters of 37.4-59 °F (3-15 °C) in the north and up to 71.6 °F (22 °C) in the Mid-Atlantic. Young-of-the-year can tolerate low salinities, while older juveniles avoid brackish waters. Adult Atlantic herring generally avoid waters with temperatures above 50 °F (10 °C) and low salinities. (NEFMC and NMFS 2018; Stevenson and Scott 2005)

Designated Essential Fish Habitat

EFH for juvenile and adult Atlantic herring encompasses subtidal habitats to 984 ft (300 m) throughout the species' range, including certain bays and estuaries (NEFMC and NMFS 2018). EFH for juveniles includes intertidal areas in additional to subtidal areas. EFH is not designated in the Chesapeake Bay estuary for juveniles. Therefore, juvenile Atlantic herring are not relevant to the NRC's staff's EFH analysis. EFH for adults is designated in the seawater salinity zone (greater than 25 ppt) of the Chesapeake Bay estuary (NEFMC and NMFS 2018). Because salinity requirements for adults are not present in the James River near Surry, this species will not be considered any further in the NRC staff's EFH analysis for the proposed action.

Diet

Atlantic herring are opportunistic feeders that prey upon a variety of planktivorous organisms. Juveniles feed on zooplankton, including copepods, decapod larvae, barnacle larvae, cladocerans, and molluscan larvae (Stevenson and Scott 2005). Adults primarily consume zooplankton prey, including euphausiids, amphipods, copepods, chateognaths, pteropods, mysids, and pandalid shrimp (Stevenson and Scott 2005). Adults may also consume fish eggs and larvae, including those of sand lance, Atlantic silverside (*Menidia menidia*), and their own species (Stevenson and Scott 2005). Fish prey make up only a small percentage of food by weight. Because Atlantic herring do not typically consume diadromous fish, the potential effects of the proposed action on Atlantic herring prey is not relevant to the NRC staff's EFH analysis.

<u>Little Skate (*Leucoraja erinacea*) – Adults</u>

Habitat Characteristics

Adult little skate inhabit intertidal and subtidal benthic habitats in coastal waters of the Gulf of Maine and in the Mid-Atlantic region as far south as Delaware Bay, and on Georges Bank, to a depth of 328 ft (100 m). Adults also occupy the high salinity zones (greater than 25 ppt) of bays and estuaries in this region. Little skate are present in waters of 33.8 to 69.8 °F (1 to 21 °C) and most common at temperatures between 35.6 °F (2 °C) and 59 °F (15 °C). The species is most common at higher salinities but has been collected in the Delaware Bay at salinities as low as 15-20 ppt. Little skate are typically associated with sand and gravel substrates but may also occur on mud. Individuals often bury themselves in depressions during the day and are more active at night. (NEFMC and NMFS 2018; Packer et al. 2003b)

Designated Essential Fish Habitat

EFH for adult little skate occurs in the Chesapeake Bay mainstem but not within the James River (NEFMC and NMFS 2018). Because EFH does not occur in the immediate project area, no life stages of this species will be considered any further in the NRC staff's EFH analysis for the proposed action.

Diet

The little skate is a generalized, opportunistic predator. Decapod crustaceans (e.g., crabs and sand shrimp) and amphipods are the most important little skate prey items, followed by polychaetes (Packer et al. 2003b). Isopods, bivalves, and fish are of minor importance. Carlson (1991) determined that decapods make up 76 percent of the little skate's diet by weight, whereas fish comprise only 10 percent of the diet by weight. Primary fish prey include sand lance, yellowtail flounder (*Pleuronectes ferruginea*), longhorn sculpin (*Myoxocephalus octodecemspinosus*), and Atlantic herring (Packer et al. 2003b). Little skate in the Woods Hole, Massachusetts, region have been reported to eat sand lance, alewives (*Alosa pseudoharengus*), herring (*Alosa* species), cunner (*Tautogolabrus adspersus*), Atlantic silverside, tomcod (*Microgadus tomcod*), and silver hake (*Merluccius bilinearis*) (Avent et al. 2001). Adults also eat hydroids, copepods, ascidians, and squid (Packer et al. 2003b). Because little skate consume certain anadromous fish (i.e., *Alosa* species), the potential effects of the proposed action on the prey of adult little skate is relevant to the NRC staff's EFH analysis.

Winter Skate (*Leucoraja ocellata*) – Adults

Habitat Characteristics

Adult winter skate inhabit subtidal benthic habitats in coastal waters in the southwestern Gulf of Maine, in coastal and continental shelf waters in southern New England and the Mid-Atlantic region, and on Georges Bank, to a depth of 263 ft (80 m). Adults also occupy the high salinity zones (greater than 25 ppt) of bays and estuaries in this region. Winter skate are present in waters of 36.3 to 66.9 °F (2.4 to 19.4 °C). The species inhabits high salinity waters of between 27.5 and 36 ppt and is most common between 20.5 and 30.5 ppt. Winter skate are typically associated with sand and gravel substrates but may also occur on mud. Individuals often bury themselves in depressions during the day and are more active at night. (NEFMC and NMFS 2018; Packer et al. 2003c)

Designated Essential Fish Habitat

EFH for adults occurs in the Chesapeake Bay mainstem but not within the James River (NEFMC and NMFS 2018). Because EFH does not occur in the immediate project area, no life stages of this species are relevant to the NRC staff's EFH analysis for the proposed action.

Diet

The winter skate is a generalized, opportunistic predator. Polychaetes and amphipods are the most important prey items, followed by decapods, isopods, bivalves, and fish (Packer et al. 2003c). American sand lance is the primary fish prey. Other fish prey include smaller skates, eels, alewives, blueback herring (*Alosa aestivalis*), Atlantic menhaden (*Brevoortia tyrannus*), smelt, chub mackerel (*Scomber japonicus*), butterfish, cunners, sculpins, silver hake, and tomcod (Packer et al. 2003c). Steimle et al. (2000) examined the stomach contents of 57 adult winter skate within the Hudson-Raritan Estuary and determined that adult winter skate consume a diverse variety of benthic invertebrates and fish. The most common prey included sand shrimp, as well as Atlantic herring, longhorn sculpin, sand lance, and winter flounder (*Pseudopleuronectes americanus*). Adults also consume rock crabs and squid (Packer et al. 2003c). Because little skate consume certain anadromous (e.g., *Alosa* species) and catadromous (e.g., eels) fish, the potential effects of the proposed action on the prey of adult winter skate is relevant to the NRC staff's EFH analysis.

Summer Flounder (*Paralichthys dentatus*) – Larvae, Juveniles, Adults

Habitat Characteristics

Summer flounder larvae occur in pelagic waters over the continental shelf from the Gulf of Maine to Cape Hatteras, North Carolina, and south of Cape Hatteras in nearshore waters of the continental shelf south to Cape Canaveral, Florida. Larvae may occur in the mixing and seawater zones of estuaries within this range. Larvae are generally most abundant near shore (12-50 mi (19-80 km) from shore) and at depths between 30-230 ft (9-70 m) (MAFMC and NMFS 1998).

Juvenile and adult summer flounder occupy demersal waters over the continental shelf from the Gulf of Maine to Cape Hatteras, North Carolina, and south of Cape Hatteras over the continental shelf to depths of 500 ft (152 m) south to Cape Canaveral, Florida. Juveniles use estuarine habitats within this region as nursery areas. This life stage also inhabits salt marsh creeks, seagrass beds, mudflats, and open bay areas in water temperatures greater than 37 °F (2.8 °C) and salinities ranging from 10 to 30 ppt. Adults occupy shallow coastal and estuarine waters during warmer months and move offshore to the outer continental shelf at depths of 500 ft (152 m) in colder months. (MAFMC and NMFS 1998).

Designated Essential Fish Habitat

EFH for larvae, juveniles, and adults includes the mixing and seawater zones of all major estuaries where the species was identified as being present in the NOAA Estuarine Living Marine Resources Database (NMFS 2019b; NOAA 2019e). This includes the Chesapeake Bay estuary for the three life stages. EFH for this species occurs within the James River near the Surry site based on appropriate salinity and bottom substrates. Therefore, the larvae, juvenile, and adult life stages of this species are relevant to the NRC staff's EFH analysis for the proposed action.

Diet

Larval and postlarval summer flounder initially feed on zooplankton and small crustaceans (Packer et al. 1999). Juveniles and adults are opportunistic feeders with fish and crustaceans making up a significant portion of the diet. Small juveniles consume crustaceans and polychaetes, and individuals consume a higher percentage of fish by weight as they increase in size. Rountree and Able (1992) found that young-of-year summer flounder in marsh creeks of Great Bay-Little Egg Harbor, New Jersey, preyed on the following in order of abundance: Atlantic silverside (*Menidia menidia*), mummichog (*Fundulus heteroclitus*), grass shrimp (*Palaemonetes vulgaris*), and sand shrimp (*Crangon septemspinosa*). Adults consume windowpane flounder (*Scopthalmus aquosus*), winter flounder, northern pipefish (*Syngnathus fuscus*), Atlantic menhaden, bay anchovy, red hake, silver hake, scup, Atlantic silverside, American sand lance, bluefish (*Pomatomus saltatrix*), weakfish, mummichog, rock crabs, squids, shrimps, small bivalve and gastropod mollusks, small crustaceans, marine worms, and sand dollars (Packet et al. 1999). Because EFH for larvae, juveniles, and adults occurs in the James River near Surry, the potential effects of the proposed action on the prey of these life stages is relevant to the NRC staff's EFH analysis.

<u>Atlantic Butterfish (*Peprilus tracanthus*) – Juveniles, Adults</u>

Habitat Characteristics

Juvenile and adult Atlantic butterfish occupy bays and estuaries in the spring through fall and the edge of the continental shelf in winter. The species inhabits waters of depths from 33 to 1,181 ft (10 to 360 m). Both life stages are considered epipelagic or semi-demersal because they exhibit a preference for mid-depth waters. Juveniles and adults inhabit mixed salinity to saline waters of 3.0 to 37 ppt and of temperatures ranging from 40.0 to 85.5 °F (4.4 to 29.7 °C). (Cross et al. 1999)

Designated Essential Fish Habitat

EFH for juveniles and adults occurs in saline and mixed saline pelagic and inshore estuaries and embayments from Massachusetts Bay to Pamlico Sound, North Carolina, as well as on the inner and outer continental shelf from southern New England to South Carolina (MAFMC and NMFS 2011). EFH for this species occurs within the James River near the Surry site based on appropriate salinity and other habitat conditions. Therefore, the juvenile and adult life stages of this species are relevant to the NRC staff's EFH analysis for the proposed action.

Diet

Butterfish feed primarily on planktonic prey, including thaliaceans, mollusks (primarily squids), crustaceans (e.g., copepods, amphipods, and decapods), coelenterates (primarily hydrozoans), polychaetes, small fishes, and ctenophores (Cross et al. 1999). Because butterfish EFH for juveniles and adults occurs in the James River near Surry, the potential effects of the proposed action on the prey of these life stages is relevant to the NRC staff's EFH analysis.

<u>Bluefish (*Pomatomus saltatrix*) – Juveniles, Adults</u>

Habitat Characteristics

Juvenile and adult bluefish inhabit pelagic waters over the continental shelf from Nantucket Island, Massachusetts, south to Key West, Florida, and all major estuaries between Penobscot Bay, Maine, and St. Johns River, Florida. Juvenile bluefish inhabit the mixing and seawater zones of North Atlantic estuaries from June through October, Mid-Atlantic estuaries from May through October, and South Atlantic estuaries from May through December. Juveniles are strongly associated with the surface and typically do not occupy waters at depth. Both the spring and summer cohorts typically occupy waters greater than 64.4 °F (18 °C), although the summer cohort exhibits higher thermal tolerances. Conversely, the spring cohort is associated with higher salinities (greater than 35 ppt) than the summer cohort (23 to 33 ppt). Adult bluefish inhabit the mixing and seawater zones of North Atlantic estuaries from June through October, Mid-Atlantic estuaries from April through October, and South Atlantic estuaries from May through January. Because the bluefish is a highly migratory species, distribution varies seasonally according to the size of the individuals comprising a particular school. Adults are present to depths of 1,312 ft (400 m) in spring and to 328 ft (100 m) in fall. Adults typically inhabit water temperatures greater than 57.2 °F (14 °C) and continental shelf salinities of greater than 25 ppt (MAFMC and NMFS 2011; Shepherd and Packer 2006).

Designated Essential Fish Habitat

EFH for juveniles and adults occurs in the mixing and seawater zones of all major estuaries between Penobscot Bay, Maine, and St. Johns River, Florida (NMFS 2019b). This includes the Chesapeake Bay estuary. However, salinity requirements for adults are not present in the James River near Surry. Therefore, only juvenile EFH is relevant to the NRC staff's EFH analysis for the proposed action.

Diet

Juvenile and adult bluefish appear to eat whatever taxa are locally abundant. In the Chesapeake Bay, oyster bar and reef habitats provide an important source of benthic prey, particularly during time periods when preferred small pelagic fish prey are less abundant (Harding and Mann 2001). Atlantic menhaden are locally important fish prey in the Chesapeake Bay estuary. During offshore residence, adults target squids, clupeids, butterfish, and other larger schooling species (Buckel et al. 1999). Because bluefish EFH for juveniles occurs in the James River near Surry, the potential effects of the proposed action on the prey of this life stage is relevant to the NRC staff's EFH analysis.

Clearnose Skate (*Raja eglanteria*) – Juveniles, Adults

Habitat Characteristics

Juvenile and adult clearnose skate inhabit subtidal benthic habitats in coastal and inner continental shelf waters from New Jersey to Cape Hatteras, including the high salinity zones (greater than 25 ppt) of the Chesapeake Bay. Both life stages are found over soft bottoms and occasionally on rocky or gravelly bottoms. Clearnose skates are present to 250 ft (76 m) inshore and to 985 ft (300 m) on the continental shelf. Within the Chesapeake Bay, juveniles and adults prefer water temperatures between 50 °F and 75.2 °F (10 °C and 24 °C). (NEFMC and NMFS 2018; Packer et al. 2003a)

Designated Essential Fish Habitat

EFH for clearnose skate occurs in the Chesapeake Bay mainstem but not within the James River (NEFMC and NMFS 2018). Because EFH does not occur in the immediate project area, no life stages of this species will be considered any further in the NRC staff's EFH analysis for the proposed action.

Diet

Clearnose skate consume polychaetes; amphipods; mysid shrimps (e.g., *Neomysis americana*), the shrimp *Crangon septemspinosa*; crabs including *Cancer* species; mud, hermit, and spider crabs; bivalves (e.g., *Ensis directus*), squids; and small fishes such as soles, weakfish, butterfish, and scup (Packer et al. 2003a). In North Carolina, Schwartz (1996) determined that clearnose skate also prey on striped anchovy (*Anchoa hepsetus*), Atlantic croaker (*Micropogonias undulatus*), spot (*Leiostomus xanthurus*), and blackcheek tonguefish (*Symphurus plagiusa*). Because clearnose skate do not consume diadromous fish, the potential effects of the proposed action on this species' prey is not relevant to the NRC staff's EFH analysis.

Windowpane Flounder (*Scopthalmus aquosus*) – Juveniles

Habitat Characteristics

Windowpane flounder juveniles and adults occur in intertidal and subtidal benthic habitats in estuarine, coastal marine, and continental shelf waters from the Gulf of Maine to northern Florida and the mixed and high salinity zones of the region's bays and estuaries, including the Chesapeake Bay. Both life stages prefer sandy or muddy substrates. In the Chesapeake Bay, juveniles commonly inhabit water depths of 20-59 ft (6-18 m) and temperatures of 57.2-78.8 °F (14-26 °C), and adults commonly inhabit water depths of 33-85 ft (10-26 m) and temperatures of 39.2-64.4 °F (4-18 °C). Both juveniles and adults tolerate salinities of 1 to 36 ppt (MAFMC and NMFS 1998).

Designated Essential Fish Habitat

EFH for juveniles and adults includes the mixing and seawater zones of major bays and estuaries from the Gulf of Maine to northern Florida, including the Chesapeake Bay. EFH for this species occurs within the James River near the Surry site based on appropriate salinity and bottom substrates. Therefore, the juvenile and adult life stages of this species are relevant to the NRC staff's EFH analysis for the proposed action.

Diet

Crustaceans (e.g., amphipods, mysids, decapods) are the primary prey of juvenile and adult windowpane flounder. Windowpane flounder also consume fish to a lesser degree, although fish become more important in the diet of larger windowpane. Known prey fish include silver hake, sand lance, cusk (*Brosme brosme*), bay anchovy, and naked goby. Because windowpane flounder EFH for juveniles and adults occurs in the James River near Surry, the potential effects of the proposed action on the prey of these life stages is relevant to the NRC staff's EFH analysis.

<u>Red Hake (*Urophycis chuss*) – Eggs, Larvae, Juveniles, Adults</u>

Habitat Characteristics

Red hake eggs and larvae occur in pelagic waters in the Gulf of Maine, on Georges Bank, and in the Mid-Atlantic bays and estuaries. Juvenile red hake inhabit intertidal and subtidal benthic habitats throughout the region described above on mud and sand substrates to a depth of 262 ft (80 m). Juveniles rely heavily on bottom habitats with depressions and biogenic complexity for shelter (e.g., eelgrass, macroalgae, shell deposits). Older juveniles often live inside bivalves. Adult red hake inhabit benthic habitats in the Gulf of Maine and outer continental shelf at depths of 164-2,460 ft (50-750 m) and as shallow as 66 ft (20 m) in inshore estuaries and embayments as far south as the Chesapeake Bay. Adults rely on shell beds, soft sediments, and artificial reefs for cover and protection (NEFMC and NMFS 2018).

Designated Essential Fish Habitat

EFH for juvenile and adult red hake occurs in the high salinity zone of the Chesapeake Bay estuary (NEFMC and NMFS 2018). Because EFH does not occur in the immediate project area, no life stages of this species will be considered any further in the NRC staff's EFH analysis for the proposed action.

Diet

Red hake larvae primarily consume copepods and other micro-crustaceans (NEFMC and NMFS 2018). Juveniles prey on small benthic and pelagic crustaceans, including larval and small decapod shrimp and crabs, mysids, euphausiids, and amphipods (NEFMC and NMFS 2018). Larger juveniles and small adult hake consume mostly decapods and gadids. Other major prey included amphipods, euphausiids, squids, and other fish (NEFMC and NMFS 2018). Because red hake do not consume diadromous fish, the potential effects of the proposed action on red hake prey is not relevant to the NRC staff's EFH analysis.

<u>Summary of Relevant EFH Species and Life Stages</u>

Based on the NRC staff's above review of habitat characteristics, designated EFH, and diets of EFH species, the NRC finds that the James River in the vicinity of the Surry site contains EFH for the following species and life stages.

- Summer flounder – larvae, juveniles, adults
- Atlantic butterfish – juveniles, adults
- Bluefish – juveniles
- Windowpane flounder – juveniles, adults

Additionally, little skate and winter skate adults consume anadromous prey that may occur in the James River in the vicinity of the Surry site. Table 3-13 summarizes this information. The NRC staff assesses the effects of the proposed action on the EFH of these species in Section 4.8, "Aquatic Resources," of this SEIS.

3.9 Historic and Cultural Resources

This section describes the cultural background and the historic and cultural resources found at Surry and in the surrounding area. The National Historic Preservation Act of 1966, as amended (NHPA) (54 U.S.C. 300101 et seq.), requires Federal agencies to consider the effects of their undertakings on historic properties. Renewing the operating license of 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 National Register of Historic Places (NRHP). The criteria for eligibility are listed in the Title 36, "*Parks, Forest, and Public Propert*y," of the *Code of Federal Regulations* (36 CFR) 60.4, "Criteria for evaluation," 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.

In accordance with 36 CFR 800.8(c), "Use of the NEPA Process for Section 106 Purposes," the NRC complies with the obligations required under National Historic Preservation Act Section 106 through its process under the National Environmental Policy Act of 1969, as amended (NEPA) (42 U.S.C. 4321 et seq.). In accordance with the provisions of the National Historic Preservation Act, the NRC is required to make a reasonable effort to identify historic properties within the area of potential effect. The area of potential effect is the 840-ac (340-ha) Surry site that may be affected by maintenance and operations activities associated with continued reactor operations during the license renewal term. The area of potential effect may extend beyond Surry property (i.e., Dominion's property at Surry) if maintenance and operations activities affect offsite historic properties. This is irrespective of land ownership or control.

If there are no historic properties within the area of potential effect or the undertaking (license renewal) would have no effect on historic properties, the NRC provides documentation of this finding to the State historic preservation officer. In addition, the NRC notifies all consulting parties, including Indian tribes, and makes this finding public (through the NEPA process) prior to 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 State historic preservation officer and any Indian Tribe that attaches religious and cultural significance to identified historic properties. The Virginia Department of Historic Resources (DHR) is responsible for administering Federal and State-mandated historic preservation programs to identify, evaluate, register, and protect Virginia's archaeological and historical resources.

3.9.1 Cultural Background

Section 2.2.9.1 of NUREG-1437, Supplement 6, describes the cultural background (history) of the Surry site, Gravel Neck Peninsula, and Hog Island (NRC 2002b: p. 2-40). A similar description is presented in Section E3.8.2 of Dominion's Environmental Report (Dominion 2018b, Section E3.8.2: pp. E-3-202 through E-3-207). This information is incorporated here by reference. No other new and significant information was identified during the environmental review, the site audit, the scoping process, or evaluation of other available information.

The Surry site, Gravel Neck Peninsula, and Hog Island hold evidence of both prehistoric and historic occupation by Native Americans and Euro-Americans. Archaeological records suggest that the Surry site and the surrounding area were potentially occupied by Native American populations during the Paleoindian Period (prior to 8000 BC), the Archaic Period (ca. 8000 BC to 1200 BC), and the Woodland Period (ca. 1200 BC to AD 1600) (Dominion 2018b, Section E3.8.2: p. E-3-202).

The northeastern portion of present-day Surry County was an early focus of colonial development in Virginia owing to its proximity to Jamestown Island. In 1608, the first English settlement at Hog Island was established by settlers from Jamestown. The principal purpose of the settlement at Hog Island was for use of the island as a natural pen for the colony's hogs (Dominion 2018b, Section E3.8.2: p. E-3-204).

Throughout much of its history, Hog Island and Gravel Neck Peninsula were reported to be forested, with little development. From the time of World War I to the present, very little additional development is noted in the Hog Island area. After World War II, Hog Island became a wildlife refuge under the jurisdiction of the Commonwealth of Virginia. Originally known as the Hog Island Waterfowl Refuge, it is currently called the Hog Island Wildlife Management Area. The Hog Island Wildlife Management Area includes all of Hog Island plus two additional tracts of land south of the Surry site (Dominion 2018b, Section E3.8.2: pp. E-3-206 and E-3-207).

As noted in the previous SEIS, construction of Surry began in the late 1960s, with Unit 1 starting commercial operation in December 1972; followed by Unit 2 in May 1973. The containment structures at Surry were purposely constructed partially below grade to reduce the visual impact of the power plant on visitors to the Jamestown Colonial National Historic Park across the river (NRC 2002b: pp. 2-42).

3.9.2 Historic and Cultural Resources at Surry

Similar to the description of the cultural history, Section 2.2.9.2 of NUREG-1437, Supplement 6, describes the survey of historic records to identify potential historic and cultural resources that may be present at the Surry site, Gravel Neck Peninsula, and Hog Island (NRC 2002b: pp. 2-42 and 2-43). A similar description is presented in Section E3.8.3 of Dominion's Environmental Report (Dominion 2018b, Section E3.8.2: p. E.3 207). This information is incorporated here by reference. No archaeological surveys were conducted of Gravel Neck Peninsula prior to construction of Surry. However, one archaeological site was subsequently identified within the site boundaries, and two other archaeological sites were identified outside and adjacent to the southern boundary of the station. The archaeological site located within the Surry site boundary was initially thought to be the location of the original Lawnes Creek Church. However, extensive testing conducted in 1967 suggests that it was a domestic house and associated well, seemingly dating to the 18th or 19th centuries. The site has not been evaluated for its eligibility for listing on the National Register of Historic Places. The two sites located outside the southern boundary of Surry appear to represent two historic brick kilns of unknown date (NRC 2002b: p. 2-43). The existence of these sites suggests that additional historic archaeological sites may be found in this area of the power station property. Constructing Surry Units 1 and 2 likely disturbed any historic and cultural material that may have been located within the power plant footprint. However, much of the surrounding area remains largely undisturbed.

An archaeological sensitivity analysis of Dominion's Surry property was completed in 2001. Its purpose was to identify portions of the property with the potential to yield archaeological material. The analysis was based on previous archaeological investigations, a review of archival and secondary historical sources, topography, and a walkover of the property. The property was divided into three zones based on the potential for cultural resources and recommendations for ground disturbance within those areas. The three zones are: no potential (disturbed land with structures); low potential – for yielding archaeological resources (near disturbed land and structures, wetland, or land with greater than 15 percent slope); and moderate to high potential – for yielding archaeological resources (undisturbed and relatively flat land) (Dominion 2018b, Section E3.8.2: pp. E-3-207).

In 2013, an area of land was surveyed for a storage building, including the building footprint, parking areas, access rounds, and underground utilities. This survey included a pedestrian survey and shovel testing. The survey revealed no cultural resources. An addendum was prepared for the report to include a new 600-ft long security border, which also revealed no cultural resources (Dominion 2018b, Section E3.8.5: pp. E-3-208).

A visual effects assessment and an underwater survey of the James River were conducted for the Surry-Skiffes Creek 500-kV transmission line project. These investigations found resources in the proximity of the Surry site, but did not identify any resources within Dominion property (Dominion 2018b, Section E3.8.5: pp. E-3-208).

Other historic properties located near Surry include prehistoric and historic era archaeological sites, historic districts, and buildings, as well as sites, structures, and objects that may be considered eligible for listing on the National Register of Historic Places. 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 National Register of Historic Places. For example, the stretch of river running along Hog Island, designated as part of the Jamestown Island-Hog Island-Captain John Smith Trail Historic District, has been determined eligible for listing in the National Register of Historic Places.

3.9.3 Procedures and Integrated Cultural Resources Management Plan

Cultural resources on the Surry site are managed and protected by Dominion's historic resources consultation guidance and cultural resources description process, which is specifically applicable to the Surry site and North Anna Power Station. The guidance document and the cultural resources description process ensure that cultural resources are protected from unauthorized disturbance and removal. The guidance protects both known and undiscovered cultural resources by establishing a step-by-step process for all activities that require a Federal permit, use Federal funding, or have the potential to impact cultural resources. (Dominion 2018b, Section E3.8.5: pp. E-3-209)

3.10 <u>Socioeconomics</u>

This section describes current socioeconomic factors that have the potential to be directly or indirectly affected by changes in power plant operations at Surry Units 1 and 2. Surry 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 Surry power plant operations depends on its ability to respond to changing environmental, social, economic, and demographic conditions.

3.10.1 Power Plant Employment

The socioeconomic region of influence is defined by the areas where Surry Units 1 and 2 workers and their families reside, spend their income, and use their benefits, thus affecting the economic conditions of the region. Dominion employs a permanent workforce of approximately 940 workers with an additional 140 temporary supplemental employees who support plant operations in rotating shifts (Dominion 2018b). Approximately 80 percent of Surry Units 1 and 2 workers reside in five independent cities and two counties in Virginia (see Table 3-14). The remaining workers are spread among 27 cities and counties in Virginia and other states, with numbers ranging from 1 to 27 workers per city or county. Because most of the Surry Units 1 and 2 workers are concentrated in Isle of Wight and Surry counties, the greatest socioeconomic effects are likely to be experienced there. The focus of the impact analysis, therefore, is on the socioeconomic impacts of continued Surry Units 1 and 2 operations on Isle of Wight and Surry counties, Virginia.

Table 3-14 Residence of Dominion Employees by County or City

County or City*	Number of Employees	Percentage of Total
Total	941	100.0
Virginia		
Chesapeake*	35	3.7
Chesterfield	33	3.5
Hampton*	37	3.9
Isle of Wight	276	29.3
Newport News*	82	8.7
Suffolk*	74	7.9
Surry	108	11.5
Williamsburg*	92	9.8
Other counties and cities	204	21.7

* Virginia independent cities.

Source: Dominion 2018b

Refueling outages occur on a staggered 18-month cycle and usually last approximately 30 days. During refueling outages, site employment typically increases by an additional 1,000 to 1,500 temporary workers (Dominion 2018b). Outage workers come from all regions of the country; however, the majority of outage workers are expected to come from Virginia.

3.10.2 Regional Economic Characteristics

Goods and services are needed to operate Surry Units 1 and 2. Although procured from a wider region, some portion of these goods and services are purchased directly from within the socioeconomic region of influence. These transactions sustain existing jobs and maintain income levels in the local economy. This section presents information on employment and income in the Surry Units 1 and 2 socioeconomic region of influence.

3.10.2.1 Regional Employment and Income

From 2010 to 2018, the labor force in the Surry region of influence increased 1.6 percent to nearly 23,000 persons. In addition, the number of employed persons increased by 6.4 percent, to approximately 22,000 persons. Consequently, from 2010–2018, the number of unemployed people in the region of influence decreased by nearly 58 percent to nearly 700 persons, or about 3 percent of the total 2018 workforce—down from 7.4 percent in 2010 (BLS 2019).

According to the U.S. Census Bureau's (USCB) 2013–2017 American Community Survey 5-Year Estimates, the educational, health, and social services industry represented the largest employment sector in the socioeconomic region of influence (approximately 21 percent) followed by manufacturing (approximately 17 percent) (USCB 2019c). These are followed by the professional, scientific, management, administrative, and waste management services industry and retail trade industry at approximately 10 percent each. A list of employment by industry in each county of the region of influence is provided in Table 3-15.

Table 3-15 Employment by Industry in the Surry Region of Influence (2013–2017, 5-Year Estimates)

Industry	Isle of Wight County	Surry County	Total	Percent
Agriculture, forestry, fishing, hunting, and mining	240	47	287	1.4
Construction	1,115	335	1,450	7.1
Manufacturing	3,097	457	3,554	17.4
Wholesale Trade	289	73	362	1.8
Retail Trade	1,638	391	2,029	9.9
Transportation, warehousing, and utilities	924	236	1,160	5.7
Information	197	11	208	1.0
Finance, insurance, real estate, rental, and leasing	905	86	991	4.8
Professional, scientific, management, administrative, and waste management services	1,964	178	2,142	10.5
Educational, health, and social services	3,670	634	4,304	21.1
Arts, entertainment, recreation, accommodation, and food services	1,102	237	1,339	6.6
Other services (except public administration)	991	192	1,183	5.8
Public administration	1,206	222	1,428	7.0
Total Employed Civilian Workers	17,338	3,099	20,437	-

Source: USCB 2019c

Estimated income information for the Surry Units 1 and 2 socioeconomic region of influence (USCB 2013–2017 American Community Survey 5-Year Estimates) is presented in Table 3-16.

Table 3-16 Estimated Income Information for the Surry Socioeconomic Region of Influence (2013–2017, 5-Year Estimates)

	Isle of Wight County	Surry County	Virginia
Median household income (dollars)[a]	67,767	54,656	68,766
Per capita income (dollars)[a]	33,172	27,162	36,268
Families living below the poverty level (percent)	7.2	10.8	7.8
People living below the poverty level (percent)	10.3	13.6	11.2

[a] In 2017 inflation-adjusted dollars

Source: USCB 2019c

3.10.2.2 Unemployment

According to the USCB's 2013–2017 American Community Survey 5-Year Estimates, the unemployment rates in Isle of Wight County and Surry County were 7.0 and 7.7 percent, respectively. Comparatively, the unemployment rate in Virginia during this same time period was 5.5 percent (USCB 2019c).

3.10.3 Demographic Characteristics

According to the 2010 Census, an estimated 442,813 people lived within 20 mi (32 km) of Surry Units 1 and 2, which equates to a population density of 352 persons per square mile (Dominion 2018b). This translates to a Category 4, "Least sparse" population density using the license renewal GEIS (NRC 1996) measure of sparseness, which is defined as "greater than or equal to 120 persons per square mile within 20 mi [32 km]." An estimated 2,296,903 people live within 50 mi (80 km) of Surry Units 1 and 2 with a population density of 292 persons per square mile (Dominion 2018b). With six communities within a 50-mile radius having populations greater than 100,000 persons, this translates to a Category 4, "Close proximity" population density, using the license renewal GEIS (NRC 1996) measure of proximity (greater than or equal to 190 persons per square mile within 50 mi (80 km)). Therefore, Surry Units 1 and 2 is in a "high" population area based on the license renewal GEIS sparseness and proximity matrix.

Table 3-17 shows population projections and percent growth from 1980 to 2060 in the two-county Surry Units 1 and 2 region of influence. Over the last several decades, Isle of Wight County has experienced an increasing population. In contrast, Surry County has experienced a more modest increasing growth rate. Based on State of Virginia forecasts and NRC staff calculated projections, the population of Isle of Wight County is projected to continue to increase at a moderate rate while the population of Surry County is projected to decrease (USCB 2019a).

Table 3-17 Population and Percent Growth in Surry Socioeconomic Region of Influence Counties 1980–2010, 2015 (Estimated), and 2020–2060 (Projected)

	Year	Isle of Wight County		Surry County	
		Population	Percent Change	Population	Percent Change
Recorded	1980	21,603	–	6,046	–
	1990	25,053	16.0	6,145	1.6
	2000	29,728	18.7	6,829	11.1
	2010	35,720	18.6	7,058	3.4
Estimated	2018	36,953	4.8	6,474	-8.3
Projected	2020	37,459	6.2	6,597	-6.5
	2030	41,640	11.2	6,545	-0.8
	2040	45,161	8.5	6,403	-2.2
	2050	49,122	8.8	6,441	0.6
	2060	52,973	7.8	6,389	-0.8

Sources: Decennial population data for 1970–2010 and estimated 2015 (USCB 2019a); projections for 2020–2040 by University of Virginia, Weldon Cooper Center for Public Service (2017); 2050–2060 calculated.

The 2010 Census demographic profile of the two-county region of influence population is presented in Table 3-18. According to the 2010 Census, minorities (race and ethnicity combined) comprised 32.5 percent of the total two-county population (USCB 2019a). The largest minority populations in the region of influence were Black or African American (28.1 percent) followed by Hispanic, Latino, or Spanish origin of any race (1.8 percent).

Table 3-18 Demographic Profile of the Population in the Surry Region of Influence in 2010

	Isle of Wight County	Surry County	Region of Influence
Total Population	**35,270**	**7,058**	**42,328**
Race (Percent of Total Population, Not Hispanic or Latino)			
White	70.8	50.8	67.5
Black or African American	24.5	45.9	28.1
American Indian and Alaska Native	0.3	0.3	0.3
Asian	0.8	0.3	0.7
Native Hawaiian and Other Pacific Islander	0.0	0.0	0.0
Some other race	0.2	0.1	0.1
Two or more races	1.5	1.4	1.5
Hispanic, Latino, or Spanish Ethnicity of Any Race			
Hispanic or Latino	658	86	744
Percent of total population	1.9	1.2	1.8

	Isle of Wight County	Surry County	Region of Influence
Minority Population (Including Hispanic or Latino Ethnicity)			
Total minority population	10,301	3,475	13,776
Percent minority	29.2	49.2	32.5
Source: USCB 2019a			

According to the Census Bureau’s 2013–2017 American Community Survey 5-Year Estimates (USCB 2019e), minority populations in the region of influence decreased slightly by approximately 40 persons since 2010, and now comprise 32.1 percent of the population (see Table 3-19). The largest changes occurred in the population of people who identify themselves as being of more than one race (which grew by nearly 500 persons since 2010, an increase of approximately 78 percent). The next largest change was an increase in the Hispanic, Latino, or Spanish origin of any race population, which grew more than 300 persons, or approximately 44 percent since 2010.

Table 3-19 Demographic Profile of the Population in the Surry Region of Influence, 2013–2017, 5-Year Estimates

	Isle of Wight County	Surry County	ROI
Total Population	**36,090**	**6,670**	**42,760**
Race (percent of total population, Not-Hispanic or Latino)			
White	70.8	52.1	67.9
Black or African American	22.3	45.6	25.9
American Indian and Alaska Native	0.3	0.0	0.2
Asian	0.8	0.4	0.8
Native Hawaiian and Other Pacific Islander	0.1	0.0	0.0
Some other race	0.0	0.1	0.0
Two or more races	3.0	0.9	2.7
Hispanic, Latino, or Spanish Ethnicity of Any Race			
Hispanic or Latino	1,013	55	1,068
Percent of total population	2.8	0.8	2.5
Minority Population (Including Hispanic or Latino Ethnicity)			
Total minority population	10,539	3,196	13,735
Percent minority	29.2	47.9	32.1
Source: USCB 2019e			

3.10.3.1 Transient Population

Within 50 mi (80 km) of Surry Units 1 and 2, colleges and recreational opportunities attract daily and seasonal visitors who create a demand for temporary housing and services. In 2018, approximately 112,000 students attended colleges and universities within 50 mi (80 km) of Surry Units 1 and 2 (NCES 2019a).

Based on the Census Bureau's 2013–2017 American Community Survey 5-Year Estimates (USCB 2019b), approximately 26,100 seasonal housing units are located within 50 mi (80 km) of Surry Units 1 and 2. Of those, 608 housing units are in the socioeconomic region of influence. Table 3-20 presents information about seasonal housing for the counties located all or partly within 50 mi (80 km) of Surry Units 1 and 2.

Table 3-20 2011–2015 5-Year Estimated Seasonal Housing in Counties Located Within 50 mi (80 km) of Surry

County	Total Housing Units	Vacant Housing Units: for Seasonal, Recreation, or Occasional Use	Percent
Total	592,426	26,091	4.4
North Carolina			
Camden	4,197	49	1.2
Currituck	15,326	3,977	25.9
Gates	5,305	75	1.4
Hertford	10,645	374	3.5
Northampton	11,654	1,352	11.6
Pasquotank	17,027	108	0.6
Virginia			
Accomack	21,243	4,685	22.1
Charles City	3,323	126	3.8
Chesterfield	127,750	403	0.3
Dinwiddie	11,655	123	1.1
Essex	5,833	686	11.8
Gloucester	16,334	675	4.1
Greensville	4,169	56	1.3
Hanover	40,325	271	0.7
Henrico	135,397	346	0.3
Isle of Wight	***15,358***	***256***	***1.7***
James City	32,357	1,618	5.0
King and Queen	3,477	261	7.5
King William	6,760	184	2.7
Lancaster	7,581	1,786	23.6
Mathews	5,736	1,393	24.3
Middlesex	7,285	2,022	27.8
New Kent	8,071	283	3.5
Northampton	7,384	905	12.3
Northumberland	9,203	2,377	25.8
Prince George	12,336	74	0.6
Richmond	3,916	207	5.3
Southampton	7,592	86	1.1

County	Total Housing Units	Vacant Housing Units: for Seasonal, Recreation, or Occasional Use	Percent
Surry	***3,545***	***352***	***9.9***
Sussex	4,145	77	1.9
York	27,497	904	3.3

Counties within 50 mi (80 km) of Surry with at least one block group located within the 50-mi (80-km) radius.
Note: ROI counties are in bold italics.

Source: USCB 2019d

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. Others may be permanent residents living near Surry Units 1 and 2 who travel from farm to farm harvesting crops.

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 underrepresented in the decennial Census population counts.

The U.S. Department of Agriculture's National Agricultural Statistics Survey conducts the Census of Agriculture every 5 years. This results in a comprehensive compilation of agricultural production data for every county in the United States. Beginning with the 2002 Census of Agriculture, farm operators were asked whether they hired migrant workers—defined as a farm worker whose employment required travel—to do work that prevented the workers from returning to their permanent place of residence the same day.

Information about both migrant and temporary farm labor (working less than 150 days) can be found in the 2017 Census of Agriculture. Table 3-21 presents information on migrant and temporary farm labor within 50 mi (80 km) of Surry Units 1 and 2.

Table 3-21 Migrant Farm Workers and Temporary Farm Labor in Counties Located Within 50 mi (80 km) of Surry (2017)

County(a)	Number of Farms with Hired Farm Labor(b)	Number of Farms Hiring Workers for Less Than 150 Days(b)	Number of Farm Workers Working for Less Than 150 Days(b)	Number of Farms Reporting Migrant Farm Labor(b)
Total	1,524	1,091	3,212	79
North Carolina				
Camden	26	15	76	1
Currituck	21	14	69	0
Gates	43	16	29	0
Hertford	55	32	93	12

County(a)	Number of Farms with Hired Farm Labor(b)	Number of Farms Hiring Workers for Less Than 150 Days(b)	Number of Farm Workers Working for Less Than 150 Days(b)	Number of Farms Reporting Migrant Farm Labor(b)
Northampton	122	94	209	1
Pasquotank	46	34	82	5
Virginia				
Accomack	118	77	250	4
Charles City	43	30	60	2
Chesterfield	27	25	111	1
Dinwiddie	111	89	239	17
Essex	29	20	40	0
Gloucester	29	23	75	1
Greensville	56	48	211	3
Hanover	161	116	402	5
Henrico	18	13	54	2
Isle of Wight	***71***	***50***	***115***	***0***
James City	25	21	109	0
King and Queen	35	27	47	0
King William	29	16	52	2
Lancaster	25	20	(c)	0
Mathews	19	14	53	0
Middlesex	30	18	54	6
New Kent	20	18	40	0
Northampton	66	53	351	8
Northumberland	36	27	57	0
Prince George	44	35	72	2
Richmond	31	17	(c)	0
Southampton	90	65	130	3
Surry	***42***	***33***	***53***	***0***
Sussex	40	22	52	4
York	16	9	27	0

(a) Counties within 50 mi (80 km) of Surry with at least one block group located within the 50-mi (80-km) radius.
(b) Table 7 (NASS 2019). Hired farm Labor – Workers and Payroll: 2017.
(c) Withheld to avoid disclosing data for individual farms.
Note: ROI counties are in bold italics.

Source: 2017 Census of Agriculture – County Data (NASS 2019)

According to the 2017 Census of Agriculture, approximately 3,200 farm workers were hired to work for less than 150 days and were employed on 1,091 farms within 50 mi (80 km) of Surry Units 1 and 2. The county with the highest number of temporary farm workers (402 workers on 116 farms) was Hanover County, VA (NASS 2019). Approximately 80 farms, in the 50-mi (80-km) radius of Surry Units 1 and 2, reported hiring approximately 1,200 migrant workers in the 2017 Census of Agriculture. Dinwiddie County, VA, had the highest number of farms (17) reporting migrant farm labor (NASS 2019).

3.10.4 Housing and Community Services

This section presents information regarding housing and local public services, including education and water supply.

3.10.4.1 Housing

Table 3-22 lists the total number of occupied and vacant housing units, vacancy rates, and median values of housing units in the region of influence. Based on the Census Bureau's 2013–2017 American Community Survey 5-year estimates (USCB 2019d), there were approximately 18,000 housing units in the region of influence, of which over 16,000 were occupied. The median values of owner-occupied housing units in the region of influence range from $249,100 in Isle of Wight County to $172,700 in Surry County. The homeowner vacancy rate also varied slightly between the two counties, from 0.9 percent in Isle of Wight County to 2.4 percent in Surry County (USCB 2019d).

Table 3-22 Housing in the Surry Region of Influence (2011–2015, 5-Year Estimate)

	Isle of Wight County	Surry County	Region of Influence
Total housing units	15,358	3,545	18,903
Occupied housing units	14,157	2,773	16,930
Total vacant housing units	1,201	772	1,937
Percent total vacant	7.8	21.8	10.4
Owner occupied units	10,939	2,110	13,049
Median value (dollars)	249,100	172,700	236,746
Owner vacancy rate (percent)	0.9	2.4	1.1
Renter occupied units	3,218	663	3,881
Median rent (dollars/month)	1,018	920	1,001
Rental vacancy rate (percent)	7.3	2.4	6.5

Source: USCB 2019d

3.10.4.2 Education

The Surry County Public School District is comprised of three public schools, with a total of 826 students in the 2016-2017 school year. These three schools include one elementary school (grades pre-kindergarten through 4), one middle school (grades 5 through 8), and one high school (grades 9 through 12). All the schools are located in the town of Dendron (NCES 2019b).

3.10.4.3 Public Water Supply

Isle of Wight County has municipal water supply systems in the towns of Smithfield and Windsor. The major water sources in the county are groundwater wells and purchased water. Overall, Isle of Wight County reported using approximately 43.79 MGD in 2010, with water use demand projected to rise to 55.00 MGD by 2040. Of this total, community water systems used approximately 2.999 MGD in 2010, with use currently projected to rise to 10.295 MGD by 2040. Small self-supplied users (under 300,000 gallons per month) used approximately 1.369 MGD in 2010, which is expected to rise to 1.900 MGD by 2040 (Dominion 2018b).

Surry County has municipal water supply systems in the towns of Surry, Dendron, and Claremont. The major water sources in the county include groundwater wells and the James River. Overall, Surry County reported using approximately 18.59 MGD in 2010, with water use demand projected to rise to approximately 18.94 MGD by 2040. Of this total, community water systems used approximately 0.135 MGD in 2010, with use currently projected to rise to 0.196 MGD by 2040. Small self-supplied users (under 300,000 gallons per month) used approximately 0.463 MGD in 2010, which is expected to rise to 0.643 MGD by 2040 (Dominion 2018b)

While population and water demand are projected to increase during the renewal term, existing water sources are expected to meet increasing needs of the population. Isle of Wight and Surry counties have enough water service capabilities to meet the needs of the public (Dominion 2018b).

3.10.5 Tax Revenues

Dominion pays annual property taxes to Surry County based on the assessed value of Surry Units 1 and 2. In 2018, Dominion Virginia, LLC paid approximately $13.3 million in property taxes to Surry County (Table 3-23). Total property tax revenues for Surry County were approximately $21.7 million in 2018. The assessed valuation of Dominion property in Surry County was approximately $1.9 billion in 2018 (Surry County 2018). As seen in Table 3-23, in 2018, Dominion's property tax payments to Surry County represented roughly 61 percent of the county's property tax revenues.

The county's total revenues from the general fund were $26.5 million for the fiscal year ending June 30, 2018. General fund revenues increased slightly by almost 2 percent, or $506,596, in fiscal year 2018. General property taxes, the largest source of revenue, were $21.7 million, including public service corporation taxes ($13.7 million), real estate taxes ($6.5 million), and personal property taxes ($1.4 million). Almost 82 percent of the county's revenue from governmental activities is derived from property taxes. The second largest local source of revenue is other local taxes, comprised primarily of local sales tax, business and vehicle licenses, utility consumption taxes, and recordation tax. Intergovernmental revenues from the State and Federal government are also included in the county total revenue (Surry County 2018).

The county's total general fund expenses of $25.1 million for fiscal year 2018 covers a wide range of services. The largest program receiving county funding was education, with 50.8 percent, or $12.76 million, in payments to the school system. This was followed by 13.1 percent, or $3.3 million, for public safety, and 9.2 percent, or $2.3 million, for health and welfare services. The remainder was expended across a variety of programs, including public works, parks, recreation, and cultural programs (Surry County 2018).

Dominion's property tax payments remained relatively consistent between 2012 and 2018, with no adjustments to payments caused by reassessments or other actions that could have resulted in notable increases or decreases. Dominion does not anticipate any future changes in tax laws, rates, assessed property value, or any other adjustments that could result in a notable future increase or decrease in property taxes or other payments to Surry County (Dominion 2018b).

Dominion also provides pass-through funds (e.g., $500,000 to $600,000) to the Commonwealth of Virginia for emergency response support (VEPC 2019d).

Table 3-23 Dominion Energy Virginia Property Tax Payments, 2012–2018

Year	Dominion Energy Virginia Property Tax Payments (in millions of dollars)	Surry County Property Tax Revenues (in millions of dollars)	Percent of County Revenue
2012	12.8	20.0	64
2013	13.2	21.0	63
2014	13.0	21.1	62
2015	12.9	21.1	61
2016	13.6	20.9	65
2017	13.5	21.7	62
2018	13.3	21.7	61

Sources: Dominion 2018b, VEPC 2019d; Surry County 2018.

3.10.6 Local Transportation

The primary road network surrounding Surry Units 1 and 2 is shown in Figures 3-1 and 3-5. A major east coast highway, Interstate 95 (I-95), which runs north to Maryland and south to North Carolina through Richmond and Petersburg, VA, traverses approximately 40 mi (60 km) west of Surry Units 1 and 2. Virginia State Route (SR) 10 runs east and west across Surry County, connecting to I-95 and I-295 between Richmond and Petersburg, VA. Further to the west, U.S. 460 provides a four-lane road corridor between Petersburg (Fort Lee) and Norfolk, VA. North of the James River, I-64 runs between the cities of Richmond and Newport News and Norfolk, VA. In addition, the Jamestown-Scotland Ferry accommodates travel between Jamestown, VA and Scotland, VA across the James River connecting to U.S. 60 and I-64 (north), and U.S. 460 (south) via SR 31.

The primary access to Surry Units 1 and 2 is from SR 650, Hog Island Road (SR 650). SR 650 intersects with SR 10 Colonial Trail (approximately 5 mi (8 km) south of the nuclear plant), which is a predominately east-west, two-lane paved road. Transportation studies show that use of SR 650 is minimal in comparison to SR 10, and traffic volume has fluctuated very little over the years. The most recent traffic volume recorded for SR 650 east of SR 10 was an average annual daily traffic count of 2,200 vehicles. An average annual daily traffic count of 4,500 was taken in 2018 on SR 10 (VDOT 2019).

Table 3-24 lists three State roads (SR 10, SR 31, and SR 650) near Surry Units 1 and 2 and 2018 Virginia Department of Transportation (VDOT) annual average daily traffic volume estimates. The average annual daily traffic values represent traffic volumes for a 24-hour period factored by both day of week and month of year.

Table 3-24 Virginia State Routes in the Vicinity of Surry: 2018 Annual Average Daily Traffic Volume Estimates

Roadway and Location	Annual Average Daily Traffic Volume Estimates
SR 10 Colonial Trail	
Town of Surry to SR 617 Bacons Castle Terrace	5,600
SR 617 Bacons Castle Terrace to Isle of Wight County Line	4,500
SR 31 Rolf Highway	
Jamestown Ferry to Town of Surry	2,100
SR 31 Rolf Highway	
SR 617 Bacons Castle Terrace to SR 650 Dead End	2,200
SR 10 Colonial Trail	650
Source: VDOT 2019_JJR	

3.11 Human Health

Surry is both an industrial facility and a nuclear power plant. Similar to any industrial facility or nuclear power plant, the operation of Surry over the subsequent license renewal 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 Surry, including from radiological exposure, chemical hazards, microbiological hazards, electromagnetic fields, and other hazards.

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 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," Dominion 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 Surry.

The Surry 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 who ensures trained and qualified workers for the program)
- Implementing Procedures
- ALARA Program to minimize dose to workers and members of the public
- Dosimetry Program (i.e., measure radiation dose of 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 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)

Regarding radiation exposure to Surry personnel, the NRC staff reviewed the data contained in NUREG-0713, Volume 39, "Occupational Radiation Exposure at Commercial Nuclear Power Reactors and other Facilities 2017: Fiftieth Annual Report" (NRC 2019d). The 50th annual report was the most recent annual report available at the time of this environmental review. It summarizes the NRC's Radiation Exposure Information and Reporting System database's occupational exposure data through 2017. Nuclear power plants are required by 10 CFR 20.2206, "Reports of individual monitoring," to report their occupational exposure data to the NRC annually. Chapter 4, "Environmental Consequences and Mitigating Actions," in this SEIS includes further discussion of radiological doses associated with the Surry subsequent license renewal.

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 Program 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 over a 1-year time period. There are no NRC or EPA standards for collective dose. Based on the data for operating pressurized-water reactors like the ones at Surry, the average annual collective dose per reactor year was 37 person-rem. In comparison, Surry had a reported annual collective dose per reactor year of 48 person-rem.

In addition, as reported in NUREG-0713, for 2017, no worker at Surry received an annual dose greater than 0.75 rem (0.0075 sievert (Sv)), which is much less than the NRC occupational dose limit of 5.0 rem (0.05 Sv) in 10 CFR 20.1201, "Occupational dose limits for adults."

Offsite dose to members of the public is discussed in Section 3.1.4, "Radioactive Waste Management Systems," of this SEIS.

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 Surry manage minor chemical spills. Chemical and hazardous wastes can potentially impact workers, members of the public, and the environment.

Dominion currently controls the use, storage, and discharge of chemicals and sanitary wastes at Surry Units 1 and 2 in accordance with its chemical control procedures, waste-management procedures, and Surry site-specific chemical spill prevention plans. Dominion monitors and controls discharges of chemical and sanitary wastes through Surry's National Pollutant Discharge Elimination System permit process. These 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 impact to workers, members of the public, and the environment (Dominion 2018b).

3.11.3 Microbiological Hazards

Thermal effluents associated with nuclear plants that discharge to a river, such as Surry, 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 microorganisms *Salmonella*, *Shigella*, *P. aeruginosa*, and *N. fowleri* during swimming, boating, or other recreational uses of freshwater. If a nuclear plant's thermal effluent enhances the growth of thermophilic microorganisms, recreational users could experience an elevated risk of exposure when using waters near the plant's discharge.

Nuclear 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. Exposure of the public to *Legionella* from nuclear plant operations is generally not a concern because *Legionella* exposure would be confined to a small area of the site within the protected area. In the case of Surry, which does not have cooling towers, human exposure to *Legionella* is very unlikely.

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 (CDC 2015). 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 2015). These bacteria grow at temperatures ranging from 77 to 113 °F (25 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). 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). The Centers for Disease Control and Prevention (CDC 2018b) reports no outbreaks or cases of waterborne *Salmonella* infection from recreational waters in the United States within the past 10 years (2009–2018). All reported *Salmonella* outbreaks during this period were associated with contaminated foods, contact with contaminated animals, or laboratory exposures (CDC 2018b).

Shigellosis infections are caused by the transmission of *Shigella* species from person to person through contaminated feces and unhygienic handling of food. Like salmonellosis, infections are more common in summer than in winter because the bacteria optimally grow at temperatures between 77 and 99 °F (25 and 37 °C) (PHAC 2011). Shigellosis outbreaks related to recreational uses of water are rare; most cases of the infection 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 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). In the past 5 years of available data (2009–2014), the Centers for Disease Control and Prevention (CDC 2018c) reported five cases of *P. aeruginosa* infection, all of which occurred in March 2012 and were associated with a private spa.

The free-living amoeba *Naegleria fowleri* prefers warm freshwater habitats and is the causative agent of human primary amebic meningoencephalitis. 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 is typically not present in waters below 95 °F (35 °C), and infections rarely occur at such temperatures (Tyndall et al. 1989). The *N. fowleri*-caused disease, primary amebic meningoencephalitis (PAM), is rare in the United States. From 1962 through 2017, the Centers for Disease Control and Prevention (CDC 2018a) reports an average of 7.3 cases of PAM annually nationwide, and 7 cases of PAM in Virginia total.

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 (Pearson 2003). *Legionella* optimally grow in stagnant surface waters with biofilms or slimes that range in temperature from 95 to 113 °F (35 to 45 °C), although the bacteria can persist in waters from 68 to 122 °F (20 to 50 °C) (Pearson 2003). As such, human infection is often associated with complex water system houses within buildings or structures, such as cooling towers (CDC 2016). Potential adverse health effects related to *Legionella* would generally not be of concern at Surry because the plant does not use cooling towers. In the past 5 years of available data (2009–2014), the Centers for Disease Control and Prevention (CDC 2018c) reported two cases of *Legionella* infection, both of which occurred in June 2014 and were associated with a private spa.

Thermophilic Microorganism Occurrence near Surry

The James River in the vicinity of Surry is a tidally influenced freshwater river upstream of Gravel Neck Peninsula and a saline estuary downstream. During late summer months, Surry's heated effluent discharge would be of sufficient temperature for the survival of thermophilic microorganisms during the later summer months. However, salinity in the region varies as the river's salt wedge moves upstream or downstream in response to tides. Thus, optimal conditions for survival of thermophilic microorganisms would depend on immediate river conditions in the area thermally influenced by the plant even within summer months.

The Virginia Department of Environmental Quality (VDEQ) limits waste heat rejected to the river through the site's VPDES permit to 12.6×10^9 Btu per hour. Although the permit does not require reporting of actual discharge temperatures, during a 5-year pre- and post-operational thermal demonstration conducted pursuant to Section 316(a) of the Clean Water Act, researchers recorded the highest surface water temperature in the Surry discharge canal on August 21, 1975, at 99.9 °F (37.7 °C).

Once Surry's heated effluent leaves the discharge canal and enters the river, mixing occurs rapidly. Dominion (Dominion 2018b) reports that temperatures decrease 1 to 2 °F (0.6 to 1.2 °C) with every 1,000 ft (300 m) from the mouth of the discharge canal and that temperatures are rarely more than 5 °F (2.8 °C) above ambient river temperatures at distances of 3,000 ft (900 m) from the discharge outfall.

In communications between Dominion and the Virginia Department of Health related to the proposed Surry license renewal, the Virginia Department of Health stated that no known risk exists, nor is risk likely given the long-term existence of the Surry discharge and the lack of known issues relating to the thermophilic microorganisms of concern on the lower James River (VDH 2019).

Within Surry's cooling water system, Dominion uses oxidizing biocides to control fouling of system components (see Section 3.1.3, "Cooling and Auxiliary Water Systems") where the thermophilic microorganism *Legionella* would most likely occur, if present (Dominion 2018b). Biocide treatments combined with Dominion's industrial hygiene practices, such as respiratory protection, minimize the potential exposure of plant workers to thermophilic microorganisms at levels that could result in infection.

3.11.4 Electromagnetic Fields

Based on its evaluation in the license renewal GEIS (NUREG-1437), 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 plants. Generally, the NRC staff also does not expect electric shock from such sources to be a human health hazard during the subsequent license renewal 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 SEIS. Transmission lines that are within the scope of the NRC's subsequent license renewal environmental review are limited to: (1) those transmission lines that connect the nuclear plant to the substation where electricity is fed into the regional distribution system, and (2) those transmission lines that supply power to the nuclear plant from the grid (NRC 2013a).

As discussed in Section 3.1.6.5, "Power Transmission Systems," of this SEIS, the only transmission lines that are in scope for Surry subsequent license renewal are onsite. Specifically, these onsite, in scope transmission lines connect Unit 1 to the onsite 230 kV switchyard and Unit 2 500-kV switchyard (Dominion 2018b). Therefore, there is no potential shock hazard to offsite members of the public from these onsite transmission lines. As discussed in Section 3.11.5, "Other Hazards," of this SEIS, Surry maintains an occupational safety program, which includes protection from acute electrical shock, and is in accordance with Occupational Safety and Health Administration regulations.

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 power line maintenance, repair work, and maintenance activities and may be exposed to potentially hazardous physical conditions (e.g., falls, excessive heat, cold, noise, electric shock, and pressure).

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.) to safeguard the health of workers. With specific regard to nuclear power plants, 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 2013c) between the NRC and OSHA. Occupational hazards are reduced when workers adhere to safety standards and use appropriate protective equipment; however, fatalities and injuries from accidents may still occur. Dominion maintains an occupational safety program for its workers in accordance with OSHA regulations (Dominion 2018b).

3.12 Environmental Justice

Under Executive Order 12898 (59 FR 7629), Federal agencies are responsible for identifying and addressing, as appropriate, disproportionately high and adverse human health and environmental impacts on minority and low-income populations. Independent agencies, such as the NRC, are not bound by the terms of EO 12898 but are, as stated in paragraph 6−604 of the Executive Order, “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), 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 Council on Environmental Quality (CEQ) provides the following information in *Environmental Justice: Guidance Under the National Environmental Policy Act* (CEQ 1997):

> 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).

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).

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 Surry Units 1 and 2 during the period of extended operation. In assessing the impacts, the following definitions of minority individuals, minority populations, and low-income population were used (CEQ 1997):

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.

<u>Minority Population</u>

According to the Census Bureau's 2010 Census data, approximately 46 percent of the population residing within a 50-mi (80-km) radius of Surry Units 1 and 2 identified themselves as minority individuals. The largest minority populations were Black or African American (approximately 34 percent), and Hispanic, Latino, or Spanish origin of any race (approximately 5 percent) (USCB 2019c).

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. This environmental justice analysis applied the meaningfully greater threshold in identifying higher concentrations of minority populations; meaningfully greater threshold is any percentage greater than the minority population within the 50-mi (80-km) radius. Therefore, for the purposes of identifying higher concentrations of minority populations, census block groups within the 50-mi (80-km) radius of Surry Units 1 and 2 were identified as minority population block groups if the percentage of the minority population in the block group exceeded 46 percent, the percent of the minority population within the 50-mi (80-km) radius of Surry Units 1 and 2.

As shown in Figure 3-31, minority population block groups (race and ethnicity) are clustered east between Williamsburg, VA, and Newport News, VA; and east-southeast of Surry Units 1 and 2 around Norfolk, VA. Based on this analysis, Surry Units 1 and 2 are not located in a minority population block group.

According to 2010 Census data, minority populations in the socioeconomic region of influence (Isle of Wight and Surry counties) comprised 32.5 percent of the total two-county population (Table 3-17). Figure 3-31 shows predominantly minority population block groups, using 2010 Census data for race and ethnicity, within a 50-mi (80-km) radius of Surry Units 1 and 2. According to the Census Bureau's 2013–2017 American Community Survey 5-Year Estimates (USCB 2019d), since 2010, minority populations in the region of influence decreased slightly by approximately 40 persons and now comprise 32.1 percent of the population (Table 3-18).

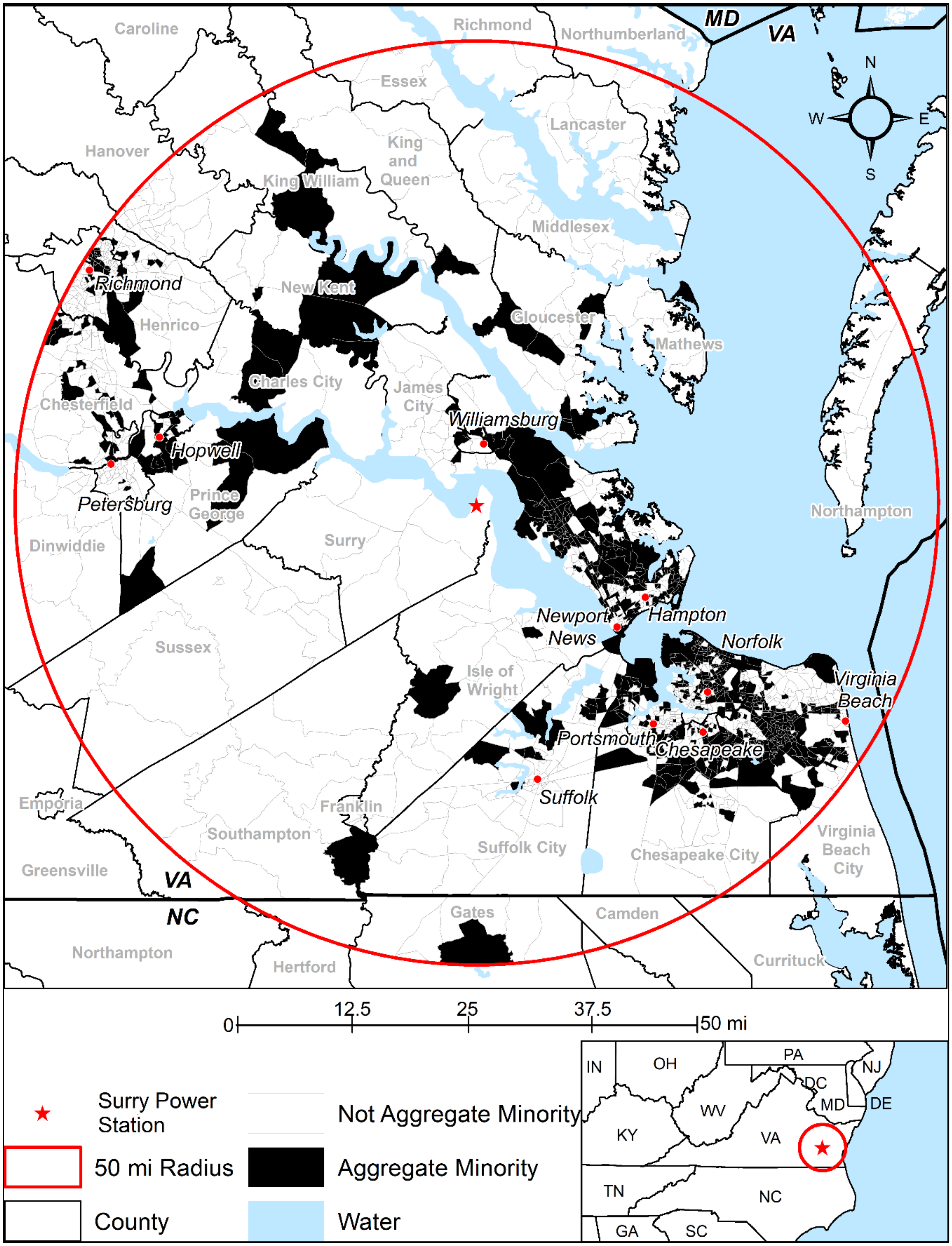
Low-Income Population

The Census Bureau's 2013–2017 American Community Survey (ACS) data identify approximately 14 percent of individuals residing within a 50-mi (80-km) radius of Surry Units 1 and 2 as living below the Federal poverty threshold in 2017 (USCB 2019e). The 2017 Federal poverty threshold was $25,094 for a family of four.

Figure 3-32 shows the location of predominantly low-income population block groups within a 50-mi (80-km) radius of Surry Units 1 and 2. Census block groups were considered low-income population block groups if the percentage of individuals living below the Federal poverty threshold within the block group exceeded 14 percent, the percent of the individuals living below the Federal poverty threshold within the 50-mi (80-km) radius of Surry Units 1 and 2.

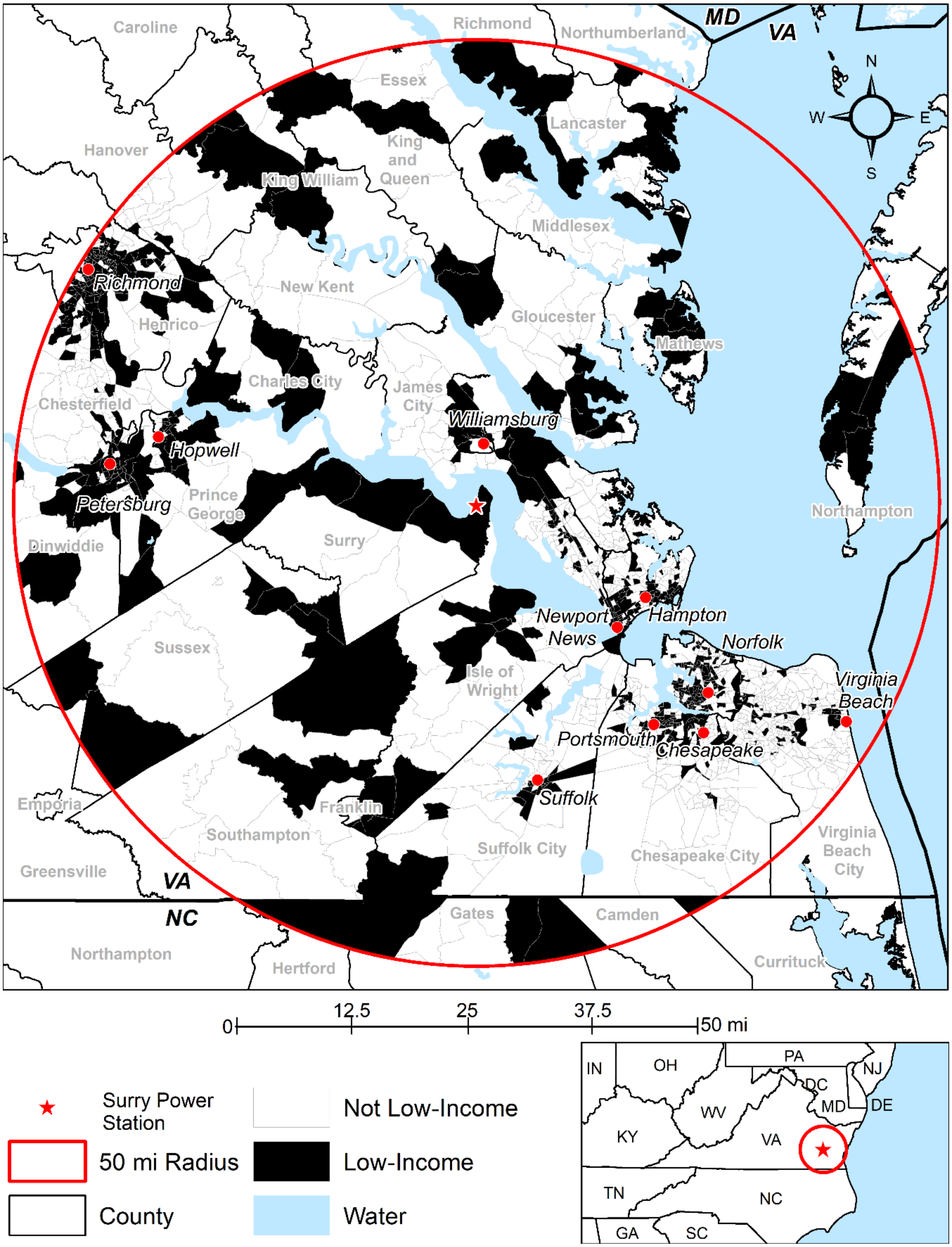
As shown in Figure 3-32, low-income population block groups are clustered east-northeast around Williamsburg, VA; west-northwest in Surry County and Petersburg, VA; and southeast of Surry Units 1 and 2 in Newport News, Hampton, and around Norfolk, VA. In addition, based on this analysis, Surry Units 1 and 2 are also located in a low-income population block group.

According to the Census Bureau's 2013–2017 American Community Survey 5-Year Estimates, 7.8 percent of families and 11.2 percent of people in Virginia were living below the Federal poverty threshold and the median household and per capita incomes for Virginia were $68,766 and $36,268, respectively (USCB 2019c). In the socioeconomic region of influence, people living in Isle of Wight County have slightly lower median household and per capita incomes ($67,767 and $33,172, respectively) than the state averages, with fewer families and people (7.2 percent and 10.3 percent, respectively) living below the poverty level. People living in Surry County also have lower median household and per capita incomes ($54,656 and $27,162, respectively) than the State averages, with 10.8 percent of families and 13.6 percent of persons living below the official poverty level (USCB 2019c).



Source: USCB 2019c

Figure 3-31 2010 Census—Minority Block Groups Within a 50-mi (80-km) Radius of Surry



Source: USCB 2019e

Figure 3-32 2011–2015, American Community Survey 5-Year Estimates—Low-Income Block Groups Within a 50-mi (80 km) Radius of Surry

3.13 Waste Management and Pollution Prevention

Like any operating nuclear power plant, Surry will produce both radioactive and nonradioactive waste during the subsequent licensing period. This section describes waste management and pollution prevention at Surry.

3.13.1 Radioactive Waste

As discussed in Section 3.1.4, "Radioactive Waste Management Systems," of this SEIS, Surry uses liquid, gaseous, and solid waste processing systems to collect and treat, as needed, radioactive materials produced as a byproduct of plant operations. Radioactive materials in liquid and gaseous effluents are reduced prior to 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 prior to 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 (42 U.S.C. § 13101 et seq.) and the Resource Conservation and Recovery Act of 1976, as amended (42 U.S.C. § 6901 et seq.) (NRC 2013a).

As described in Section 3.1.5, "Nonradioactive Waste Management System," Surry has a nonradioactive waste management program to handle nonradioactive waste in accordance with Federal, State, and corporate regulations and procedures. Surry maintains a waste minimization program that uses material control, process control, waste management, recycling, and feedback to reduce waste.

Surry has a Stormwater Pollution Prevention Plan that identifies potential sources of pollution that may affect the quality of stormwater discharges from permitted outfalls. The Stormwater Pollution Prevention Plan also describes best management practices for reducing pollutants in stormwater discharges and assuring compliance with the site's NPDES permit.

Surry also has a Pollution Incident/Hazardous Substance Spill Procedure (Dominion 2018 ER) to monitor areas within the site that have the potential to discharge oil into or upon navigable waters, in accordance with the regulations in 40 CFR Part 112, "Oil Pollution Prevention." The Pollution Incident/Hazardous Substance Spill Procedure identifies and describes the procedures, materials, equipment, and facilities that Dominion uses to minimize the frequency and severity of oil spills at Surry.

Surry is subject to the EPA reporting requirements in 40 CFR Part 110, "Discharge of Oil," pursuant to Section 311(b)(4) of the Federal Water Pollution Control Act. Under these regulations, Surry must report to the National Response Center any discharges of oil if the quantity may be harmful to the public health or welfare or to the environment. From 2012 through 2017, one inadvertent release of approximately 8 gallons of glycol-based hydraulic fluid occurred during cleaning of the Surry Unit 2 D service water intake bay. The release was reported to VDEQ and no notice of violation (NOV) resulted (Dominion 2018 ER).

Surry is also subject to the reporting provisions of the State Water Control Law §62.1-44.34:19 (Article 11). This reporting provision requires that any release of oil in a quantity of 25 gallons or greater to the environment be reported to the VDEQ, the coordinator of emergency services of the locality that could reasonably be expected to be impacted, and appropriate Federal authorities. Based on review of records from 2012−2017, one inadvertent release of approximately 8 gallons of glycol-based hydraulic fluid occurred during cleaning of the Surry Unit 2 D service water intake bay. The release was reported to VDEQ and no NOV resulted. No sheen was observed and no impact to state waters resulted (Dominion 2018 ER).

4 ENVIRONMENTAL CONSEQUENCES AND MITIGATING ACTIONS

4.1 Introduction

In this chapter, the U.S. Nuclear Regulatory Commission (NRC) staff evaluates the environmental consequences of issuing a renewed license authorizing an additional 20 years of operation for Surry Power Station, Units 1 and 2 (Surry, or Surry Units 1 and 2). The NRC staff's evaluation of environmental consequences will include the following:

- impacts associated with 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 issuing the renewed license) and replacement power alternatives (new nuclear, natural gas combined-cycle, and a combination of natural gas, solar, and demand-side management)
- impacts from the termination of nuclear power plant operations and decommissioning after the license renewal term (with emphasis on the incremental effect caused by an additional 20 years of reactor operation)
- impacts associated with the uranium fuel cycle
- impacts of postulated accidents (design-basis accidents and severe accidents)
- cumulative impacts of the proposed action of issuing a renewed license for Surry
- 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 on environmental issues related to the impacts of operation during the renewal term

In this chapter, the NRC staff also compares the environmental impacts of license renewal with those of the no-action alternative and replacement power alternatives to determine whether the adverse environmental impacts of license renewal are so great that it would be unreasonable to preserve the option of license renewal for energy-planning decisionmakers. Chapter 2 of this supplemental environmental impact statement (SEIS) describes in detail the attributes of the agency's proposed action (i.e., license renewal of Surry) and the no-action alternative. Chapter 2, Section 2.2.2, further describes the NRC staff's process for developing a range of reasonable alternatives to the proposed action including the replacement power alternatives that the staff selected for detailed analysis in this chapter, including supporting assumptions and data relied upon. As noted in Chapter 2, Table 2-1, the site location for various replacement power alternatives would be within the Surry site. Chapter 2, Table 2-2, summarizes the environmental impacts of the proposed action and alternatives to the proposed action.

The affected environment (i.e., environmental baseline) for each resource area considered, and against which the potential environmental impacts of the alternatives are measured, is described in Chapter 3. As documented in Chapter 3, the effects of ongoing reactor operations at Surry have become well established as environmental conditions have adjusted to and reflect the presence of the nuclear power plant.

As stated in Sections 1.4 and 1.5, this SEIS documents the NRC staff's environmental review of the Surry license renewal application and supplements the information provided in NUREG-1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (GEIS) (NRC 2013a). The GEIS identifies 78 issues (divided into Category 1 and Category 2 issues) to be evaluated for the proposed action in the license renewal environmental review process. Section 1.4 of this SEIS provides an explanation of the criteria for Category 1 issues (generic to all nuclear power plants) and Category 2 issues (specific to individual nuclear power plants) as well as the definitions of SMALL, MODERATE, and LARGE impact significance.

For Category 1 issues, the NRC staff can rely on the analysis in the GEIS unless otherwise noted. Table 4-1 lists the Category 1 (generic) issues that apply to Surry during the proposed license renewal period. For these issues, the NRC staff did not identify any new and significant information during its review of the applicant's environmental report (ER), the site audits, or the scoping period that would change the conclusions presented in the GEIS. Therefore, there are no impacts related to these issues beyond those already discussed in the GEIS, and accordingly, these issues are not addressed further in this SEIS. The staff's process for evaluating new and significant information is described in Section 4.14.

Table 4-1 Applicable Category 1 (Generic) Issues for Surry

Issue	GEIS Section	Impact
Land Use		
Onsite land use	4.2.1.1	SMALL
Offsite land use	4.2.1.1	SMALL
Visual Resources		
Aesthetic Impacts	4.2.1.2	SMALL
Air Quality		
Air quality impacts (all plants)	4.3.1.1	SMALL
Air quality effects of transmission lines	4.3.1.1	SMALL
Noise		
Noise Impacts	4.3.1.2	SMALL
Geologic Environment		
Geology and soils	4.4.1	SMALL
Surface Water Resources		
Surface water use and quality (non-cooling system impacts)	4.5.1.1	SMALL
Altered current patterns at intake and discharge structures	4.5.1.1	SMALL
Altered salinity gradients	4.5.1.1	SMALL
Scouring caused by discharged cooling water	4.5.1.1	SMALL
Discharge of metals in cooling system effluent	4.5.1.1	SMALL
Discharge of biocides, sanitary wastes, and minor chemical spills	4.5.1.1	SMALL
Surface water use conflicts (plants with once-through cooling systems)	4.5.1.1	SMALL
Effects of dredging on surface water quality	4.5.1.1	SMALL
Temperature effects on sediment transport capacity	4.5.1.1	SMALL
Groundwater Resources		
Groundwater contamination and use (non-cooling system impacts)	4.5.1.2	SMALL

Issue	GEIS Section	Impact
Groundwater quality degradation resulting from water withdrawals	4.5.1.2	SMALL
Terrestrial Resources		
Exposure of terrestrial organisms to radionuclides	4.6.1.1	SMALL
Cooling tower impacts on vegetation (plants with cooling towers)	4.6.1.1	SMALL
Bird collisions with plant structures and transmission lines	4.6.1.1	SMALL
Transmission line ROW management impacts on terrestrial resources	4.6.1.1	SMALL
Electromagnetic fields on flora and fauna (plants, agricultural crops, honeybees, wildlife, livestock)	4.6.1.1	SMALL
Aquatic Resources		
Entrainment of phytoplankton and zooplankton (all plants)	4.6.1.2	SMALL
Infrequently reported thermal impacts (all plants)	4.6.1.2	SMALL
Effects of cooling water discharge on dissolved oxygen, gas supersaturation, and eutrophication	4.6.1.2	SMALL
Effects of nonradiological contaminants on aquatic organisms	4.6.1.2	SMALL
Exposure of aquatic organisms to radionuclides	4.6.1.2	SMALL
Effects of dredging on aquatic resources	4.6.1.2	SMALL
Effects on aquatic resources (non-cooling system impacts)	4.6.1.2	SMALL
Impacts of transmission line ROW management on aquatic resources	4.6.1.2	SMALL
Losses from predation, parasitism, and disease among organisms exposed to sublethal stresses	4.6.1.2	SMALL
Socioeconomics		
Employment and income, recreation and tourism	4.8.1.1	SMALL
Tax revenues	4.8.1.2	SMALL
Community services and education	4.8.1.3	SMALL
Population and housing	4.8.1.4	SMALL
Transportation	4.8.1.5	SMALL
Human Health		
Radiation exposures to the public	4.9.1.1.1	SMALL
Radiation exposures to plant workers	4.9.1.1.1	SMALL
Human health impact from chemicals	4.9.1.1.2	SMALL
Microbiological hazards to plant workers	4.9.1.1.3	SMALL
Physical occupational hazards	4.9.4.1.5	SMALL
Postulated Accidents		
Design-basis accidents	4.9.1.2	SMALL
Waste Management		
Low-level waste storage and disposal	4.11.1.1	SMALL
Onsite storage of spent nuclear fuel	4.11.1.2	SMALL
Offsite radiological impacts of spent nuclear fuel and high-level waste disposal	4.11.1.3	[(a)]
Mixed waste storage and disposal	4.11.1.4	SMALL
Nonradioactive waste storage and disposal	4.11.1.4	SMALL
Uranium Fuel Cycle		
Offsite radiological impacts—individual impacts from other than the disposal of spent fuel and high-level waste	4.12.1.1	SMALL

Issue	GEIS Section	Impact
Offsite radiological impacts—collective impacts from other than the disposal of spent fuel and high-level waste	4.12.1.1	[b]
Nonradiological impacts of the uranium fuel cycle	4.12.1.1	SMALL
Transportation	4.12.1.1	SMALL
Termination of Nuclear Power Plant Operations and Decommissioning		
Termination of plant operations and decommissioning	4.12.2.1	SMALL

[a] The environmental impact of this issue for the time frame beyond the licensed life for reactor operations is contained in NUREG-2157 (NRC 2014a).

[b] 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. The Commission concludes that the collective impacts are acceptable.

The Commission concludes that the 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 should be eliminated. Accordingly, while the Commission has not assigned a single level of significance for the collective impacts of the uranium fuel cycle, this issue is considered Category 1.

Source: Table B-1 in Appendix B, Subpart A, to 10 CFR Part 51; NRC 2013aa

The NRC staff analyzed the Category 2 (site-specific) issues applicable to Surry during the proposed license renewal period and assigned impacts to these issues as shown in Table 4-2.

Table 4-2 Applicable Category 2 (Site-Specific) Issues for Surry

Issue	GEIS Section	Impact[a]
Groundwater Resources		
Groundwater use conflicts (plants that withdraw more than 100 gallons per minute)	4.5.1.2	SMALL
Radionuclides released to groundwater	4.5.1.2	SMALL
Terrestrial Resources		
Effects on terrestrial resources (noncooling system impacts)	4.6.1.1	SMALL
Aquatic Resources		
Impingement and entrainment of aquatic organisms (plants with once-through cooling systems or cooling ponds)	4.6.1.2	SMALL
Thermal impacts on aquatic resources (plants with once-through cooling systems or cooling ponds)	4.6.1.2	SMALL
Special Status Species and Habitats		
Threatened, endangered, and protected species and essential fish habitat	4.6.1.3	May affect, but is not likely to adversely affect northern long-eared bat, shortnose sturgeon, and Atlantic sturgeon. May affect, but is not likely to adversely modify

Issue	GEIS Section	Impact[a]
		designated critical habitat of the Chesapeake Bay distinct population segment of Atlantic sturgeon. No more than minimal adverse effects on essential fish habitat of the summer flounder (larvae, juveniles, and adults), Atlantic butterfish (juveniles and adults), bluefish (juveniles), and windowpane flounder (juveniles and adults) or on the prey base of the little skate (adults) or winter skate (adults)
Historic and Cultural Resources		
Historic and cultural resources	4.7.1	Would not adversely affect historic properties
Human Health		
Microbiological hazards to the public (plants with cooling ponds or canals or cooling towers that discharge to a river)	4.9.1.1.1	SMALL
Chronic effects of electromagnetic fields[b]	4.9.1.1.1	Uncertain Impact
Electric shock hazards	4.9.1.1.1	SMALL
Postulated Accidents		
Design-basis accidents	4.9.1.2	SMALL
Severe accidents	4.9.1.2	See SEIS Appendix F
Environmental Justice		
Minority and low-income populations	4.10.1	No disproportionately high and adverse human health and environmental effects on minority and

Issue	GEIS Section	Impact[(a)]
		low-income populations No disproportionately high and adverse human health impacts would be expected in special pathway receptor populations in the region because of subsistence consumption of water, local food, fish, and wildlife
Cumulative Impacts		
Cumulative Impacts	4.13	Not applicable

(a) Impact determinations for Category 2 issues based on findings described in Sections 4.2 through 4.13 for the proposed action.

(b) This issue was not designated as Category 1 or 2 and is discussed in Section 4.11.1 below.

Source: Table B-1 in Appendix B, Subpart A, to 10 CFR Part 51; NRC 2013aa

4.2 Land Use and Visual Resources

This section describes the potential land use and visual resources impacts of the proposed action (license renewal) and alternatives to the proposed action.

4.2.1 Proposed Action

As identified in Table 4-1, the impacts of all generic land use or visual resource issues would be SMALL. The NRC staff did not identify any applicable site-specific (Category 2) land use or visual resource issues, as shown in Table 4-2.

4.2.2 No-Action Alternative

4.2.2.1 Land Use

Under the no-action alternative, the NRC would not issue subsequent renewed licenses, and Surry would shut down on or before the expiration of the current renewed operating licenses in 2032 and 2033. Under this alternative, land uses would remain similar to those that would occur under the proposed subsequent license renewal except that land could be converted to other uses sooner if Surry were to shut down instead of operating for an additional 20 years. Plant structures and other facilities would remain in place until decommissioning. Most transmission lines would remain in service after the plant stops operating. Maintenance of most existing infrastructure would continue. Therefore, land use impacts from the termination of Surry Units 1 and 2 operations would be SMALL.

4.2.2.2 Visual Resources

Shutdown of Surry would not significantly change the visual appearance of the site. At the Surry site, the containment buildings are the most visible structures and they would likely remain in place for some time during decommissioning, until they are eventually dismantled. This action would reduce the visual impact. Overall, the NRC staff concludes that the impacts of the no-action alternative on visual resources would be SMALL.

4.2.3 Replacement Power Alternatives: Common Impacts

4.2.3.1 Land Use

The NRC staff's analysis of land use impacts focuses on the amount of land area that would be affected by the construction and operation of a replacement power plant.

<u>Construction</u>

Construction would require the permanent commitment of land zoned for industrial use at the Surry site for replacement power plants and associated infrastructure. Existing Surry transmission lines and infrastructure would adequately support each of the replacement power alternatives, thus reducing the need for additional land commitments.

<u>Operations</u>

Operation of new power plants 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 mining, extraction, and waste disposal activities associated with each alternative.

4.2.3.2 Visual Resources

The NRC staff's visual impact analysis focuses on the degree of contrast between the replacement power plant and the surrounding landscape and the visibility of the new power plant.

<u>Construction</u>

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

<u>Operations</u>

Visual impacts during plant operations of any of the replacement power 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 plant stacks may require aircraft warning lights, which would be visible at night.

4.2.4 New Nuclear (Small Modular Reactor) Alternative

4.2.4.1 Land Use

Construction

Approximately 50 acres (ac) (20 hectares (ha)) of previously developed and undeveloped land would be needed to construct a new small modular reactor power plant. An additional 83 ac (34 ha) may be needed to relocate existing facilities on the Surry site. Land use impacts would be SMALL at the Surry site because the land is already zoned for industrial use.

Operations

Offsite land use impacts associated with uranium mining and fuel fabrication needed to support nuclear power plant operations would generally be similar to the amount of land needed to support Surry Units 1 and 2 operations, although more land would be required for mining additional uranium for up to 40 years of operation. Based on this information, onsite and offsite land use impacts from constructing and operating a new nuclear power plant could range from SMALL to MODERATE depending on how much additional land may be needed for uranium mining and fuel fabrication.

4.2.4.2 Visual Resources

Construction and Operations

Visual impacts from a new nuclear alternative would be similar to the common impacts of all replacement power alternatives described in Section 4.2.3.2, "Visual Resources." The visual appearance of the power block for the new nuclear power plant would differ from that of the existing Surry Unit 1 and 2 power blocks. This difference is attributable to the lower profile of the mechanical draft cooling towers that would be used and that of the power block for the small modular reactor. However, the water vapor plumes that would be produced from the new mechanical draft cooling towers would add to the visual impact. In total, visual impacts during the construction and operation of a new nuclear power plant at the Surry site, including cooling tower plumes that could be visible from great distances, could range from SMALL to MODERATE depending on seasonal weather conditions.

4.2.5 Natural Gas Combined-Cycle Alternative

4.2.5.1 Land Use

Construction

The natural gas combined-cycle power plant would require 80 ac (32 ha) of land. In addition, some additional acreage would be required to construct a spur to connect the plant to an existing natural gas pipeline corridor that supplies gas to the adjacent Gravel Neck Combustion Turbines Station. No new gas wells would be needed to support the new natural gas power plant on the Surry site (Dominion 2018b). These land use impacts would be partially offset by the elimination of land used for uranium mining to supply fuel to Surry Units 1 and 2. Land use impacts caused by uranium mining and natural gas extraction and collection are described in Section 4.15.1, "Fuel Cycle."

Constructing the natural gas power plant at the Surry site would make use of available infrastructure. In addition, the land is already zoned for industrial use. However, undisturbed forested land would be converted to industrial use. Although this use of the land would be noticeable, construction would not likely destabilize adjacent land use, because of the current industrial nature of the Surry property. Accordingly, construction impacts could have SMALL to MODERATE land use impacts. This is primarily due to the amount of forested land that would be converted to industrial use under this alternative.

<u>Operations</u>

Operation of a natural gas power plant would not result in any additional land use changes; thus, land use impacts during operations would be SMALL. Overall land use impacts of the natural gas combined-cycle alternative, including both construction and operation, would therefore range from SMALL to MODERATE.

4.2.5.2 Visual Resources

<u>Construction and Operations</u>

Visual impacts from a natural gas power plant would be similar to those described in Section 4.2.3.2, "Visual Resources," for the common impacts from all replacement power alternatives. However, construction and operation of the natural gas power plant would have little to no additional visual impact. The height of the mechanical draft cooling towers and plant stack would be less than the height of Surry Units 1 and 2 reactor containment buildings. Therefore, visual impacts during the construction and operation of a new natural gas plant, including vapor plumes that could be visible from great distances, could range from SMALL to MODERATE depending on seasonal weather conditions.

4.2.6 Combination Alternative (Natural Gas Combined-Cycle, Solar, and Demand-Side Management)

4.2.6.1 Land Use

<u>Construction and Operations</u>

The natural gas power plant component of the combination alternative would affect approximately the same footprint as the full-scale natural gas power plant described in Section 4.2.5.1. The other assumptions for the natural gas component cited in Section 4.2.5.1 also apply to this alternative. As a result, the land use impacts would range from SMALL to MODERATE.

The two, offsite utility-scale solar photovoltaic (solar) facilities would require a total of approximately 5,000 ac (2,000 ha) of cleared land. Standalone solar facilities cannot be collocated with other land uses (such as grazing and crop-producing agricultural fields). Land use impacts would range from MODERATE to LARGE, depending on the amount and types of land uses that would be affected by construction of the two solar facilities.

The NRC staff did not identify any land use impacts associated with the demand-side management component of this alternative.

4.2.6.2 Visual Resources

<u>Construction and Operations</u>

Visual impacts from the natural gas and solar components of this alternative would be similar to the common impacts described in Section 4.2.3.2, "Visual Resources," for replacement power alternatives. However, construction and operation of the natural gas power plant would have no additional visual impact. Visual impacts of the natural gas component would be very similar to the impacts described in Section 4.2.5.2.

The visual impacts of the solar component of this alternative would vary, depending on location and topography. Depending on the location, standalone solar facilities could have a MODERATE to LARGE visual impact. The NRC staff did not identify any visual impacts associated with the demand-side management component of this alternative. Visual resource impacts of the combination alternative could therefore range from SMALL to LARGE. This range is primarily due to the potential visual impacts from the solar photovoltaic components of this alternative.

4.3 <u>Air Quality and Noise</u>

This section describes the potential air quality and noise impacts of the proposed action (subsequent license renewal) and alternatives to the proposed action.

4.3.1 Proposed Action

4.3.1.1 Air Quality

According to the GEIS, the generic issues related to air quality as identified in Table 4-1 would not be affected by continued operations associated with license renewal. As discussed in Chapter 3, the NRC staff identified no new and significant information for these issues. Thus, as concluded in the GEIS, the impacts of those generic issues related to air quality would be SMALL. Table 4-2 does not identify any site-specific (Category 2) air quality issues for Surry Units 1 and 2.

4.3.1.2 Noise

As identified in Table 4-1, the impacts of all generic noise issues would be SMALL. The NRC staff did not identify any applicable site-specific (Category 2) noise issues, for Surry, as shown in Table 4-2.

4.3.2 No-Action Alternative

4.3.2.1 Air Quality

Under the no-action alternative, the cessation of Surry operations would reduce overall air pollutant emissions (e.g., from diesel generators, engines, and vehicle traffic). Therefore, the NRC staff concludes that if emissions decrease, the impact on air quality from the direct shutdown of Surry would be SMALL.

4.3.2.2 Noise

The termination of reactor operations would result in a reduction in noise from activities related to plant operation, including 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 plant operations; therefore, the NRC staff concludes that impacts on noise levels from the no-action alternative would be SMALL.

4.3.3 Replacement Power Alternatives: Air Quality and Noise Common Impacts

4.3.3.1 Air Quality

Construction

Construction of a power station under a replacement power alternative would result in temporary impacts on local air quality. 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 (e.g., watering disturbed areas, reducing equipment idle times, and using ultra-low sulfur diesel fuel) could be used to minimize air emissions and to reduce fugitive dust. Air emissions include criteria pollutants (particulate matter, nitrogen oxides, carbon monoxide, and sulfur dioxide), volatile organic compounds, hazardous air pollutants, and greenhouse gases (GHGs). Small quantities of volatile organic compounds and hazardous air pollutants would also be released from equipment refueling, onsite maintenance of the heavy construction equipment, and other construction finishing activities as well as from cleaning products, petroleum-based fuels, and certain paints.

Operations

The impacts on air quality as a result of operation of a power station for a replacement power alternative would depend on the energy technology (e.g., fossil-fuel based, nuclear, or renewable). Fossil fuel-based power plants generally produce more air emissions than nuclear or renewable energy power plants. Worker vehicles, auxiliary power equipment, and mechanical draft cooling tower operation will also result in additional air emissions.

4.3.3.2 Noise

Construction

Construction of a replacement power facility would be similar to the construction of any industrial facility in that all involve many noise-generating activities. In general, noise emissions would vary during each phase of construction, depending on the level of human 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 and would generate noise at levels similar to noise levels from Surry Units 1 and 2 operations.

Operations

Noise generated during operations could include noise from mechanical draft cooling towers, transformers, turbines, machinery, equipment, and communication announcements and sirens, as well as offsite sources, such as employee and delivery vehicular traffic. Noise from vehicles would be intermittent and at levels similar to noise levels generated by vehicles at Surry. Similarly, with the exception of noise from mechanical draft cooling towers, operational noise levels at a replacement power plant, excluding solar photovoltaic facilities, would likely be similar to existing noise levels at Surry Units 1 and 2.

4.3.4 New Nuclear (Small Modular Reactor) Alternative

4.3.4.1 Air Quality

Construction

Air emissions and sources associated with construction of the new nuclear alternative would include those identified as common to all replacement power alternatives in Section 4.3.3.1, "Air Quality." Because air emissions from construction activities would be limited, local, and temporary, the NRC staff concludes that the associated air quality impacts from construction of a new nuclear alternative would be SMALL.

Operations

Operation of the new nuclear alternative would result in air emissions similar in magnitude to air emissions from the operation of Surry. Sources of air emissions would include stationary combustion sources (e.g., diesel generators, auxiliary boilers, and fire pumps) and mobile sources (e.g., worker vehicles, onsite heavy equipment, and support vehicles). Additional air emissions would result from the new nuclear plant's use of mechanical draft cooling towers (rather than the once-through cooling system currently used by Surry) and could contribute to impacts associated with the formation of visible plumes, fogging, and subsequent icing downwind of the towers. In general, most stationary combustion sources at a nuclear power plant would operate only for limited periods, often during periodic maintenance testing. A new nuclear power plant would need to secure a permit from the Virginia Department of Environmental Quality for air pollutants associated with its operations (e.g., criteria pollutants, volatile organic compounds, hazardous air pollutants, and greenhouse gases). The NRC staff expects the air emissions for combustion sources from a new nuclear plant to be similar to those currently being emitted from Surry (see Section 3.3.2, "Air Quality"). Emissions from the mechanical draft cooling towers would be approximately 7 tons/year (6 MT/year) for particulate matter less than 10 microns (NRC 2018a). Therefore, the NRC staff expects that the combined air quality impact of emissions from onsite sources would be minor. Additional air emissions would result from the approximately 1,000 employees commuting to and from the new nuclear facility. The NRC staff does not expect air emissions from operation of a new nuclear alternative to contribute to National Ambient Air Quality Standard violations. The NRC staff concludes that the impacts of operation of a new nuclear alternative on air quality would be SMALL.

4.3.4.2 Noise

<u>Construction</u>

Noise generated during the construction and operation of a new nuclear power plant would be similar to noise for all replacement power alternatives as discussed in Section 4.3.3.2, “Noise.” Noise impacts during construction would be limited to the immediate vicinity of the Surry site. Based on the temporary nature of construction activities, the distance of noise-sensitive receptors from the site, consideration of noise attenuation from the construction site, and good noise control practices, the NRC staff concludes that the potential noise impacts of construction activities from a new nuclear alternative would be SMALL.

<u>Operations</u>

Mechanical draft cooling towers generate noise during operations. Other sources of noise during nuclear power plant operations would include industrial equipment, machinery, vehicles, and communications. In general, noise would be limited to the immediate vicinity of the Surry site and, with the exception of the cooling towers, the NRC staff assumes that noise levels would be similar to or less than noise levels generated during the operation of Surry Units 1 and 2. Therefore, noise impacts during power plant operations for a small modular reactor power plant would be SMALL.

4.3.5 Natural Gas Combined-Cycle Alternative

4.3.5.1 Air Quality

<u>Construction</u>

Air emissions and sources associated with construction of the natural gas alternative would include those identified as common to all replacement power alternatives in Section 4.3.3.1, “Air Quality.” There would also be additional air emissions resulting from construction of new or upgraded pipeline that would connect to existing natural gas supply lines. Air emissions would be localized, intermittent, and short lived, 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 of relatively short duration and would be SMALL.

<u>Operations</u>

Operation of a natural gas plant would result in emissions of criteria pollutants and greenhouse gases. The sources of air emissions during operation include gas turbines through heat recovery steam generator stacks. The 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 2012). Assuming a total gross capacity of 1,930 MW and a capacity factor of 0.87 (EIA 2015b), the NRC staff estimates the following air emissions would result from operation of a natural gas alternative:

- sulfur oxides—23 tons (21 metric tons (MT)) per year
- nitrogen oxides—490 tons (450 MT) per year
- carbon monoxide—51 tons (46 MT) per year

- PM_{10}—36 tons (33 MT) per year
- carbon dioxide equivalents (CO_{2eq})—6.4 million tons (5.8 million MT) per year

Operation of the mechanical draft cooling towers and approximately 170 worker vehicles would also result in additional criteria emissions above those presented in the list. 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 (PSD) and Title V air permitting requirements under the Clean Air Act of 1970, as amended (42 U.S.C. 7651 et seq.), to ensure that air emissions are minimized and that the local air quality is not substantially degraded. Additionally, various Federal and State regulations aimed at controlling air pollution would affect a natural gas alternative.

Based on the NRC staff's air emission estimates, nitrogen oxide and greenhouse gas emissions from a natural gas plant would be noticeable and significant. Carbon dioxide emissions would be much larger than the threshold in the U.S. Environmental Protection Agency's (EPA's) Greenhouse Gas Tailoring Rule, and nitrogen oxide emissions would exceed the threshold for major sources. The NRC staff concludes that the overall air quality impacts associated with operation of a natural gas alternative would be SMALL to MODERATE.

4.3.5.2 Noise

Construction

In addition to the common impacts discussed in Section 4.3.3.2, "Noise," additional noise would be generated during the construction of a pipeline spur to support an onsite natural gas power plant. Because of the short distance to Dominion's existing pipeline corridor, noise impacts during the construction of a natural gas power plant and gas pipeline would be SMALL.

Operations

Noise generated during the operation of a natural gas power plant would include noise from mechanical draft cooling towers, compressor stations, and pipeline blowdowns. However, the majority of noise-producing equipment (e.g., mechanical draft cooling towers, turbines, pumps) would be located inside the power block. Therefore, noise impacts during power plant operations would be SMALL.

4.3.6 Combination Alternative (Natural Gas Combined-Cycle, Solar, and Demand-Side Management)

4.3.6.1 Air Quality

Construction

Air emissions and sources associated with construction of both the natural gas and solar portions of this combination alternative would include those identified as common to all replacement power alternatives in Section 4.3.3.1, "Air Quality." Air emissions from construction would be localized and intermittent, and well understood construction best management practices would mitigate air quality impacts. No air emissions would result from demand-side management initiatives. Therefore, the NRC staff concludes that construction-related impacts on air quality from the combination alternative would be SMALL.

Operations

Air emissions associated with the operation of the natural gas portion of the combination alternative would be similar to, but less than, those associated with the natural gas alternative. Assuming a total gross capacity of 1,500 MW and a capacity factor of 0.87 (EIA 2015b), the NRC staff estimates the following air emissions would result from operation of a natural gas alternative based on emission factors developed by the U.S. Department of Energy's National Energy Technology Laboratory (NETL 2012):

- sulfur oxides—18 tons (16 metric tons (MT)) per year
- nitrogen oxides—380 tons (350 MT) per year
- carbon monoxide—40 tons (36 MT) per year
- PM_{10}—28 tons (25 MT) per year
- carbon dioxide equivalents (CO_{2eq})—4.9 million tons (4.5 million MT) per year

Operation of the mechanical draft cooling towers and approximately 170 worker vehicles would also result in additional criteria emissions above those presented in the list. The new natural gas units would qualify as major emitting industrial facilities and would be subject to Prevention of Significant Deterioration and Title V air permitting programs aimed at controlling air pollution. Carbon dioxide emissions would be greater than the threshold in EPA's Greenhouse Gas Tailoring Rule, and nitrogen oxide emissions would exceed the threshold for major sources.

Air emissions associated with the operation of solar energy facilities are negligible because no fossil fuels are burned to generate electricity. Emissions from solar fields would include fugitive dust and engine exhaust emissions from vehicles and heavy equipment associated with site inspections, maintenance activities (panel washing or replacement), and wind erosion from cleared lands and access roads. The types of emission sources and pollutants during operation would be similar to those during construction, but much fewer emissions would be released during operation. These emissions should not cause exceedances of air quality standards or have any impacts on climate change. No air emissions would result from demand-side management initiatives. The NRC staff concludes that the overall air quality impacts associated with operation of the combination alternative would be SMALL to MODERATE.

4.3.6.2 Noise

Construction

Construction-related noise sources for the natural gas component of the combination alternative would be similar to the impacts discussed for the standalone natural gas alternative discussed in Section 4.3.5.2, "Noise," and the common impacts discussed in Section 4.3.3.2, "Noise," for all replacement power alternatives. Noise impacts during the construction of the two, offsite utility-scale solar photovoltaic facilities could range from SMALL to MODERATE depending on their location in proximity to noise-sensitive receptors. Therefore, overall construction impacts from the combination alternative could range from SMALL to MODERATE.

Operations

Noise generated during natural gas power plant operations would include noise from mechanical draft cooling towers, compressor stations, and pipeline blowdowns. Noise impacts during operation of the natural gas power plant component of the combination alternative would be similar to those described in Section 4.3.5.2, "Noise." Except for maintenance activities, very little noise would be generated during operations of the utility-scale solar photovoltaic facilities. Therefore, noise impacts from operations under the combination alternative would be SMALL.

4.4 Geologic Environment

This section describes the potential geology and soil resource impacts of the proposed action (subsequent license renewal) and alternatives to the proposed action.

4.4.1 Proposed Action

According to the 2013 GEIS (NRC 2013a), plant-specific environmental reviews conducted by the NRC did not identify any significant impact issues related to geology and soil resources. The NRC staff's review of the Surry subsequent license renewal application has not identified any new or significant information that would change the conclusion in the GEIS. Thus, as concluded in the GEIS, the impacts of continued operation on geology and soil resources would be SMALL.

As identified in Table 4-1, the impacts of the single geologic environment issue (geology and soils) would be SMALL. The NRC staff did not identify any applicable site-specific (Category 2) geologic environment issues, as shown in Table 4-2.

4.4.2 No-Action Alternative

Under the no-action alternative, the NRC would not issue subsequent renewed licenses and Surry Units 1 and 2 would shut down on or before the expiration of the current renewed licenses. With the shutdown of the facility, there would not be any impacts to the geology and soils at the Surry site. No additional land would be disturbed. Therefore, the NRC staff concludes that impacts on geology and soil resources from the no-action alternative would be SMALL.

4.4.3 Replacement Power Alternatives: Common Impacts

During construction, for all the replacement power alternatives, sources of aggregate material, such as crushed stone and sand and gravel, would be required to construct buildings, foundations, roads, and parking lots. The NRC staff presumes that these resources would likely be obtained from commercial suppliers using local or regional sources. Land clearing during construction and installation of power plant structures and impervious surfaces would expose soils to erosion and alter surface drainage. Best management practices (BMPs) would be implemented in accordance with applicable permitting requirements so as to reduce soil erosion. These practices would include the use of (1) sediment fencing, (2) staked hay bales, (3) check dams, (4) sediment ponds, (5) riprap aprons at construction and laydown yard entrances, (6) mulching and geotextile matting of disturbed areas, and (7) rapid reseeding of temporarily disturbed areas. Removed soils and any excavated materials would be stored onsite for redistribution such as for backfill at the end of construction. Construction impacts would be temporary and localized. Before construction, top soils would be removed, stockpiled, and stored until the sites are decommissioned. Therefore, the common impacts of construction on geology and soil resources from continued operations would be SMALL.

During operations for all the replacement power alternatives, no additional land would be disturbed. Therefore, the common impacts of operations on geology and soil resources from continued operations would be SMALL.

4.4.4 New Nuclear (Small Modular Reactor) Alternative

The NRC staff did not identify any impacts for this alternative beyond those discussed above. Therefore, NRC staff concludes that the impacts to geology and soil resources from construction and operation would be SMALL.

4.4.5 Natural Gas Combined-Cycle (NGCC) Alternative

The NRC staff did not identify any impacts for this alternative beyond those discussed above. Therefore, NRC staff concludes that the impacts to geology and soil resources from construction and operation would be SMALL.

4.4.6 Combination Alternative (Natural Gas Combined-Cycle, Solar, and Demand-Side Management)

The NRC staff did not identify any impacts for this alternative beyond those discussed above. Therefore, NRC staff concludes that the impacts to geology and soil resources from construction and operation would be SMALL.

4.5 Water Resources

This section describes the potential surface water and groundwater resources impacts of the proposed action (license renewal) and alternatives to the proposed action.

4.5.1 Proposed Action

4.5.1.1 Surface Water Resources

As identified in Table 4-1, the impacts of all generic surface water resource issues would be SMALL. According to the GEIS (NRC 1996, NRC 2013a), for the most part, no significant surface water impacts for Category 1 (generic) issues are anticipated during the license renewal term that would be different from those occurring during the current license term. The NRC staff's review of the Surry ER, the site audit, and comments during the scoping period, has not identified any new and significant information that would change the conclusion in the GEIS. Thus, as concluded in the GEIS, for these Category 1 (generic) issues, the impacts of continued operation on surface water resources would be SMALL. The NRC staff did not identify any applicable site-specific (Category 2) issues.

4.5.1.2 Groundwater Resources

According to the GEIS (NRC 1996, NRC 2013a), groundwater resources would not be significantly affected by continued operations associated with license renewal in most circumstances. As discussed in Section 3.5.2 of this SEIS, the NRC staff identified no new and significant information for applicable Category 1 issues relating to groundwater use and quality. Therefore, as identified in Table 4-1, the impacts for applicable Category 1 groundwater resources issues would be SMALL.

As shown in Table 4-2, the NRC staff identified two site-specific (Category 2) issues related to groundwater resources applicable to Surry during the license renewal term. These issues are analyzed below.

Groundwater use conflicts (plants that withdraw more than 100 gallons per minute [gpm]

The issue of "Groundwater use conflicts (plants that withdraw more than 100 gallons per minute [gpm]" is a site-specific issue, as pumping rates of this magnitude have the potential to create water consumption conflicts with nearby groundwater users. Section 3.5.2.2 of this SEIS contains a description of local and regional groundwater consumption.

This Category 2 issue is applicable to Surry. Between 2013 and 2017, the wells supplying the Surry facility and the Gravel Neck Combustion Turbines Station consumed 121 million gallons per year (mgy) (458 million liters per year (mLy)). This is approximately 230 gpm (870 liters per minute (Lpm). The site is permitted to consume 154.7 mgy (586 mLy). This is approximately 294 gpm (1,113 Lpm).

As Surry is located on a peninsula and surrounded on three sides by the James River there are few wells located near the site (see Section 3.5.2.2, "Local and Regional Water Consumption"). In addition, the water supply wells at the Surry site have been licensed by the Commonwealth of Virginia. As previously stated, as part of the permitting process, groundwater modeling of the Potomac aquifer and overlying Aquia aquifer was conducted by the Commonwealth of Virginia to evaluate the impacts on water levels and on other lawful consumers of groundwater from the water supply wells at Surry. The permitting process concluded that water-level drawdown impacts were acceptable. Groundwater restoration activities and sump pumps consume a small amount of water from fill or the Columbia and Yorktown-Eastover aquifers (see Tritium in Groundwater under Section 3.5.2.3). Therefore, groundwater use conflicts during continued operations would be SMALL.

Radionuclides Released to Groundwater

The issue of "radionuclides released to groundwater" looks at the potential contamination of groundwater from the release of radioactive liquids from plant systems into the environment. Section 3.5.2.3 of this SEIS contains a description of Surry groundwater quality and radionuclides that Surry has released into groundwater. Other than tritium, no radionuclides have been detected above background concentrations.

Tritium contamination has been detected in the groundwater in fill material and the Columbia and Yorktown-Eastover aquifers in a small area in the power block area and near the discharge canal (Figure 3-26). As the Yorktown-Eastover aquifer is underlain by approximately 100 ft (30.5 m) (Figure 3-15) of confining units, it is unlikely that tritium contamination has moved into any deeper underlying aquifers (see Section 3.5.2.3).

There is no evidence of tritium contamination in water samples obtained from the Upper Potomac aquifer. The stratigraphy and structure of the sediments that overlie the Upper Potomac aquifer should prevent tritium from reaching the aquifer. Water supply wells are located where they cannot become pathways for tritium to reach the Upper Potomac aquifer (see Section 3.5.2.3).

While tritium concentrations in groundwater are above background concentrations, they are all below the EPA established drinking water maximum contaminant level of 20,000 pCi/L. As discussed in Section 3.5.2.3, the quality of offsite groundwater aquifers and surface water bodies has not been impacted by radiological contamination in the groundwater at Surry. These water resources should continue to be unaffected over the period of license renewal. The NRC staff has concluded that over the period of extended operation, groundwater contamination will likely remain onsite and no offsite wells should be impacted.

The site has implemented a groundwater corrective action program to identify and stop leaks and is actively pumping groundwater in the power block area to reduce tritium concentrations. The monitor well system is robust enough that should future releases of tritium into the groundwater occur, they should be readily detected. Therefore, over the period of continued operations, there is little chance of significant impacts to the groundwater quality of onsite and offsite aquifers. Present and future operations at Surry are not expected to impact the quality of groundwater in any aquifers that are current or potential future sources of water for offsite users. Therefore, the NRC staff concludes that the impacts on groundwater use and quality related to radionuclide release from continued operations would be SMALL.

4.5.2 No-Action Alternative

4.5.2.1 Surface Water Resources

Under the no-action alternative, the NRC would not issue subsequent renewed licenses, and Surry would shut down on or before the expiration of the current renewed operating licenses. 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 would reduce the overall impacts on surface water use and quality. Therefore, the impact of the no-action alternative on surface water resources would remain SMALL.

4.5.2.2 Groundwater Resources

With the cessation of operations, there should be a reduction in onsite groundwater consumption 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.

4.5.3 Replacement Power Alternatives: Common Impacts

4.5.3.1 Surface Water Resources

<u>Construction</u>

Construction activities associated with replacement power alternatives may cause temporary impacts to surface water quality by increasing sediment loading to waterways. Construction activities may also impact surface water quality through pollutants in stormwater runoff from disturbed areas and excavations, spills and leaks from construction equipment, and any dredge and fill activities. These sources could potentially affect downstream surface water quality.

Construction activities might alter surface water drainage features within the construction footprints, 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.

Site construction activities would have to be conducted under a Virginia Department of Environmental Quality issued General Virginia Pollutant Discharge Elimination System permit for discharges from construction activities (VAR10) if more than 1 ac of land would be disturbed

(9 VAC 25-880). In accordance with the General Virginia Pollutant Discharge Elimination System permit for discharges from construction activities, Dominion would need to develop and implement a stormwater pollution prevention plan (SWPP) that includes erosion and sediment controls, stormwater pollution prevention, and pollution prevention practices to prevent or minimize any surface water quality impacts during construction.

To the maximum extent possible, after being refurbished, the existing Surry surface water intake and discharge infrastructure would be used. This would largely eliminate the impacts associated with the construction of new surface water intake and discharge structures. Dredging of the intake channel would be conducted under a permit from the U.S. Army Corps of Engineers (USACE) and State-equivalent permits requiring the implementation of applicable BMPs to minimize associated impacts.

For all replacement power alternatives, water would be required for potable and sanitary use by the construction workforce and for concrete production, equipment cleaning, dust suppression, soil compaction, and other miscellaneous uses depending on the replacement power alternatives. In its environmental report, Dominion (2019a) assumes that water use for these purposes would be trucked in by the construction contractor or supplied by groundwater wells.

<u>Operation</u>

The thermoelectric power generating components of the replacement power alternative would use closed-cycle cooling with mechanical draft cooling towers. Makeup water would be obtained from the James River. 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 plants because of evaporative and drift losses during cooling tower operation (NRC 2013a). Surface water withdrawals would be subject to the Virginia Water Protection Permit Program (9 VAC 25-210). In addition, closed-cycle cooling systems typically require chemical treatment. Specifically, cooling towers commonly require biocide injections to control biofouling (NRC 2013a). As brackish water from the James River would be used, the water would require other chemical additives for corrosion control and scale buildup in plant systems.

Residual concentrations of these chemical additives would be present in the cooling tower blowdown discharged to receiving waters, such as the James River, under all thermoelectric power alternatives. Chemical additions would be accounted for in the operation and permitting of liquid effluents. Effluent discharges from the thermoelectric power generation components would be subject to Virginia Pollutant Discharge Elimination System permit requirements for the discharge of wastewater and industrial stormwater to state waters. A stormwater pollution prevention plan and associated best management practices and procedures, along with VPDES requirements, would help reduce surface water quality impacts during operation of a replacement power alternative.

4.5.3.2 Groundwater Resources

<u>Construction</u>

For all the replacement power alternatives, construction water would be obtained from onsite groundwater or from offsite sources. There is also likely to be a need for groundwater dewatering during excavation and construction. Pumped groundwater removed from excavations would be discharged in accordance with appropriate State and local permits.

The application of best management practices in accordance with a Commonwealth of Virginia Pollutant Discharge Elimination System general permit, including an appropriate waste management, water discharge, and stormwater pollution prevention plan as well as spill prevention practices, would prevent or minimize groundwater quality impacts during construction. These groundwater impacts would be short lived. Therefore, the NRC staff concludes that the common impacts from construction on groundwater resources would be SMALL.

Operation

For all the replacement power alternatives, the NRC staff assumes that during operations, potable water and any water for various plant systems would be obtained from onsite wells. Any groundwater withdrawals would be subject to applicable State water appropriation and registration requirements. Therefore, the NRC staff concludes that the common impacts from the consumption of groundwater resources would be SMALL.

4.5.4 New Nuclear (Small Modular Reactor) Alternative

4.5.4.1 Surface Water Resources

The hydrologic and water quality assumptions and implications for construction and operations described in Section 4.5.3.1 as common to all replacement power alternatives also apply to this alternative. Additionally, deep excavation work required to construct the nuclear island could require groundwater dewatering (NRC 2019c). Water pumped from excavations would be managed and discharged in accordance with VPDES requirements. Therefore, the staff expects that dewatering would not impact surface water quality.

During operations, the closed-cycle cooling would withdraw approximately 53 mgd (200,000 m^3/d) of makeup water, with consumptive use of 37 mgd (140,000 m^3/d). This would be greater but comparable to Surry's estimated consumptive rate of 22,500 gpm (50 cfs; 32 mgd). Consumptive water use for this is equivalent to about 1 percent of the James River's annual average discharge.

Based on this analysis, the NRC staff concludes that the overall impacts on surface water resources from construction and operations under the new nuclear alternative would be SMALL.

4.5.4.2 Groundwater Resources

The NRC staff did not identify any impacts on groundwater resources for this alternative beyond those discussed above as common to all replacement power alternatives. Therefore, the NRC staff concludes that the impacts on groundwater resources from construction and operation of a new nuclear power plant would be SMALL.

4.5.5 Natural Gas Combined-Cycle (NGCC) Alternative

4.5.5.1 Surface Water Resources

The hydrologic and water quality assumptions and implications for construction and operations described in Section 4.5.3.1 as common to all replacement power alternatives also apply to this alternative. Additionally, a spur line would be required to connect to the existing pipeline corridor that supplies the adjacent Gravel Neck Combustion Turbines Station. Stream or wetland crossings could be necessary. However, water quality impacts would be minimized by the application of BMPs and by compliance with the General Virginia Pollutant Discharge Elimination System permit and U.S. Army Corps of Engineers permits that regulate construction of the spur in waterways and wetlands.

Operation of a natural gas alternative using closed-cycle cooling would withdraw approximately 10 mgd (38,000 m^3/d) and consumptive water use would be 7.9 mgd (30,000 m^3/d). This would be less than Surry's estimated consumptive rate of 22,500 gpm (50 cfs; 32 mgd).

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.

4.5.5.2 Groundwater Resources

The NRC staff did not identify any impacts on groundwater resources for this alternative beyond those discussed above as common to all replacement power alternatives. Therefore, the NRC staff concludes that the impacts on groundwater resources from construction and operation of a new nuclear power plant would be SMALL.

4.5.6 Combination Alternative (Natural Gas Combined-Cycle, Solar, and Demand-Side Management)

4.5.6.1 Surface Water Resources

The hydrologic and water quality assumptions and implications for construction and operations described in Section 4.5.3.1 as common to all replacement power alternatives also apply to this alternative.

Construction and operation impacts from the natural gas component of the combination alternative would be similar to those discussed for the natural gas only alternative. Construction of the solar component of this alternative has substantial land requirements to support solar panels and roads. Large volumes of water would be needed for dust control, soil compaction, or concrete preparation. The solar PV facilities would be located within the region of influence (ROI) with access to Dominion's transmission system. Installation of utility scale solar facilities would also require construction of access roads and possibly transmission lines. During operation, there would be no direct use of surface water and no industrial waste water effluents would be produced. Solar PV facilities do require small amounts of water to clean solar PV panels. 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 this analysis, the NRC staff concludes that the overall impacts on surface water resources from construction and operation of the combination alternative would be SMALL

4.5.6.2 Groundwater Resources

The NRC staff did not identify any impacts on groundwater resources for this alternative beyond those discussed above as common to all replacement power alternatives. Therefore, the NRC staff concludes that the impacts on groundwater resources from construction and operation of a new nuclear power plant would be SMALL.

4.6 Terrestrial Resources

This section describes the potential impacts to terrestrial resources from the proposed action (subsequent license renewal) and alternatives to the proposed action.

4.6.1 Proposed Action

As identified in Table 4-1, "Applicable Category 1 (Generic) Issues for Surry," the impacts of all generic terrestrial resource issues would be SMALL. Table 4-2 identifies only one site-specific (Category 2) issue related to terrestrial resources during the Surry subsequent license renewal term: Effects on terrestrial resources from non-cooling system impacts. This issue is analyzed below. The Surry site uses a once-through cooling system to remove waste heat from the reactor steam electric system and plant auxiliary (service water) systems (Dominion 2018│ER, p. E-2-4) and does not utilize cooling ponds or cooling towers (Dominion 2018│ER, p. E-4-37). Therefore, the Category 2 issue identified in the GEIS related to the effects of water use conflicts with terrestrial resources is not applicable.

Category 2 Issue Related to Terrestrial Resources: Effects on Terrestrial Resources (Non-cooling System Impacts)

According to the GEIS, non-cooling system impacts on terrestrial resources can include those impacts that result from site and landscape maintenance activities, stormwater management, elevated noise levels, and other ongoing operations and maintenance activities that would occur during the license renewal period on and near a plant site. The NRC staff based its analysis in this section on information derived from Dominion's ER (Dominion 2018│ER) unless otherwise cited. Dominion has not identified any refurbishment activities during the proposed subsequent relicensing term (Dominion 2018│ER, p. E-4-39). No further analysis of potential impacts from refurbishment activities is therefore necessary.

Dominion (Dominion 2018│ER, p. E-4-39) indicates that it expects to continue ongoing operational and maintenance activities at the Surry site throughout the subsequent relicensing term. According to Dominion, operational and maintenance activities at the site might include maintenance and repair of plant infrastructure such as roadways, piping installations, fencing, and other security infrastructure. Dominion states that these operational and maintenance activities would be confined to previously disturbed areas. 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 not encroach into wetlands or into the remaining areas of mixed pine-hardwood forest. The NRC staff agrees with Dominion that the anticipated activities would have only minimal effects on terrestrial resources.

Dominion indicates that it has administrative controls in place at the Surry site to ensure that operational changes or construction activities are reviewed, and that environmental impacts are minimized through implementation of BMPs, permit modifications, or acquisition of new permits as needed. Dominion further states that the site is currently subject to regulatory programs regarding issues such as stormwater management, spill prevention, dredging, and herbicide usage that further serve to minimize impacts to terrestrial resources (Dominion 2018 | ER, p. E-4-39). The NRC staff agrees with Dominion that continued adherence to environmental management practices and BMPs already established for the Surry site would continue to be protective of terrestrial resources over the course of the SLR operational period.

Operational noise extends from the Surry facilities into the remaining natural areas on the Surry site and nearby offsite lands on the Gravel Neck Peninsula, including the diverse upland and wetland habitats of the Hog Island Wildlife Management Area (WMA). Waterfowl and other wildlife using the tidal wetlands and coastal forests on the James River shoreline could also be exposed to noise emanating from Surry operation. Surry is the only industrial noise source on the Gravel Neck Peninsula and therefore likely the only major source of noise affecting the subject habitats, including these in the Hog Island WMA. However, the subject habitats have been exposed to similar operational noise levels since Surry was constructed more than 45 years ago. The NRC staff therefore expects that wildlife in the affected habitats has long ago acclimated to the noise and human activity of Surry operations and adjusted its behavior patterns accordingly. Extension of existing operational noise levels over the SLR period is therefore unlikely to noticeably change current patterns of wildlife movement or habitat usage.

Based on the NRC staff's independent review, the staff concludes that the landscape maintenance activities, stormwater management, elevated noise levels, and other ongoing operations and maintenance activities that Dominion might undertake during the renewal term would primarily be confined to already disturbed areas of the Surry 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 Surry site. Accordingly, the NRC staff concludes that non-cooling system impacts on terrestrial resources from non-cooling system activities during the subsequent relicensing term would be SMALL.

4.6.2 No-Action Alternative

Under the no-action alternative, the NRC would not issue a renewed license, and Surry would shut down on or before the expiration of the current facility operating license. Much of the operational noise and human activity at Surry would cease, reducing disturbance to wildlife in forest cover and other natural vegetation on and near the site. Some continued maintenance of the Surry site would however still be necessary; thus, at least some human activity, noise, and herbicide application would still be necessary 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 license renewal term would be SMALL.

4.6.3 Replacement Power Alternatives: Common Impacts

Each of the replacement power alternatives would make use mostly of the previously developed or disturbed lands on the Surry site but would still require limited expansion of the development footprint into some of the forest and other naturally vegetated habitats that surround the existing facilities. Expansion of the development footprint, whether to build new SMR facilities or a new NGCC plant, could result in the permanent loss of up to 70 ac (28 ha) of forest and 0.5 ac (0.2 ha) of non-tidal wetlands. Encroachment into the forest cover immediately north of the existing Surry facilities could also reduce the availability of habitat for forest-interior birds. The combination alternative would also involve building solar PV cells on undeveloped lands on an unspecified tract off the Surry site and involve an indeterminate loss of offsite forest and wetlands.

Removing forest cover on the Surry site would involve the loss of wildlife habitat and reduce the available forest capable of buffering other nearby wildlife habitat, including Hog Island WMA, from operational noise and human activity. 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, but implementation of appropriate BMPs and revegetation of temporarily disturbed lands would minimize impacts.

In the GEIS (NRC 2013), the NRC staff concluded that terrestrial impacts from operation of nuclear and fossil-fueled plants would be similar and would include cooling tower salt drift, noise, bird collisions with plant structures and transmission lines, impacts connected with herbicide application and landscape management, and potential water use conflicts connected with cooling water withdrawals. The applicability of this conclusion is however limited, because the existing Surry nuclear facilities use once-through cooling with no cooling towers, whereas new SMRs or a new NGCC plant would instead use new cooling towers. Alternatives involving fossil fuel use (the NGCC and combination alternatives) would also expose terrestrial habitats and wildlife to air emissions of criteria pollutants. Additional impacts to terrestrial resources under the NGCC and combination alternatives could occur from offsite extraction of natural gas.

4.6.4 New Nuclear (Small Modular Reactor) Alternative

Dominion (Dominion 2018│ER, p. E-7-31) indicates that the new SMRs would be built in an area of approximately 50 ac (20 ha) between the existing nuclear units and the ISFSI, a land area that presently comprises a mix of developed and undeveloped land. Dominion also indicates that some existing buildings in the affected area may have to be relocated, thereby disturbing other forested areas on the Surry site. For purposes of analysis, the NRC staff assumes that building the SMRs would disturb as much forest as would building a NGCC unit under the NGCC alternative. As indicated below in Section 4.6.5, Dominion (Dominion 2018│ER) estimates that building the NGCC plant would require clearing and permanent loss of as much as 66 ac (27 ha) of mature mixed pine-hardwood forest. The NRC staff therefore assumes that the forest loss would be no more than 70 ac (28 ha). There may be some loss in habitat for some State-listed species and for forest-interior birds.

There are no data on the extent of wetlands in the affected lands. For purposes of analysis, the NRC staff is assuming that building the SMRs would impact wetlands to the same extent described for the NGCC alternative. Dominion estimates that building the NGCC would permanently disturb approximately 0.31 ac (0.13 ha) of non-tidal wetlands and 757 linear ft of ephemeral stream channel (Dominion 2018 │ER, p. E-7-27). The NRC staff therefore assumes that the wetland loss would be no more than 0.5 ac (0.2 ha) of non-tidal wetlands, all or some of which may be forested. Dominion would have to perform wetland delineations of affected lands and apply for permits for any wetland fill from the U.S. Army Corps of Engineers and the Virginia Department of Environmental Quality. The NRC staff expects that any Federal or State permits authorizing wetland impacts would require mitigation. Wetland losses of this magnitude can typically be mitigated through various forms of compensatory wetland mitigation, such as mitigation banks.

The NRC staff recognizes that the affected acreage provides habitat for the wildlife characterized in Section 3.6 of this SEIS and some of the important species characterized in Section 3.6.3. As noted by Dominion (Dominion 2018│ER, p. E-7-18), loss of forest cover on the Surry site influences localized wildlife migration patterns, and construction noise could affect wildlife in adjoining forested areas and wetlands, including the Hog Island WMA. The construction noise would be of a different character than the operational noise of Surry and may therefore affect wildlife that has acclimated to existing noise levels.

Dominion states that no new transmission lines would have to be built in connection with the new SMRs (Dominion 2018│ER, p. E-7-4). The NRC staff therefore expects that there would therefore be no increased potential in wildlife injury from transmission lines. However, Dominion notes that building the cooling towers necessary to operate the SMRs would introduce new, taller structures to the landscape and could result in avian (bird) collisions (Dominion 2018│ER, p. E-7-18). Additionally, some bats, including bats of the federally and State-listed species noted in Section 3.6.4, could collide with the towers and die. However, the NRC staff expects that bird and bat populations would become accustomed to the presence of the towers and avoid them. Once the SMRs are built, operational impacts to terrestrial resources would likely remain as expected for the proposed action. Based on the preceding analysis, the NRC staff concludes that impacts to terrestrial resources from the SMR option would be MODERATE, primarily because of the loss of forested habitat and wetlands close to the Hog Island WMA.

4.6.5 Natural Gas Combined-Cycle Alternative

Terrestrial impacts from the NGCC alternative would generally be as described above for the SMR alternative. Dominion (Dominion 2018│ER, p. E-7-13 and p. E-7-18) indicates that the new NGCC plant would be built on approximately 66 ac (27 ha) of forested land in undeveloped areas of the Surry site. For purposes of analysis, the NRC staff assumes that building the new NGCC plant would result in the permanent clearing and loss of as much as 70 ac (28 ha) of mixed pine-hardwood forest on the site. The NRC staff recognizes that the affected acreage provides habitat for the wildlife characterized in Section 3.6.2 of this SEIS and some of the important species characterized in Section 3.6.4. As noted by Dominion (Dominion 2018│ER, p. E-7-18), loss of the forest cover could influence localized wildlife migration patterns, and construction noise could affect wildlife in adjoining forested areas and wetlands, including the Hog Island WMA. The construction noise would be of a different character than the operational noise of Surry and may therefore affect wildlife that has acclimated to existing noise levels.

There are no data on the extent of wetlands in the affected lands. Dominion estimates that building the NGCC would permanently disturb approximately 0.31 ac (0.12 ha) of non-tidal wetlands and 757 linear ft (231 linear m) of ephemeral stream channel (Dominion 2018 │ER, p. E-7-27). The NRC staff therefore assumes that the wetland loss would be no more than 0.5 ac (0.2 ha) of non-tidal wetlands, all or some of which may be forested. Dominion would have to perform wetland delineations of affected lands and apply for permits for any wetland fill from the U.S. Army Corps of Engineers and Virginia Department of Environmental Quality. The NRC staff expects that any Federal or State permits authorizing wetland impacts would require mitigation. Wetland losses of this magnitude can typically be mitigated through various forms of compensatory wetland mitigation, such as mitigation banks.

Dominion notes that building the cooling towers necessary to operate the NGCC plant would introduce new, taller structures to the landscape and could result in avian (bird) collisions (Dominion 2018│ER, p. E-7-18). Additionally, some bats, including bats of the federally and State-listed species noted in Section 3.6.4, could collide with the towers and die. However, the

NRC staff expects that bird and bat populations would become accustomed to the presence of the towers and avoid them. Once the NGCC plant is built, operational impacts to terrestrial resources would likely remain as expected for the proposed action. Based on the preceding analysis, the NRC staff concludes that impacts to terrestrial resources from the NGCC alternative would be MODERATE, primarily because of the loss of forested habitat and wetlands close to the Hog Island WMA.

4.6.6 Combination Alternative (Natural Gas Combined-Cycle, Solar, and Demand-Side Management)

Terrestrial impacts from building the NGCC plant as part of this alternative would be as described for the NGCC alternative. However, terrestrial impacts from the combined alternative would also include impacts to offsite land needed to build the solar PV cells. Dominion has estimated that building the solar PV cells would require the use of 560 ac (226 ha) of land on two unspecified offsite parcels (Dominion 2018 | ER, p. E-7-41). Dominion suggests that part of the offsite land may comprise previously disturbed land but does not quantify how much, if any, forest clearing would result. Based on its knowledge of the landscape surrounding the Surry site, the NRC staff estimates that it may be possible to build at least half of the solar PV cells on land already cleared of forest for agriculture or other past uses. To be conservative, however, the NRC staff estimates that half of the affected land (280 ac) (113ha) would be forested (mixed pine-hardwood forest or hardwood forest). The total forest loss for the combination alternative would therefore be as much as 350 ac (142 ha), including 70 ac (28 ha) for the NGCC plant and 280 ac (113 ha) for the solar PV cells.

Dominion provided no information on the extent of wetlands that would have to be disturbed to build the solar PV cells. The USACE and VDEQ would likely require Dominion to configure the solar PV cells on the landscape to minimize wetland encroachment. Based on its understanding of the surrounding landscape, the NRC staff estimates that building the solar PV cells may require the temporary disturbance of up to 5 ac (2 ha) of non-tidal wetlands and up to 5,280 linear ft (1609 m or 1 mi) of stream channel plus the permanent filling and loss of as much as 5 additional ac (2 ha) of non-tidal wetlands and as much as 5,280 additional linear ft (1609 m or 1 mi) of stream channel. The USACE and VDEQ are unlikely to approve filling tidal wetlands for a non-water dependent action such as building solar PV cells. For conservatism, the NRC staff assumes that the affected wetlands are all forested. The total wetland impact for the combination alternative would therefore be as much as 10.5 ac (4.2 ha), including 0.5 ac (0.2 ha) for the NGCC plant and 10 ac (4 ha) for the solar PV cells. Wetland losses of this magnitude can typically be offset through various forms of compensatory wetland mitigation, such as mitigation banks.

The NRC staff expects that the affected habitats both on and off the Surry site provide habitat for the wildlife characterized in Section 3.6.2 of this SEIS and some of the important species characterized in Section 3.6.4. As noted by Dominion (Dominion 2018 | ER, p. E-7-18), loss of the forest cover could influence localized wildlife migration patterns, and construction noise could affect wildlife in adjoining forested areas and wetlands, including the Hog Island WMA. The potential wildlife impacts for the combination alternatives would be substantially greater than for the other alternatives because of the substantially greater area of land affected to build the solar PV cells.

Dominion notes that building cooling towers necessary to operate the NGCC plant would introduce new, taller structures to the landscape and could result in avian (bird) collisions (Dominion 2018 | ER, p. E-7-18). Additionally, some bats, including bats of the federally and

State-listed species noted in Section 3.6.4, could collide with the towers and die. However, the NRC staff expects that bird and bat populations would become accustomed to the presence of the towers and avoid them. Dominion does not indicate whether new transmission lines would have to be built to serve the solar PV cells, but considering the network of existing transmission infrastructure in the regional landscape, the NRC staff expects that impacts from building any required transmission lines would be minimal.

Once the NGCC plant is built, operational impacts on the Surry site to terrestrial resources would likely remain as expected for the proposed action, but there would be a greater potential for operational impacts from the solar PV cells. Although the operational impacts of solar PV cells on wildlife are not well understood, the NRC staff acknowledges the possible increased risk of injury to birds and other volant (flying) wildlife such as bats. Concerns have been raised regarding the possible injury of birds flying close to large concentrations of solar PV cells (Upton 2014). Three main sources of avian injury from solar PV cells have been identified: impact trauma, solar flux (injury from reflection), and predation (whereby solar PV cells concentrate prey, easing its consumption by predators) (Kagan et al. 2014).

Based on the preceding analysis, the NRC staff concludes that impacts to terrestrial resources from the combination alternative would be MODERATE, primarily because of the loss of forested habitat and wetlands. A contributing consideration is the uncertainty over possible injury to birds, bats, and other volant wildlife from the operation of solar PV cells. The potential impacts would be greater than for the proposed action, SMR, or NGCC alternatives.

4.7 Aquatic Resources

This section describes the potential impacts of the proposed action (license renewal) and alternatives to the proposed action on aquatic resources.

4.7.1 Proposed Action

As identified in Table 4-1, “Applicable Category 1 (Generic) Issues for Surry,” the impacts of all generic aquatic resource issues would be SMALL. Table 4-2, “Applicable Category 2 (Site-Specific) Issues for Surry,” identifies two site-specific (Category 2) issues that could affect aquatic resources during the proposed license renewal term. These issues are analyzed below.

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

For plants with once-through cooling systems or cooling ponds such as Surry, the NRC has determined in the GEIS (NRC 2013a) that impingement and entrainment of aquatic organisms is a Category 2 issue that requires site-specific evaluation. In 2002, the NRC evaluated the impacts of the initial Surry 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 determined that the impacts of continued operation of Surry would be SMALL during the initial license renewal term (i.e., 2012-2032 for Unit 1 and 2013-2033 for Unit 2) (NRC 2002b). In 2013, the NRC issued Revision 1 of the GEIS (NUREG-1437) (NRC 2013a). In the revised GEIS, the staff combined the two aquatic issues into a single site-specific issue: “impingement and entrainment of aquatic organisms (plants with once-through cooling systems or cooling ponds).” This section evaluates this consolidated issue as it applies to continued operation of Surry during the proposed subsequent license renewal term (i.e., 2032-2052 for Unit 1, and 2033-2053 for Unit 2).

Impingement occurs when organisms are trapped against the outer part of a screening device of an intake structure (79 FR 48299). The force of the intake water traps the organisms against the screen, and they are unable to escape. Impingement can kill organisms immediately or contribute to later mortality resulting from exhaustion, suffocation, injury, and other physical stresses. The potential for injury or death is generally related to the amount of time an organism is impinged, its susceptibility to injury, and the physical characteristics of the screen wash and fish return systems of the plant. The U.S. Environmental Protection Agency (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 48299). Because impingeable organisms are typically fish with fully formed scales and skeletal structures and well-developed survival traits, such as behavioral responses to avoid danger, many impinged organisms can survive under proper conditions (79 FR 48299).

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 48299). Organisms susceptible to entrainment are of smaller size than those susceptible to impingement. Such organisms include ichthyoplankton (fish eggs and larvae), 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). Because entrainable organisms generally consist of fragile life stages (e.g., early larvae, which lack a skeletal structure or swimming ability, and eggs, which exhibit poor survival after interacting with a cooling water intake structure), the EPA has concluded that for purposes of assessing the impacts of a cooling water intake system on the aquatic environment, all entrained organisms die (79 FR 48299).

A species can be susceptible to both impingement and entrainment if several life stages occupy the waterbody from which a plant's intake draws cooling water. For instance, the adults and juveniles of a given species of fish may be impinged against the screens, while larvae and eggs may be entrained. The susceptibility to either impingement or entrainment ultimately relates to the size of the individual and the size of the mesh on the cooling water intake system's screening device. The EPA considers aquatic organisms that can be collected or retained on a sieve with 0.56-inch (1.4-cm) diagonal openings to be susceptible to impingement (79 FR 48299). This opening size equates to 1/2-inch by 1/4-inch (1.3-cm by 0.635-cm) rectangular mesh openings, which is slightly larger than the openings on the typical 3/8-inch square mesh found at many power plants. Organisms smaller than the 0.56-inch (1.4-cm) mesh are considered susceptible to entrainment.

The magnitude of impacts on the aquatic environment resulting from impingement and entrainment depends on plant-specific characteristics of the cooling system (e.g., location of the plant intake, intake velocities, withdrawal volumes, screen technologies, and presence or absence of a fish return system) as well as characteristics of the local aquatic community (e.g., species present in the region, population abundance and distributions, life history characteristics, conservation status, and management objectives).

<u>Baseline Condition of the Resource</u>

For the purposes of its impingement and entrainment analysis, the NRC staff assumes that the baseline condition of the resource is the James River aquatic community as it occurs today. The current community is a complex network of species tolerant of the tidal influence of the Chesapeake Bay estuary and capable of inhabiting the transitional region between the freshwater tidal river upstream and the saline waters of the estuary proper downstream. Section 3.7.5, "Aquatic Community of the Lower James River," of this SEIS characterizes the aquatic community in detail. While species richness, evenness, and diversity within the community may change or shift between now and when the proposed subsequent license renewal period would begin (i.e., 2032 for Unit 1, and 2033 for Unit 2), the NRC staff finds the aquatic community as it occurs today to be a reasonable surrogate in the absence of fishery- and species-specific projections for the James River.

Analysis Approach

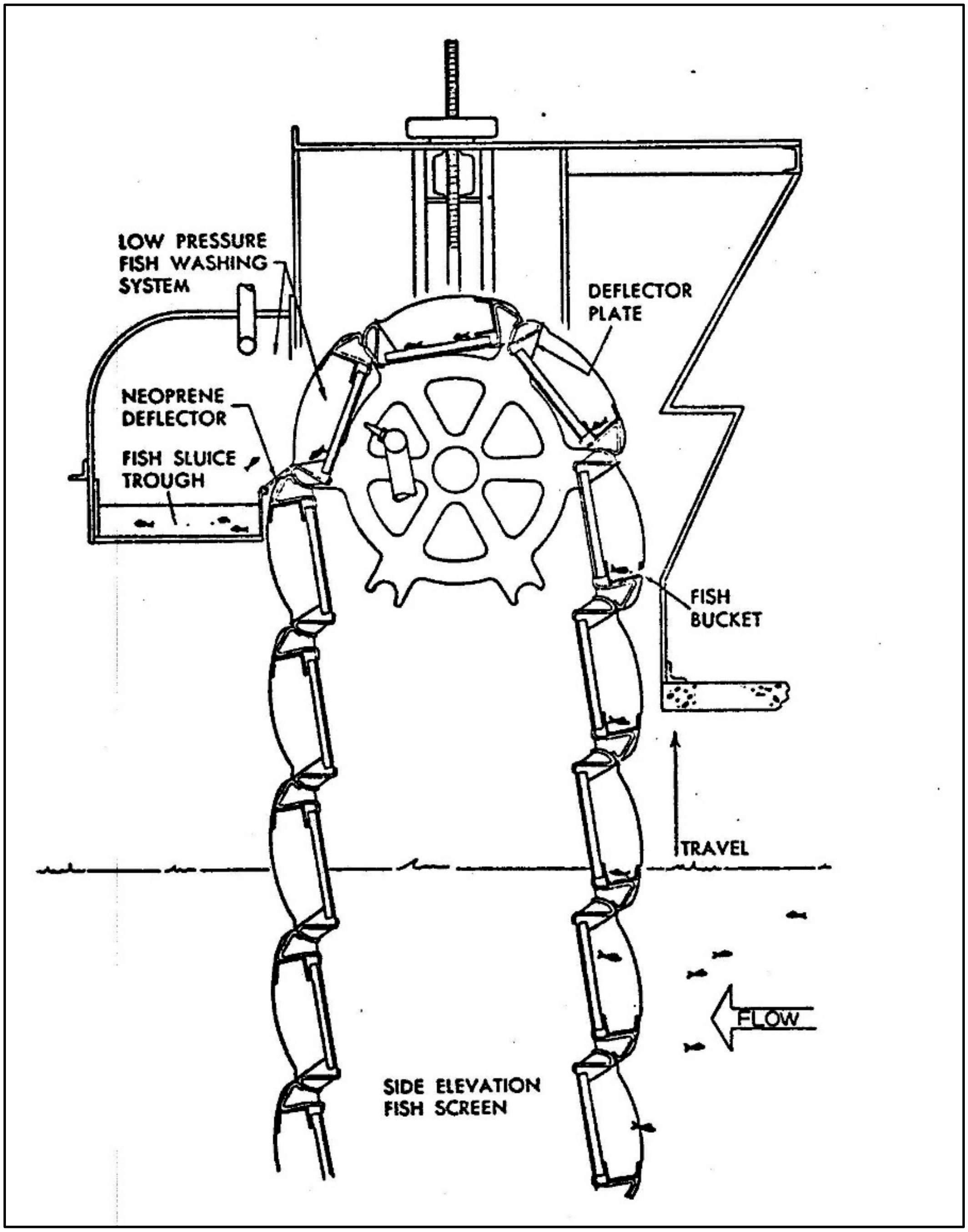
Below, the NRC staff analyzes the potential impacts of impingement and entrainment during the proposed Surry license renewal term using a weight of evidence approach. In this approach, the staff considers multiple lines of evidence to assess the presence or absence of ecological impairment (i.e., noticeable or detectable impact) on the aquatic environment. The lines of evidence that the NRC staff considers are the cooling water intake system design, the results of impingement and entrainment studies performed at Surry, and trends in fish and shellfish population abundances. The staff then considers these lines of evidence together to predict the level of impact that the aquatic environment is likely to experience over the course of the proposed subsequent license renewal term (i.e., through 2052 for Unit 1, and through 2053 for Unit 2).

Cooling Water Intake System Design

Aquatic organisms may be impinged or entrained as Surry's cooling water intake system withdraws water from the James River for use in the plant's cooling and auxiliary water systems. James River water first interacts with Surry's cooling water intake structure through a dredged channel in the river bed at River Mile (RM) 29 (River Kilometer (RKM) 47). Water flows through this channel and into a low-level intake structure that lies parallel to and flush with the western shore of the river on the east side of the Gravel Neck Peninsula. At the low-level intake structure, the James River is approximately 3 mi (4.8 km) wide and 26 ft (8 km) deep and flows in a generally southerly direction (HDR 2016a). As Surry withdraws river water, fish and other aquatic organisms that cannot swim fast enough to escape the flow of water may be swept into the intake. Intake flow is 0.98 fps (0.3 m/s) at the low-level intake structure trash racks, and the through-rack velocity is 1.12 fps (0.34 m/s) (HDR 2016b). Thus, organisms within the source water that are incapable of resisting or escaping this flow rate are drawn into the intake structure along with the flow of water.

Once within the intake structure, organisms encounter Ristroph traveling screens made of 1/8-inch (0.32-cm) by 1/2-inch (1.3-cm) mesh with 0.53-inch (1.34-cm) diagonal openings (HDR 2017). Organisms small enough to pass through the traveling 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 James River along with heated effluent via Surry's discharge canal. During this process, entrained organisms are subject to mechanical, thermal, and toxic stresses.

Organisms that are too large to pass through the traveling screen mesh, such as juvenile and adult fish and shellfish, become impinged on the screens. Low-pressure sprays wash impinged organisms and other debris off the screens and into steel fish buckets. The screens continuously rotate at a low speed such that the average residence time of an impinged organism on the screens is less than 3 minutes (Dominion 2018b). Screen operators can manually increase the screen rotation rate when fish abundance is high or river levels are low to reduce the residence time of organisms on the screens to 90 seconds or less (HDR 2017). Once organisms are washed into the steel buckets, the buckets release the organisms into a single return trough, which transports both organisms and debris back to the river through a discharge canal located approximately 1,000 ft (300 m) south of the intake structure and 300 ft (91 m) from the shoreline (HDR 2017). Section 3.1.3, "Cooling and Auxiliary Systems," of this SEIS describes Surry's cooling and auxiliary water systems in more detail. Figure 4-1 depicts Surry's fish return system.



Source: VEPC 1980

Figure 4-1 Surry Fish Return System

The EPA has determined that certain approaches or cooling water intake structure technologies at power generating facilities can reduce or minimize impingement mortality and entrainment. These approaches are: (1) flow reduction and (2) installation of technologies or operation in a manner that either gently excludes organisms or collects and returns organisms without harm (79 FR 48299). Although not available to all facilities, two other approaches to reducing impingement and entrainment are: (3) relocating the facility's intake to a less biologically rich area in a waterbody and (4) reducing the intake velocity (79 FR 48299). The NRC staff evaluates the Surry cooling water intake system design against these approaches below.

Flow Reduction

Flow reduction is where a facility installs a technology or operates in a manner to reduce or eliminate the quantity of water being withdrawn (79 FR 48299). Reducing the volume of water removed from the aquatic environment produces a corresponding reduction in impingement mortality and entrainment because entrainment and impingement (and associated mortality) is generally proportional to the source water intake volume.[1] Some common flow reduction technologies include variable frequency drives and variable speed pumps, seasonal operation or seasonal flow reductions, unit retirements, use of alternate cooling water sources, water reuse, and closed-cycle cooling systems (79 FR 48299).

Surry employs one of the above flow reduction technologies: variable frequency drives and variable speed pumps. Surry's cooling water intake system includes eight circulating water pumps (four pumps per unit), each of which can pump up to 220,000 gpm (13.8 m^3/s) for a combined maximum design flow of 2,534.4 MGD (1,760,000 gpm or 111 m^3/s) (Dominion 2018b). Dominion varies pump operation in response to power generation demand and unit maintenance activities rather than to specifically reduce impingement and entrainment. For instance, Dominion may vary pumping when ambient river water temperatures are colder (and therefore capable of dissipating more heat), or when one or both of Surry's units are operating at less than full power. Such reductions in intake flow effectively reduce impingement and entrainment during these periods.

The EPA estimates that facilities could achieve a 5 to 10 percent reduction in flow simply through intermittent water withdrawals (79 FR 48299). Assuming proportionality, this would equate to a 5 to 10 percent reduction in impingement and entrainment. Dominion has performed no calculations specific to Surry to estimate the percent reduction in impingement and entrainment that is likely achieved from typical or average pump use versus maximum (i.e., 100 percent) pump capacity. The Surry VPDES permit (VDEQ 2016) also does not require Dominion to vary pump operation seasonally or otherwise. Nonetheless, the NRC staff finds that variable pump operation likely reduces impingement and entrainment at Surry to some degree. However, the level of reduction attributable to this operational approach has not been quantified and likely varies year-to-year.

Gentle Exclusion or Collection and Return of Organisms Without Harm

Exclusion technologies divert organisms that would have otherwise been subject to impingement and entrainment away from the intake. Collection and return technologies allow

[1] Impingement rates are related to intake flow, intake velocity, and the swimming ability of the fish subject to impingement. Entrainment is generally considered to be proportional to flow and therefore a reduction in flow results in a proportional reduction in entrainment assuming that entrainable organisms are uniformly distributed throughout the source water (79 FR 48299).

organisms to be impinged, but these technologies collect and return those organisms to the source water, thereby reducing or preventing impingement mortality. Collection and return technologies do not affect entrainment.

Surry's cooling water intake system includes a fish return system that returns impinged fish to the James River, as described previously in this section and depicted in Figure 4-1. The system includes continuously rotating Ristroph traveling screens, low-pressure spray washes, steel fish buckets, and a return trough. These components collectively reduce mortality of impinged fish and shellfish to an estimated 2.03 percent and result in a higher than expected survival rate of fragile finfish species, as described below.

The Virginia Electric and Power Company (VEPCO) commissioned the Virginia Institute of Marine Sciences (VIMS) to perform a multi-year impingement study at Surry from May 1974 through May 1978, as described in detail below under "Impingement Studies." As one component of the study, VIMS researchers investigated impingement survival. The researchers found that 94.4 percent of all fish impinged on the traveling screens during the sampling period were returned alive to the James River (VEPC 1980). Of the 73 impinged species, 61 exhibited a survival rate exceeding 90 percent, and 68 exhibited a survival rate exceeding 80 percent. The five species with lower than 80 percent survival rates were: hickory shad (*Alosa mediocris*), spotted seatrout (*Cynoscion nebulosus*), Atlantic Spanish mackerel (*Scomberomorus maculatus*), blackcheek tonguefish (*Symphurus plagiusa*), and Atlantic cutlassfish (*Trichiurus lepturus*), none of which were collected with regularity in the study. Notably, many species exhibited a 100 percent survival rate. Only one species, the Atlantic cutlassfish, exhibited a survival rate of less than 70 percent. This species, which was represented by only two individuals over the 4.5 years of sampling, exhibited zero survival. In terms of sheer numbers, most of the fish that did not survive impingement were comprised of only a few species, all of which were also among the most commonly impinged species over the study period. These included bay anchovy (*Anchoa mitchilli*) (21.3 percent of all dead fish), blueback herring (*Alosa aestivalis*) (20.0 percent), Atlantic menhaden (*Brevoortia tyrannus*) (16.3 percent), threadfish shad (*Dorosoma petenense*) (13.2 percent), and spot (8.3 percent). VIMS also investigated delayed mortality (with recovery periods up to 96 hours) and found no significant differences between instantaneous and delayed mortality rates.

During a more recent impingement study conducted from August 2015 through July 2016, HDR Engineering, Inc. (HDR 2017) collected initial impingement survival data for the first 10 minutes of impingement sample processing during 4-hour sampling periods. Each fish or shellfish was classified into one of four categories: live undamaged, live damaged, fresh dead, or dead decaying. Live undamaged individuals represented the most likely to survive impingement after being returned to the source water, although some percentage of live damaged individuals (i.e., those that were alive but had evidence or indication of abrasion or laceration) likely also survived impingement following return to the source water. HDR Engineering calculated impingement survival for each taxon using its impingement survival sampling data in combination with other information (i.e., fragility of the species, understanding of typical species/group hardiness, data from nearby power plants, and best professional judgment) in cases where data were lacking.

HDR Engineering (HDR 2017) determined that 56 of the 70 taxa impinged at Surry during the 2015–2016 study exhibited an impingement survival rate of 70 percent or greater. Species most susceptible to impingement mortality included inland silverside (*Menidia beryllina*), dusky pipefish (*Syngnathus floridae*), Atlantic menhaden, and Atlantic cutlassfish. Consistent with the 1974–1978 study, Atlantic cutlassfish appeared in small numbers (four individuals) over the sampling period and again exhibited zero survival. By sheer numbers, most impingement mortality was of blue crab (*Callinectes sapidus*), Atlantic menhaden, Atlantic croaker, white perch (*Morone americana*), and gizzard shad (*Dorosoma cepedianum*). These species collectively accounted for 83 percent of all estimated impingement mortality (finfish and shellfish combined). As explained in further detail below in this section under "Best Technology Available Standard for Impingement Mortality," the NRC staff calculated an overall mortality rate of 2.03 percent of the total number of organisms impinged at Surry under maximum design intake flow (i.e., 100 percent power operation). This impingement mortality equates to an annual maximum mortality of 1,813,894 organisms, of which 1,326,165 (73 percent) are finfish and 487,729 (27 percent) are shellfish, assuming 365 days of maximum design intake flows. While HDR Engineering's impingement survival results among the various taxa differed from the VIMS's results, HDR Engineering did not explain any likely reasons for this variation. The NRC staff was unable to independently determine possible explanations for these differences because water withdrawal volumes, plant operating status, and other relevant data that would make comparisons between the two studies possible were lacking.

Nonetheless, many of the fragile finfish species exhibit higher than expected impingement survival rates at Surry in both studies. The EPA defines "fragile species" as those fish and shellfish that are least likely to survive any form of impingement (40 CFR 125.92). Fragile species have a documented survival rate of less than 30 percent and include, but are not limited to, alewife (*Alosa pseudoharengus*), American shad, Atlantic menhaden, bay anchovy, blueback herring, bluefish (*Pomatomus saltatrix*), butterfish, gizzard shad, gray snapper (*Lutjanus griseus*), and hickory shad (79 FR 48299). All fragile species collected in Surry impingement studies have exhibited higher than 30 percent survival. Table 4-3 shows impingement survival rates observed during the 1974–1978 and 2015–2016 studies for each of the fragile species. Alewife, blueback herring, gizzard shad, and gray snapper exhibited high survival rates in both studies: 70 percent or more of individuals of these species are expected to survive impingement at Surry based on 2015–2016 impingement sampling data. American shad and hickory shad both exhibited moderate survival. Bay anchovy and Atlantic menhaden exhibited the lowest survival at 50.1 and 40.1 percent, respectively, in the 2015-2016 study. Two additional fragile species, bluefish and butterfish, may occur in the salinity mixing zone of the James River. However, researchers collected neither species in impingement mortality samples.

Table 4-3 Impingement Mortality of Fragile Species at Surry, 1974–1978 and 2015–2016

Species[(a)]	Estimated Annual Impingement (No. Fish)[(b)]	Impingement Survival (%)	
		1974–1978[(c)]	**2015–2016[(d)]**
bay anchovy	67,029,316	83.6	50.1
Atlantic menhaden	1,234,679	95.1	40.1
blueback herring	1,104,321	89.9	83.1
gizzard shad	703,277	97.1	74.7
alewife	30,512	93.3	80.0
American shad	13,867	94.0	69.0
gray snapper	2,800	100.0	100.0
hickory shad	2,112	77.8	69.0

(a) The EPA defines "fragile species" as those fish and shellfish that are least likely to survive any form of impingement (40 CFR 125.92).

(b) Estimated annual impingement assumes design intake flows (i.e., 100 percent power operation of both units) for the full 12-month period, as reported in HDR 2017, Table 4-14.

(c) As reported in VEPC 1980, Table 25.

(d) As reported in HDR 2017, Table 4-11.

Location of the Facility Intake in a Less Biologically Rich Area

If a facility withdraws cooling water farther from shore, at greater depths, or otherwise in a less biologically productive area of the source water, impingement and entrainment may be less than if the facility were to withdraw water from elsewhere in the waterbody. In many waterbodies, cooling water withdrawal from shoreline locations can result in greater environmental impact because shoreline areas are typically the most biologically productive waters and contain a high density of early life stage organisms. The lowest potential for impingement and entrainment is often at far offshore locations at distances of several hundred feet (79 FR 48299). Although offshore areas may exhibit a lower density of organisms, the species found will also change as a function of the distance of the intake from the shoreline and the depth of the intake within the water column. Thus, the assemblage of impingeable and entrainable organisms, in addition to the sheer number of impingeable and entrainable organisms, changes with distance from the shoreline.

Surry withdraws cooling water from a location within the James River that exhibits a biologically rich assemblage of juvenile and adult finfish. Because Surry lies at the transitional zone between the tidally influenced freshwater river upstream and the saline estuary downstream, freshwater, estuarine, and marine fishes may all be found in the river near the facility depending on season and salinity conditions. The local finfish community includes permanent residents that occur year-round and diadromous species that pass through the region seasonally during migrations to and from spawning grounds. Local aquatic surveys, such as those described in Section 3.7.5, "Aquatic Community of the Lower James River," report high species richness. For instance, during the 2015−2016 impingement study, researchers collected 61 distinct taxa of finfish (HDR 2017). In addition to salinity, the river's wide bed, which is approximately 3 mi (5 km) wide at Gravel Neck Peninsula where Surry is located, extensive shallow (less than 6 ft (1.8 m)) areas on both the upstream and downstream sides of the peninsula, and diverse substrates, which include soft mud, clay, sand, and pebbles, further support the diverse local fish community. Thus, the location of Surry's intake structure alone is unlikely to minimize or mitigate impingement of juvenile and adult finfish.

In contrast, local ichthyoplankton, plankton, and benthic invertebrate diversity is typically low. Eggs and larvae of only five species were collected in ichthyoplankton sampling conducted in 2005–2006: bay anchovy, naked goby (*Gobiosoma bosc*), Atlantic croaker, Atlantic silverside, and blue crab (EA Engineering 2006). Plankton and benthic invertebrate biomass is low in comparison to both upstream and downstream reaches of the river (Jordan et al. 1977; Dominion 2001b; HDR 2017). Because water depth at the low-level intake structure is 26 ft (8 m), which is deeper than the level at which the navigation channel in the middle of the river is maintained (24.9 ft (7.6 m)), early life stages of aquatic organisms would not be expected to be present in higher densities in the immediate vicinity of the intake than elsewhere in the river. However, as described below under "Entrainment Study Results," entrainment samples taken from in front of the low-level intake structure have yielded relatively high species diversity. While only a few species have dominated each of the entrainment study periods, the sheer diversity of taxa collected across the studies indicates that many entrainable organisms of a variety of species are present near Surry's intake. Thus, the location of Surry's intake alone is unlikely to minimize or mitigate entrainment of early life stages fish and shellfish.

Reduction of the Intake Velocity

Reduction of the intake velocity affords motile organisms the opportunity to escape impingement by swimming away from the intake structure. While this approach can be very effective in reducing impingement and associated mortality, it has no effect on entrainment.

The NRC staff assumes that motile organisms occurring within the James River near Surry are capable of navigating water with velocities at least as high as those that would naturally be experienced in the river. Tides dictate the river's natural water flow: average maximum flood and ebb tidal currents are 1.9 fps (0.58 m/s) and 2.23 fps (0.68 m/s), respectively (HDR 2017). Surry's low-level intake structure draws water at a rate of 0.98 fps (0.3 m/s) in front of the trash racks and 1.12 fps (0.34 m/s) through the trash racks (HDR 2016b). Thus, Surry withdraws water at a rate low enough that fish, shellfish, and other motile organisms should generally be capable of swimming against the intake velocity and escaping impingement. Therefore, Surry's intake velocity likely reduces impingement and entrainment as compared to if the facility were to withdraw water at a rate exceeding the river's natural tidal flows.

Cooling Water Intake System Design Conclusion

Based on the above comparison of Surry's cooling water intake design with EPA-identified approaches and technologies to reduce or minimize impingement mortality and entrainment, the NRC staff finds that Dominion employs three approaches in its operation of Surry. These approaches are: flow reduction, gentle exclusion or collection and return of organisms without harm, and reduction in intake velocity. Although the amount or extent to which these approaches affect impingement mortality and entrainment has not been specifically quantified, these approaches likely reduce the potential impact on the local aquatic community to some measurable degree. The EPA's fourth approach, location of the facility intake in a less biologically rich area, does not reduce either impingement mortality or entrainment because Surry withdraws cooling water from the biologically rich transitional zone of the James River inhabited by a diverse assemblage of freshwater, estuarine, and marine organisms.

Impingement Study Results

As the second line of evidence, the NRC staff considered the results of impingement studies. Two studies have been undertaken at Surry: VIMS, on behalf of VEPCO, conducted the first study in 1974–1978, and HDR Engineering, on behalf of Dominion, conducted the second study in 2015–2016. This section summarizes each study and compares the results with the EPA's best technology available (BTA) standards for impingement mortality at existing facilities to evaluate the significance of impingement in the local aquatic community.

Impingement Sampling, 1974–1978

From May 1974 through May 1978, VIMS researchers performed daily (Monday through Friday) impingement sampling at Surry (VEPC 1980). Researchers conducted two consecutive 5-minute sampling events each sampling day for a total of 146 samples. During sampling events, personnel diverted fish impinged on the low-level intake structure's Ristroph traveling screens to a holding pool for inspection and identification. VIMS used total counts and other sample data to estimate daily, weekly, and annual fish impingement and survival, among other factors influencing impingement. Notably, researchers only collected finfish data during this study, whereas later studies collected finfish and shellfish data. Paired with its impingement sampling effort, VIMS conducted ambient fish sampling and entrainment sampling. Section 3.7.5.3, "Adult and Juvenile Fish," of this SEIS describes ambient fish sampling results. Entrainment sampling results are described later in this section.

In total, VIMS researchers collected 136,624 fish representing 73 species and 39 families during the sampling period (VEPC 1980). The most abundantly collected species was spot, which accounted for 21.7 percent of the estimated total number of impinged fish. Together with spot, Atlantic menhaden (18.5 percent), blueback herring (11.2 percent), threadfin shad (10.9 percent), and bay anchovy (7.3 percent) collectively accounted for 70 percent of all estimated fish impinged. Most impinged fish were young-of-the-year or juveniles and ranged from 2.7–3.7 inches (55–94 mm) in total length except for bay anchovy, which is a small-sized adult fish. Figure 4-2 depicts the composition of taxa comprising 2 percent or more in impingement samples, and Table 4-5 lists the estimated annual impingement that VIMS calculated for each taxon collected during the study.

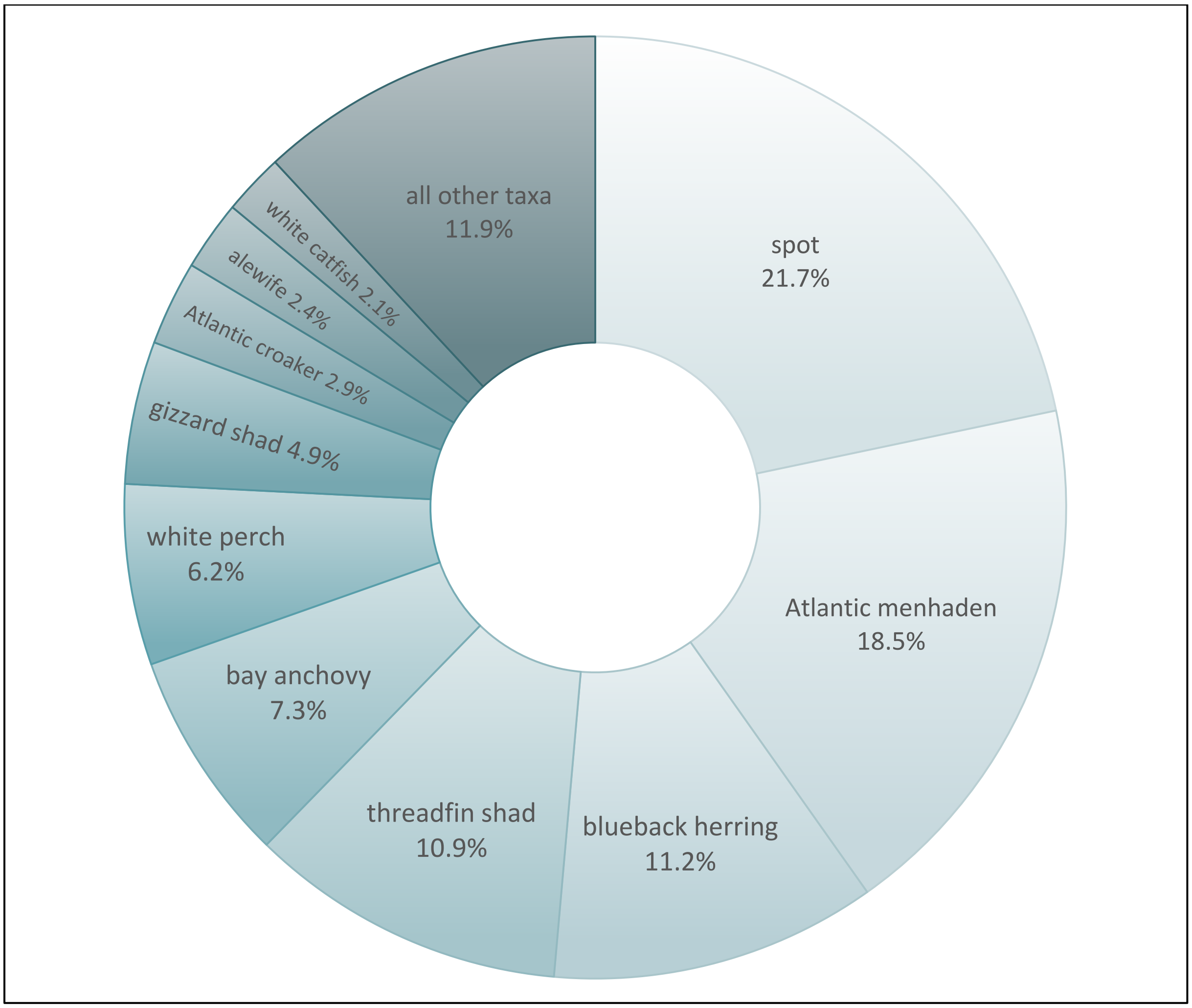
Impingement frequency for many species was highly seasonal. For instance, spot and Atlantic menhaden impingement was highest in summer and early fall, which correlates with the seasonal movements of juveniles between oceanic spawning grounds, inshore nurseries, and overwintering areas. In contrast, white perch, blueback herring, and threadfin shad were primarily impinged in late fall and winter. Bay anchovy and Atlantic croaker impingement was prominent only in the spring. The catfishes, which are resident species, were impinged at relatively constant levels throughout the year. VIMS also observed interannual fluctuations that appeared to correlate with annual spawning success of the given species (VEPC 1980).

VIMS also investigated impingement survival during the study. Of all fish impinged on Surry's Ristroph traveling screens during the sampling period, 94.4 percent were returned alive to the James River (VEPC 1980). More detailed results of this component of the study appear previously in this section under "Gentle Exclusion or Collection and Return of Organisms Without Harm." Table 4-5 identifies the impingement mortality and estimated annual loss to impingement for each species collected during the study.

In its report, VIMS compared impingement losses with available fish population and commercial stock data for three of the five major species (blueback herring, Atlantic menhaden, and spot) (VEPC 1980). Researchers estimated that impingement at Surry resulted in the loss of the following:

- 0.0033 percent of the James River standing crop of blueback herring in 1975
- 0.0003 percent of the total Virginia commercial landings of Atlantic menhaden in 1976
- 0.1 percent of total Virginia commercial landings of spot in 1976

VIMS concluded that impingement at Surry was so low as to not be measurable or discernable among any of the commonly impinged species' populations or within the aquatic community as a whole (VEPC 1980). The NRC (NRC 2002b) staff reviewed the results of VIMS's 1974−1978 impingement study during the initial license renewal review and concluded that the study supported a finding of "SMALL" with respect to the impacts of impingement on the aquatic environment.



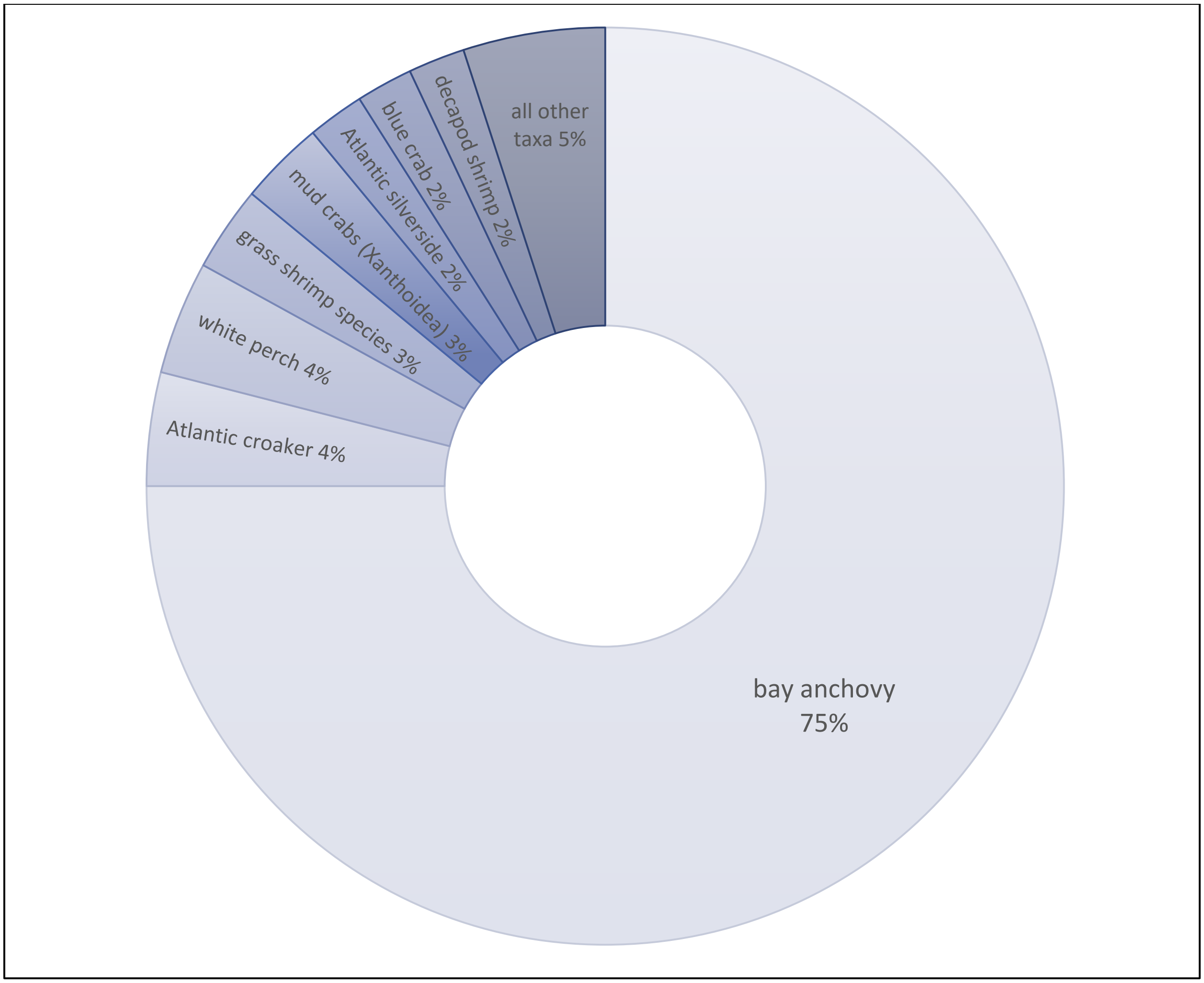
Source: Created with data from VEPC 1980, Table 22

Figure 4-2 Composition of Taxa Comprising Two Percent or Greater in Impingement Samples, 1974−1978

Impingement Sampling, 2015–2016

From August 2015 through July 2016, HDR Engineering (HDR 2017) conducted bimonthly impingement sampling at Surry. HDR Engineering researchers collected 30-minute sampling events every 4 hours each sampling day for a total of 144 samples. During sampling events, researchers diverted fish and shellfish collected in the low-level intake system's return trough into a fish holding pool for inspection and identification. Researchers also collected initial survival data for the first 10 minutes of sample processing by classifying each fish and shellfish into one of four categories: live undamaged, live damaged, fresh dead, or dead decaying. HDR Engineering used the impingement sampling data to determine impingement density, estimated monthly and annual impingement by taxa, and impingement survival, among other factors influencing impingement.

In total, HDR Engineering (2017) collected 316,163 organisms comprising 285,868 finfish distributed among 61 taxa and 30,295 shellfish distributed among 6 taxa. Table 3-9 is a taxonomic inventory of species collected during the study. Bay anchovy was the most abundantly impinged species by far; it accounted for 75 percent of all collected organisms (finfish and shellfish combined). Atlantic croaker and white perch each comprised 4 percent of collections. Grass shrimp species (*Palaemonetes* species) and mud crab (superfamily Xanthoidea) were the most abundantly collected shellfish. These taxa comprised 36 percent and 28 percent of total shellfish, respectively, and 3 percent each of total finfish and shellfish combined. All other taxa accounted for 2 percent or less of collections. Collected finfish ranged in total length from 0.35 inch (9 mm) (naked goby) to 34.5 inches (876 mm) (longnose gnar, *Lepisosteus osseus*). Shellfish measured between 0.2 inch (5 mm) (blue crab) and 6.9 inches (174 mm) (decapod shrimp) in carapace length. Figure 4-3 depicts the composition of taxa comprising 2 percent or more in impingement samples. Table 4-4 summarizes estimated impingement for finfish and shellfish under actual intake and maximum design intake flow scenarios, and Table 4-5 lists the estimated annual impingement by taxa under maximum design flow.



Source: Created with data from HDR 2017, Table 4-4

Figure 4-3 Composition of Taxa Comprising Two Percent or Greater in Impingement Samples, 2015-2016

Table 4-4 Summary of Impingement Sampling Findings, 2015–2016

	Finfish	Shellfish	Total
Impingement Collection Totals			
Organisms Collected	285,868	30,295	316,163
Distinct Taxa Collected	61	6	67
Total Estimated 12-Month Impingement			
Actual Intake Flow	64,851,328	6,576,792	71,428,120
Maximum Design Intake Flow	80,718,430	8,548,784	89,267,214
Total Estimated 12-Month Impingement Mortality[(a)]			
Actual Intake Flow	1,125,574	439,202	1,564,776
Maximum Design Intake Flow	1,326,165	487,729	1,813,894

	Finfish	Shellfish	Total

[a] Net estimated annual impingement accounts for impingement survival and subsequent return of organisms to the source water as well as converts (e.g., individuals converted from entrainable to impingeable organisms due to Ristroph screen mesh size finer than the baseline measurements (0.56-inch (1.4-cm) diagonal openings) established by the EPA under the final rule implementing Section 316(b) of the Clean Water Act (79 FR 48299). Because converts reflect a reduction in entrainment, these organisms are excluded from estimates of impingement mortality.

Source: HDR 2017

HDR Engineering (HDR 2017) also investigated initial impingement survival during the study. Researchers classified 18 taxa, including a variety of sunfishes, catfishes, and shrimp, as 100 percent alive and undamaged after initial impingement. An additional 25 taxa exhibited 50 percent or greater initial survival after impingement. HDR Engineering did not measure latent mortality (i.e., mortality with 48-hour or longer hold times) because results of such monitoring during the previous impingement study (VEPC 1980) yielded no significant differences in delayed mortality rates with hold times of up to 4 days. Further discussion of this component of the study appears previously in this section under "Gentle Exclusion or Collection and Return of Organisms without Harm" and "Best Technology Available Standard for Impingement Mortality." Table 4-5 identifies impingement mortality and estimated annual loss to impingement for each species collected during the study.

Finfish and shellfish impingement sample density exhibited different trends than one another during the study. Finfish exhibited an episodic trend in density that peaked in late winter (mid-January and mid-February 2016) at greater than 600 organisms per 130,800 yd^3 (100,000 m^3). Smaller peaks also occurred in early March, early April, and mid-May 2016. Shellfish impingement density, on the other hand, exhibited one distinct peak in mid-October 2015 at greater than 1,100 organisms per 130,800 yd^3 (100,000 m^3). This collection primarily consisted of grass shrimp species and decapod shrimp.

Finfish and shellfish impingement density also exhibited diel periodicity (i.e., a regular pattern in the density of organisms impinged over a 24-hour period). Finfish impingement peaked in night (2200 hours) and pre-dawn (0400 hours) collections. Shellfish impingement peaked in pre-dawn collections followed by night collections. Mid-morning (1000 hours) and late afternoon (1600 hours) collections were generally of low density for both finfish and shellfish.

HDR Engineering (HDR 2017) investigated impingement by tidal stage as well. Because the James River near Surry is tidally influenced, and salinity and current, among other characteristics, vary with ebb and flood tides, tidal stage has the potential to influence impingement composition and abundance. Researchers collected many taxa more commonly during ebb tides. These included gizzard shad, Atlantic silverside, bay anchovy, blueback herring, hogchoker, white perch, mud crabs, and decapod shrimp. Taxa more common during flood tides included Atlantic croaker, Atlantic menhaden, and spot. Some taxa (e.g., Atlantic croaker) that occurred with higher abundance during ebb tides were more commonly associated with elevated salinities. Overall, HDR Engineering found that tidal influence varied among taxa but that ebb tides appeared to result in higher susceptibility to impingement.

HDR Engineering (HDR 2017) did not draw any species-specific or population-wide conclusions in its study because the EPA regulations implementing Section 316(b) of the Clean Water Act only require facilities to characterize impingement impacts and do not require selection or evaluation of representative important species. Additionally, because cooling water intake flow volumes and unit outages varied between the 2015–2016 and 1974–1978 studies, HDR Engineering did not draw comparisons between the two studies or explain differences in impingement survival beyond the general trend that species abundance among those taxa that dominated samples varied between the two studies. The five most dominant species collected in 1974–1978 impingement samples at Surry were spot, Atlantic menhaden, blueback herring, threadfin shad, and bay anchovy; and percent composition of each varied among the years. In contrast, bay anchovy, a species that typically exhibits highly variable abundance year to year, dominated all samples during the 2015–2016 study.

Table 4-5 Summary of Impingement Sampling Results by Taxa, 1974−1978 and 2015−2016

Common Name(a)	Species	1974−1978			2015−2016		
		Estimated Annual Impingement (b)	Impingement Survival (%) (c)	Annual Loss to Impingement (d)	Estimated Annual Impingement (e)	Impingement Survival (%) (f)	Annual Loss to Impingement (g)
Finfish							
blueback herring*	*Alosa aestivalis*	443,646	89.9	44,808	1,104,321	83.1	19,685
hickory shad*	*Alosa mediocris*	1,037	77.8	230	2,112	69.0	283
alewife*	*Alosa pseudoharengus*	97,020	93.3	6,500	30,512	80.0	5,724
American shad*	*Alosa sapidissima*	13,546	94.0	813	13,867	69.0	4,299
river herrings*	*Alosa* species	**	**	**	288	69.0	89
orange filefish	*Aluterus schoepfi*	86	100.0	0	–	–	–
white catfish	*Ameiurus catus*	81,845	99.1	737	17,925	99.2	132
yellow bullhead	*Ameiurus natalis*	–	–	–	142	100.0	0
brown bullhead	*Ameiurus nebulosus*	41,785	97.8	919	1,715	100.0	0
bowfin	*Amia calva*	547	100.0	0	–	–	–
American sand lance	*Ammodytes americanus*	58	100.0	0	–	–	–
bay anchovy*	*Anchoa mitchilli*	289,768	83.6	47,522	67,029,316	50.1	44,829
American eel	*Anguilla rostrata*	23,266	98.7	302	21,919	100.0	0
fourspine stickleback	*Apeltes quadracus*	–	–	–	530	100.0	0
silver perch	*Bairdiella chrysoura*	365	100.0	0	19,811	82.5	3,337
Atlantic menhaden*	*Brevoortia tyrannus*	734,366	95.1	35,984	1,234,679	40.1	418,890
Crevalle jack	*Caranx hippos*	576	90.0	58	–	–	–
flier	*Centrarchus macropterus*	29	100.0	0	283	100.0	0
Atlantic spadefish	*Chaetodipterus faber*	29	100.0	0	1,464	75.0	320
striped blenny	*Chasmodes bosquianus*	–	–	–	283	75.0	71
grass carp	*Ctenopharyngodon idella*	–	–	–	144	90.0	14

Common Name(a)	Species	1974–1978			2015–2016		
		Estimated Annual Impingement (b)	Impingement Survival (%) (c)	Annual Loss to Impingement (d)	Estimated Annual Impingement (e)	Impingement Survival (%) (f)	Annual Loss to Impingement (g)
spotted seatrout	*Cynoscion nebulosus*	182	79.0	38	1,177	75.1	293
gray trout	*Cynoscion regalis*	6,047	87.7	744	260,844	67.5	18,511
sheepshead minnow	*Cyprinodon variegatus*	864	100.0	0	283	75.0	0
common carp	*Cyprinus carpio*	3,139	95.5	141	331	90.0	33
gizzard shad*	*Dorosoma cepedianum*	193,485	97.1	5,611	703,277	74.7	177,619
threadfish shad	*Dorosoma pentenense*	432,915	93.3	29,005	4,742	66.7	1,579
ladyfish	*Elops saurus*	274	100.0	0	–	–	–
bluespotted sunfish	*Enneacanthus gloriosus*	374	100.0	0	–	–	–
chain pickerel	*Esox niger*	86	100.0	0	–	–	–
tessellated darter	*Etheostoma olmstedi*	115	100.0	0	–	–	–
marsh killifish	*Fundulus confluentus*	29	100.0	0	–	–	–
banded killifish	*Fundulus diaphanus*	1,699	95.0	85	1,021	75.0	0
mummichog	*Fundulus heteroclitus*	38,882	99.5	194	2,964	75.0	127
striped killifish	*Fundulus majalis*	29	100.0	0	–	–	–
Alaskan stickleback	*Gasterosteus aculeatus*	86	100.0	0	283	100.0	0
skilletfish	*Gobiesox strumosus*	86	100.0	0	807	75.0	71
naked goby	*Gobiosoma bosc*	12,797	99.8	26	24,076	75.0	0
seaboard goby	*Gobiosoma ginsburgi*	230	100.0	0	–	–	–
Mississippi silvery minnow	*Hybognathus nuchalis*	3,946	98.6	55	–	–	–
eastern silvery minnow	*Hybognathus regius*	–	–	–	1,905	90.0	190
blue catfish	*Ictalurus furcatus*	–	–	–	97,461	62.8	35,595
channel catfish	*Ictalurus punctatus*	47,309	98.6	662	1,497	100.0	0
pinfish	*Lagodon rhomboides*	58	100.0	0	–	–	–
spot	*Leiostomus xanthurus*	859,424	97.9	18,048	229,495	85.2	33,881
longnose gar	*Lepisosteus osseus*	202	100.0	0	240	100.0	0

Common Name(a)	Species	1974–1978 Estimated Annual Impingement (b)	1974–1978 Impingement Survival (%) (c)	1974–1978 Annual Loss to Impingement (d)	2015–2016 Estimated Annual Impingement (e)	2015–2016 Impingement Survival (%) (f)	2015–2016 Annual Loss to Impingement (g)
redbreast sunfish	*Lepomis auritus*	259	100.0	0	–	–	–
pumpkinseed	*Lepomis gibbosus*	25,363	98.7	330	265	100.0	0
bluegill	*Lepomis macrochirus*	1,488	100.0	0	793	100.0	0
gray snapper*	*Lutjanus griseus*	374	100.0	0	2,800	100.0	0
rough silverside	*Membras martinica*	9,917	83.9	1,597	–	–	–
inland silverside	*Menidia beryllina*	10,080	88.3	1,179	2,703	50.0	0
Atlantic silverside	*Menidia*	45,111	94.0	2,707	1,752,505	64.8	15,263
southern kingfish	*Menticirrhus americanus*	–	–	–	1,202	75.1	72
Atlantic croaker	*Micropogonias undulatus*	115,848	89.7	11,932	3,668,529	65.2	294,175
largemouth bass	*Micropterus salmoides*	115	100.0	0	283	100.0	0
white perch	*Morone americana*	246,590	97.1	7,151	3,218,977	93.9	191,693
striped bass	*Morone saxatilis*	5,170	97.8	114	483,280	87.5	14,729
shorthead redhorse	*Moxostoma macrolepidotum*	29	100.0	0	–	–	–
striped mullet	*Mugil cephalus*	5,458	99.5	27	7,362	100.0	0
silver mullet	*Mugil curema*	–	–	–	506	100.0	0
golden shiner	*Notemigonus crysoleucas*	8,107	100.0	0	1,472	75.0	368
satinfin shiner	*Notropis analostanus*	29	100.0	0	–	–	–
bridle shiner	*Notropis bifrenatus*	–	–	–	283	75.0	0
spottail shiner	*Notropis hudsonius*	55,992	96.9	1,736	5,011	75.0	557
rainbow trout	*Oncorhynchus mykiss*	29	100.0	0	–	–	–
summer flounder	*Paralichthys dentatus*	3,082	97.2	86	1,707	95.0	85
harvestfish	*Peprilus alepidotus*	17,591	98.4	281	32,268	91.6	2,582
Atlantic butterfish	*Peprilus triacanthus*	58	100.0	0	–	–	–
yellow perch	*Perca flavescens*	202	100.0	0	603	93.9	37
lake lamprey	*Petromyzon marinus*	302	100.0	0	283	100.0	0

Common Name(a)	Species	1974–1978			2015–2016		
		Estimated Annual Impingement (b)	Impingement Survival (%) (c)	Annual Loss to Impingement (d)	Estimated Annual Impingement (e)	Impingement Survival (%) (f)	Annual Loss to Impingement (g)
black drum	*Pogonias cromis*	–	–	–	2,024	75.1	504
bluefish	*Pomatomus saltatrix*	10,819	93.1	747	866	30.0	130
black crappie	*Poxomis nigromaculatus*	86	100.0	0	283	100.0	0
common searobin	*Prionotus carolinus*	144	100.0	0	878	75.0	0
cownose ray	*Rhinoptera bonasus*	58	100.0	0	–	–	–
Atlantic Spanish mackerel	*Scomberomorus maculatus*	576	100.0	0	434	100.0	0
lookdown	*Selene vomer*	144	70.0	43	–	–	–
creek chub	*Semotilus atromaculatus*	38	100.0	0	–	–	–
Atlantic needlefish	*Strongylura marina*	806	100.0	0	4,121	88.9	0
blackcheek tonguefish	*Symphurus plagiusa*	288	89.3	31	1,725	95.0	70
dusky pipefish	*Syngnathus floridae*	–	–	–	3,173	50.0	165
northern pipefish	*Syngnathus fuscus*	115	70.0	35	–	–	–
Atlantic cutlassfish	*Trichiurus lepturus*	58	100.0	0	12,080	0.0	6,348
hogchoker	*Trinectes maculatus*	70,239	97.7	1,616	697,819	95.1	33,599
unidentified catfish	unidentified catfish	**	**	**	283	100.0	0
unidentified finfish	unidentified finfish	**	**	**	4,196	81.3	218
Shellfish							
blue crab	*Callinectes sapidus*	***	***	***	1,299,952	67.4	420,193
sand shrimp	*Crangon septemspinosa*	***	***	***	36,250	98.6	461
decapod shrimp	Decapoda species	***	***	***	1,432,907	98.6	19,950
brown shrimp	*Farfantepenaeus aztecus*	***	***	***	1,134	98.6	4
northern white shrimp	*Litopenaeus setiferus*	***	***	***	51,500	100.0	0
grass shrimp species	*Palaemonetes* species	***	***	***	3,575,476	97.1	1,938

Common Name(a)	Species	1974–1978 Estimated Annual Impingement (b)	1974–1978 Impingement Survival (%) (c)	1974–1978 Annual Loss to Impingement (d)	2015–2016 Estimated Annual Impingement (e)	2015–2016 Impingement Survival (%) (f)	2015–2016 Annual Loss to Impingement (g)
mud crabs (Panopeidae)	Panopeidae species	***	***	***	61,221	97.9	1,286
mud crabs (Xanthoidea)	Xanthoidea species	***	***	***	2,090,344	97.9	43,897
TOTAL (finfish and shellfish)		**3,964,792**	**100.0**	**222,094**	**89,267,212**	**100.0**	**1,813,896**

[(a)] An asterisk (*) indicates EPA-designated fragile species.

[(b)] Estimated annual impingement is calculated by dividing the total estimated impingement, as reported in VEPC 1980, Table 22, by five (the number of sample years in the study). Notably, VEPCO uses a withdrawal rate of 6,360 m^3/min (2,014.6 MGD; 1,680,000 gpm; or 106 m^3/s), which is slightly lower than the Surry circulating water pump maximum design flow rate of 2,534.4 MGD (1,760,000 gpm or 111 m^3/s).

[(c)] As reported in VEPC 1980, Table 25.

[(d)] Annual loss to impingement is calculated as: (estimated annual impingement)*(impingement survival, as reported in VEPC 1980, Table 25).

[(e)] As reported in HDR 2017, Table 4-14, which assumes maximum design intake flow of 2,534.4 MGD (1,760,000 gpm or 111 m^3/s).

[(f)] As reported in HDR 2017, Table 4-11.

[(g)] As reported in HDR 2017, Table 4-14.

– = species not collected during study.

**VEPC 1980 did not estimate impingement for taxa not identified to the species.

***VEPC 1980 did not sample shellfish impingement.

Best Technology Available Standard for Impingement Mortality

Under Section 316(b) of the Clean Water Act, the EPA requires owners or operators of existing facilities with cooling water intake structures that withdraw greater than 2 MGD (1,390 gpm or 0.1 m^3/s) and that use at least 25 percent of the water for cooling purposes to comply with one of seven best technology available (BTA) Standards for Impingement Mortality, as explained in detail at 40 CFR 125.94(c) and summarized below.

(1) closed-cycle recirculating system and daily monitoring of actual intake flows; or

(2) demonstrated less than or equal to 0.5 fps (less than or equal to 1.5 m/s) through-screen design velocity; or

(3) demonstrated less than or equal to 0.5 fps (less than or equal to 1.5 m/s) through-screen actual velocity and daily monitoring of velocity; or

(4) existing offshore velocity cap and daily monitoring of intake flow; or

(5) modified traveling screens, optimized to minimize impingement mortality; or

(6) BTA systems of technology, management practices, and operational measures; or

(7) 12-month impingement mortality performance standard and monthly monitoring where the number of fish killed divided by the number of fish impinged is less than 24 percent.

Under the 2014 final rule that establishes regulations implementing Section 316(b) of the Clean Water Act (79 FR 48299), existing facilities must also comply with any additional measures for shellfish and fragile species, as established by the EPA or the State, where delegated, under the National Pollutant Discharge Elimination System (NPDES) program.[2]

In Virginia, the Virginia Department of Environmental Quality (VDEQ) is responsible for administering the NPDES program and regulating water quality under the Clean Water Act. The VDEQ has not yet evaluated or made conclusions on BTA for impingement mortality at Surry under the 2014 regulations. As interim BTA measures, the VDEQ requires Dominion to implement a modified traveling screen, low-pressure screen wash system, and fish return system in a manner that minimizes the impingement and entrainment of aquatic species and associated adverse impacts under Condition E.1. of the 2016 VPDES permit (VDEQ 2016). Condition E.3. of the permit requires Dominion to submit to the VDEQ certain impingement and entrainment information, including results of impingement and entrainment sampling, consideration of impingement and entrainment reduction technologies and operating modes, and the chosen method(s) of compliance with the impingement mortality BTA standard, as specified at 40 CFR 122.21(r). Dominion is scheduled to submit this information to the VDEQ on or before the regulatory deadline of June 3, 2020 (VEPC 2019a). Following its review of Dominion's submittal, the VDEQ will make a BTA determination for impingement mortality at Surry. Based on the results of its review, the VDEQ may impose additional requirements to reduce impingement or entrainment at the facility in a future renewed VPDES permit. While it is ultimately the VDEQ's responsibility (and not the NRC's) to determine Clean Water Act 316(b) BTA for impingement mortality at Surry, the NRC staff considers the BTA standards in this SEIS to draw conclusions under NEPA regarding the impacts of impingement at Surry on the surrounding aquatic environment. The NRC staff's NEPA conclusions are separate from the BTA determination that the VDEQ will make in the future. The NRC staff's conclusions should

[2] In Virginia, this program is referred to as the Virginia Pollutant Discharge Elimination System (VPDES) program.

not be construed as either constituting a BTA determination for Surry's cooling water intake structure or ultimately evaluating Dominion's compliance with Section 316(b) of the Clean Water Act.

Among the seven BTA standards identified above, the 2015–2016 impingement sampling results can be meaningfully compared to the 12-month impingement mortality performance standard. This standard requires that a facility must achieve a 12-month impingement mortality performance of all life stages of fish and shellfish of no more than 24 percent mortality, including latent mortality, for all nonfragile species that are collected or retained in a sieve with maximum opening dimension of 0.56 inch (1.4 cm) and kept for a holding period of 18 to 96 hours, unless an alternative holding period is prescribed (79 FR 48299). The 12-month average of impingement mortality is calculated as the sum of total impingement mortality for the previous 12 months divided by the sum of total impingement for the previous 12 months (79 FR 48299). A facility must choose to demonstrate compliance with this requirement for the entire facility or for each individual cooling water intake structure, and biological monitoring must be completed with a minimum frequency of monthly (79 FR 48299).

The NRC staff calculated impingement mortality of nonfragile species at Surry as follows.

$$Impingement\ Mortality = \frac{\#\ dead\ organisms\ (nonfragile\ species)}{\#\ total\ impinged\ organisms\ (nonfragile\ species)}$$

Using this formula and the impingement data in Table 4-5, the NRC staff calculated impingement mortality for nonfragile species to range from 3.68 percent (1974–1978 data) to 5.97 percent (2015–2016 data). When all taxa (fragile and nonfragile) are considered, the impingement mortality range drops slightly to between 2.03 percent (2015–2016 data) and 5.60 percent (1974–1978 data). This decrease is caused by the high observed survival rates of many of the fragile species at Surry (Table 4-3). These percentages are well below the EPA's impingement mortality performance standard of 24 percent. Based on these calculations, the NRC staff finds that the impingement mortality rate is so low as to be unlikely to contribute to noticeable or measurable impacts on the local aquatic community.

Impingement Study Conclusion

Based on the above review of impingement studies conducted at Surry, paired with the NRC staff's impingement mortality calculations, the NRC staff concludes that impingement-related fish and shellfish mortality at Surry is so low that impingement, considered alone, is unlikely to measurably affect or noticeably alter the local aquatic community.

<u>Entrainment Study Results</u>

As the third line of evidence, the NRC staff considered the results of entrainment studies. Three studies have been undertaken at Surry: VIMS conducted the first study from 1975–1978, EA Engineering conducted the second study from 2005–2006, and HDR Engineering conducted the third study from 2015–2017. This section summarizes each study and compares the results with the EPA BTA standards for entrainment at existing facilities to evaluate the significance of entrainment in the local aquatic community.

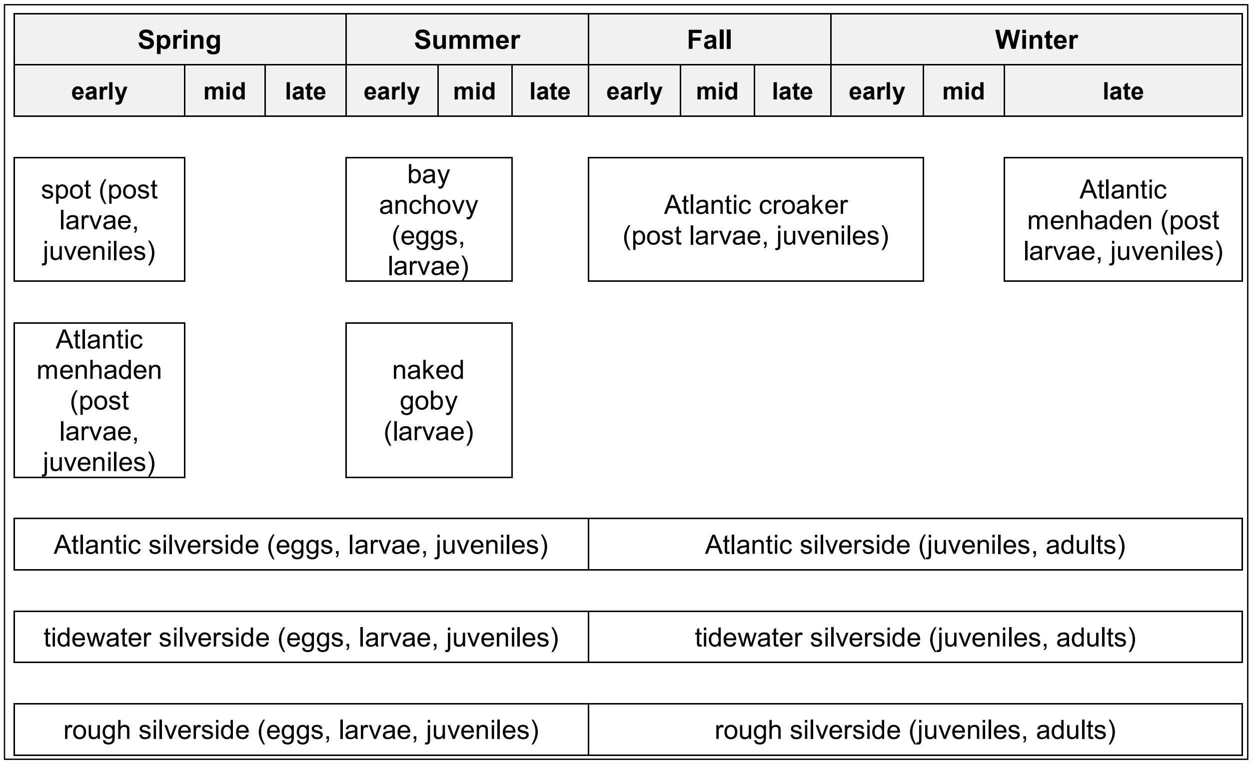
Entrainment Sampling, 1976–1978

From January 1975 through December 1978, VIMS conducted bimonthly entrainment sampling at Surry (VEPC 1980). VIMS researchers gathered ichthyoplankton samples with 505-μm mesh conical plankton nets equipped with flowmeters at near surface, mid-water, and near bottom depths in the low-level intake structure forebay as well as mid-channel in the discharge canal. Ten-minute tows were gathered six times per sample day for a total of 1,080 samples over the study period. All samples were collected and preserved and then later processed in a laboratory for identification, enumeration, and further analysis. Although researchers also collected entrainment data in 1975, data from the first year of the study were primarily used to assess sampling and gear techniques for the following sample years.

VIMS collected 42 taxa of ichthyoplankton, 30 of which were identified to species, in its entrainment samples (VEPC 1980). Bay anchovy and naked goby were the most abundantly collected species; together these comprised 91.1 percent (64.5 percent bay anchovy eggs and larvae and 26.6 percent naked goby larvae). Naked goby eggs rarely appeared in samples due to the demersal and adhesive nature of this species' eggs. All other species and life stages appeared at much lower concentrations (generally less than $1/m^3$ as compared to a maximum concentration of $62.6/m^3$ for bay anchovy eggs, $25.7/m^3$ for naked goby larvae, and $7.0/m^3$ for bay anchovy larvae). Other collected species included Atlantic croaker, spot, Atlantic menhaden, Atlantic silverside, tidewater silverside (*Menidia peninsulae*), rough silverside (*Membras martinica*), striped bass, and white perch.

Entrainment was highly seasonal. Overall density of entrained organisms peaked in mid-to-late spring and summer. Researchers observed maximum concentrations of eggs in mid-May 1976, late July 1977, and mid-August 1978 and maximum concentrations of larvae in late July 1976 and 1977, and mid-August 1978. Bay anchovy (eggs, larvae) and naked goby (larvae) generally peaked in early to mid-summer. Figure 4-4 depicts peak ichthyoplankton entrainment concentrations of the major species and life stages by season.

With respect to bay anchovy and naked goby, VIMS concluded that entrainment of these species at Surry does not result in an adverse impact to either species' regional populations because the major spawning areas are downstream in more saline waters (VEPC 1980). VIMS posited that most bay anchovy eggs collected in entrainment samples were likely dead prior to entrainment or would have soon died because salinities near the low-level intake structure observed during the study (0.1 to 14.3 parts per thousand (ppt) and typically less than 10 ppt) were well below the optimum salinity range for this species' successful spawning (20-30 ppt). VIMS found that the lack of decline in the relative abundances of bay anchovy and naked goby juveniles and adults in James River haul seine and otter trawl surveys supported this conclusion. With respect to all other species, VIMS found no adverse impacts based on a combination of low entrainment concentrations, life history characteristics, and relative age class abundances.



Source: Created with data from VEPC 1980

Figure 4-4 Peak Ichthyoplankton Entrainment Concentrations of Species and Life Stages by Season, 1976–1978

Entrainment Sampling, 2005-2006

From June 2005 through May 2006, EA Engineering (EA Engineering 2006) conducted bimonthly entrainment sampling at Surry. Researchers collected samples in front of the low-level intake structure at three depths (near surface, mid-depth, and near bottom) using paired conical plankton nets from a boat. Each sampling event consisted of four 10-minute sample periods over a 24-hour period (i.e., samples at 0400 hours, 1000 hours, 1600 hours, 2200 hours). During this study, researchers collected and identified both finfish and shellfish, unlike the previous 1976-1978 study, which only characterized entrainment of finfish.

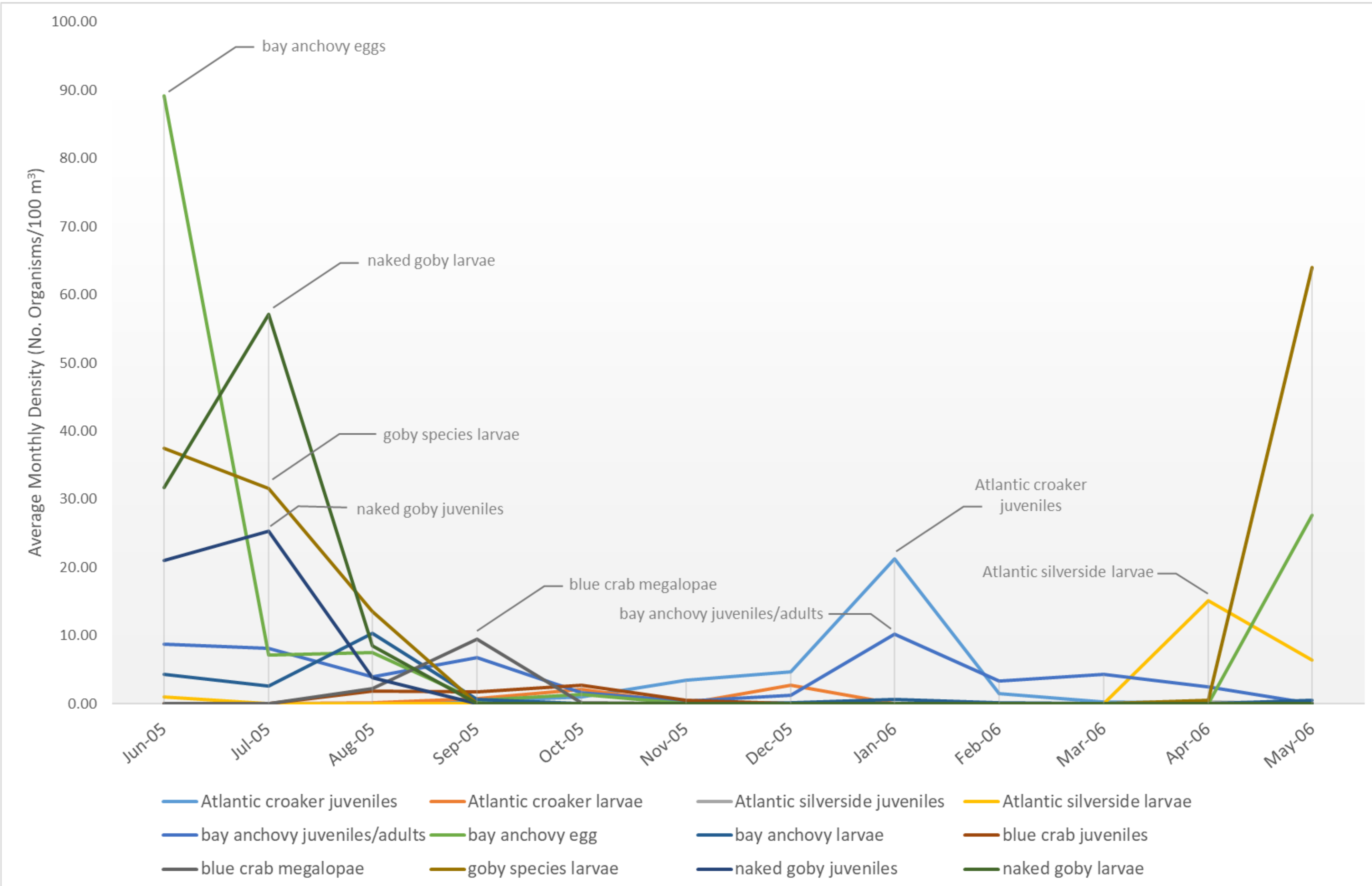
EA Engineering (EA Engineering 2006) collected 46 taxa over 24 samples. Young life stages of invertebrates comprised 96.8 percent of all samples. Unidentified shrimp (primarily mysid shrimp) (66.5 percent) and unidentified crab zoea (24 percent) were the most abundant taxa; these accounted for a collective 90.5 percent of total estimated entrainment. Blue crab megalops and juveniles together comprised 0.14 percent of total entrainment. Unidentified shrimp and bivalves appeared in entrainment samples throughout the year, although shrimp appeared in greatest numbers from March through June, and bivalves appeared in greatest numbers from December through May. Blue crab juveniles appeared in entrainment samples beginning in August, increased in abundance through October, declined in November, and were absent in December. Blue crab megalops appeared in entrainment samples in August through October with peak abundance in September. Blue crab zoea appeared in entrainment samples in May and June, in contrast to other zoea-stage crabs, which were present in the samples throughout most of the year.

Finfish ichthyoplankton accounted for 3.2 percent of total estimated entrainment (finfish and shellfish combined) (EA Engineering 2006). Bay anchovy and goby of various life stages accounted for 89.1 percent of the finfish entrainment component and 2.9 percent of all entrainment. The percentages of these species, as a component of total finfish entrainment were as follows: bay anchovy eggs (25.8 percent), goby (unidentified species) post-yolk sac larvae (25.3 percent), naked goby post-yolk sac larvae (15.6 percent), and naked goby juveniles (6.8 percent). Atlantic croaker juveniles and post-yolk sac larvae represented 5.45 percent and 0.99 percent of total finfish entrainment. Finfish species were present in samples primarily from October through September, and relatively low entrainment of finfish eggs and larvae occurred outside of these months. Finfish entrainment density was highest during night samples. Seasonal occurrences of species within samples were roughly similar to those observed by VEPCO (VEPC 1980) during the previous entrainment study. Figure 4-5 depicts the average monthly density of the most commonly entrained taxa during the study. During the same period, EA Engineering undertook ambient ichthyoplankton sampling. Section 3.7.5.3, "Adult and Juvenile Fish," of this SEIS summarizes the results of this sampling effort.

EA Engineering (EA Engineering 2006) calculated monthly and annual estimated entrainment for each entrained finfish and shellfish taxon based on entrainment sample density and cooling water flow data. In a related analysis, CH2M Hill, Inc. (CH2M 2006) used EA Engineering's data to calculate baseline entrainment. Baseline entrainment is the entrainment that would occur in the source water in the absence of design and construction technologies or operational measures that a facility may employ to reduce entrainment. Under the 2004 final rule implementing Section 316(b) of the Clean Water Act, the EPA required existing facilities to demonstrate a 60 to 90 percent reduction in entrainment from the baseline calculation (69 FR 41576). CH2M Hill calculated Surry's baseline entrainment to be 878.2 million organisms per year, for which 100 percent mortality was assumed (CH2M 2006). This estimate consisted of the following:

- 448,457,000 bay anchovy eggs (51.07 percent of entrained organisms)
- 117,933,600 bay anchovy juveniles (13.43 percent)
- 94,729,000 Atlantic croaker juveniles (10.79 percent)
- 57,487,000 bay anchovy post-yolk sac larvae (6.55 percent)
- 51,017,000 blue crap megalops (5.81 percent)

All other taxa and life stages accounted for less than 5 percent composition each of the total estimated baseline entrainment.



Source: Created with Data from EA Engineering 2006

Figure 4-5 Average Monthly Density of Most Commonly Entrained Taxa, 2005–2006

Following an evaluation of Surry's design technologies and operational measures that reduce entrainment, such as Surry's Ristroph traveling screens, CH2M HILL (CH2M 2006) found that Surry entrains 716.5 million organisms per year, which represents a reduction of 18.4 percent from baseline. CH2M HILL concluded that for Surry to meet the 2004 rule's requirements, Dominion would have to reduce entrainment at the facility by an additional 41.6 percent. However, Federal courts remanded the 2004 rule to the EPA for revision, and the EPA replaced it with a new rule in 2014 (79 FR 48299). Under the new rule, the 2004 rule's entrainment standard no longer applies. Neither EA Engineering nor CH2M HILL evaluated species-specific or population-level impacts of entrainment at Surry or otherwise interpreted the results of the entrainment study beyond the baseline entrainment calculations described above.

Entrainment Sampling, 2015–2017

From August 2015 through July 2017, HDR Engineering (HDR 2016a) conducted bimonthly entrainment sampling at Surry to meet the requirements of the 2014 final rule establishing regulations for existing facilities under Section 316(b) of the Clean Water Act. Researchers gathered ichthyoplankton samples by pumping water through 335-μm plankton nets suspended in a buffering tank at near surface, mid-water, and near bottom depths in front of the bar racks of the low-level intake structure. Each sampling event consisted of four 100-minute collections at three depths over a 24-hour period (i.e., samples at 0400 hours, 1000 hours, 1600 hours, 2200 hours). The study targeted both finfish and shellfish. Collected samples were transported to a laboratory for sorting and analysis where researchers gathered detailed morphometric data to support an evaluation of alternative BTA technologies.

Although HDR Engineering has completed the above-described entrainment sampling, final sampling results were not available at the time of the NRC staff's environmental review. HDR Engineering is in the process of preparing a final entrainment characterization report analyzing the 2015–2017 sampling data. Dominion will submit this report, along with other required information, to the VDEQ on or before the regulatory deadline of June 3, 2020, in accordance with Condition E.3. of its VPDES permit. In responses to NRC staff requests for additional information, Dominion (VEPC 2019a) provided the NRC staff with preliminary results of the 2015–2017 entrainment sampling. Because these results are preliminary, information reported in this SEIS relative to the 2015–2017 impingement sampling is subject to change upon HDR Engineering's completion of its final report. At the time of the NRC staff's review, these preliminary results, as summarized below, represent the best available information.

Over the course of 2015–2017 entrainment sampling, HDR Engineering collected 801,493 shellfish and finfish over 560 samples (VEPC 2019a). In comparison to the 2005–2006 study, total entrainment varied considerably. In the first year of the 2015–2017 study, entrainment was 97.2 percent lower than the annual estimated entrainment in 2005–2006 based on actual intake flows (VEPC 2019a). In the second year of the study, entrainment was 3.0 percent higher (VEPC 2019a). Such fluctuations are likely associated with the highly variable annual production of entrainable organisms (i.e., finfish eggs and larvae and early life stages of shellfish) and the fluctuating local conditions (e.g., salinity) of the tidally influenced James River. As with the previous study, shellfish and goby (unidentified species) larvae dominated 2015–2017 entrainment collections, and the greatest entrainment density was observed from May through September. Table 4-6 lists the percent composition of each collected taxa during the 2 years of sampling. Further discussion and interpretation of these results, including any species-specific or population-level conclusions, will not be available until HDR Engineering completes its final entrainment characterization report.

Table 4-6 Percent Composition of Taxa Collected in Entrainment Sampling, 2015-2017

Taxa[a]	Common Name	Life Stage[b]	Composition of Entrained Organisms (%)	
			Year 1	Year 2
Finfish				
Alosa aestivalis	blueback herring	juvenile	<1	<1
Alosa aestivalis	blueback herring	adult	–	<1
Alosa species	river herrings	PYSL	<1	<1
Anchoa mitchilli	**bay anchovy**	**juvenile**	**13**	**6**
Anchoa mitchilli	**bay anchovy**	**PYSL**	**8**	**4**
Anchoa mitchilli	bay anchovy	adult	1	4
Anchoa mitchilli	bay anchovy	UIDL	<1	–
Anguilla rostrata	American eel	juvenile	<1	<1
Atherinidae species	silversides	PYSL	<1	7
Atherinidae species	silversides	egg	<1	<1
Atherinidae species	silversides	YSL	<1	<1
Atherinidae species	silversides	UIDL	<1	–
Bairdiella chrysoura	silver perch	PYSL	<1	<1
Bairdiella chrysoura	silver perch	juvenile	–	<1
Blenniiformes species	blennies	PYSL	<1	<1
Brevoortia tyrannus	Atlantic menhaden	juvenile	1	1
Brevoortia tyrannus	Atlantic menhaden	PYSL	<1	<1
Clupeidae and Engraulidae species	herring and anchovies	PYSL	1	3
Clupeidae and Engraulidae species	herring and anchovies	UIDL	3	–
Conger species	conger eel	juvenile	<1	<1
Cynoscion regalis	gray trout	juvenile	<1	<1
Cynoscion regalis	gray trout	PYSL	<1	<1
Dorosoma cepedianum	gizzard shad	adult	<1	–
Dorosoma cepedianum	gizzard shad	juvenile	<1	–
Dorosoma cepedianum	gizzard shad	YSL	–	<1
Engraulidae species	common anchovies	PYSL	5	1
Engraulidae species	common anchovies	adult	<1	–
Gobiesox strumosus	skilletfish	PYSL	<1	<1
Gobiidae species	**gobies**	**PYSL**	**6**	**5**
Gobiosoma bosc	**naked goby**	**PYSL**	**24**	**14**
Gobiosoma bosc	naked goby	juvenile	<1	1
Gobiosoma bosc	naked goby	adult	<1	–
Gobiosoma bosc	naked goby	egg	<1	–
***Gobiosoma* species**	**naked/seaboard goby**	**PYSL**	**30**	**51**
Leiostomus xanthurus	spot	juvenile	<1	<1
Leiostomus xanthurus	spot	PYSL	<1	<1

Taxa[a]	Common Name	Life Stage[b]	Composition of Entrained Organisms (%)	
			Year 1	Year 2
Leiostomus xanthurus	spot	adult	<1	–
Menidia beryllina	inland silverside	PYSL	<1	–
Menidia	Atlantic silverside	adult	<1	<1
Menidia	Atlantic silverside	egg	<1	<1
Menidia	Atlantic silverside	PYSL	<1	<1
Menidia	Atlantic silverside	YSL	<1	<1
Menidia	Atlantic silverside	juvenile	<1	–
Menidia	Atlantic silverside	UIDL	<1	–
Menticirrhus americanus	southern kingfish	juvenile	<1	<1
Menticirrhus americanus	southern kingfish	PYSL	<1	<1
Microgobius thalassinus	green goby	PYSL	<1	<1
Micropogonias undulatus	Atlantic croaker	PYSL	3	1
Micropogonias undulatus	Atlantic croaker	juvenile	<1	<1
Morone americana	white perch	adult	<1	<1
Morone americana	white perch	juvenile	<1	<1
Morone americana	white perch	PYSL	<1	<1
Morone saxatilis	striped bass	juvenile	<1	<1
Morone saxatilis	striped bass	PYSL	<1	<1
Morone saxatilis	striped bass	YSL	<1	–
Morone species	temperate basses	PYSL	<1	<1
Morone species	temperate basses	YSL	<1	–
Paralichthys dentatus	summer flounder	juvenile	<1	–
Phoxinus	minnow	PYSL	–	<1
Sciaenidae species	drums and croakers	PYSL	<1	<1
Symphurus plagiusa	blackcheek tonguefish	juvenile	<1	<1
Symphurus plagiusa	blackcheek tonguefish	adult	–	<1
Syngnathus fuscus	northern pipefish	juvenile	<1	<1
Syngnathus fuscus	northern pipefish	PYSL	<1	<1
Trinectes maculatus	hogchoker	adult	<1	<1
Trinectes maculatus	hogchoker	juvenile	<1	<1
Trinectes maculatus	hogchoker	PYSL	<1	<1
unidentified egg	unidentified egg	egg	<1	–
unidentified finfish	unidentified finfish	UIDL	<1	1
unidentified finfish	unidentified finfish	PYSL	<1	<1
unidentified finfish	unidentified finfish	juvenile	<1	–
Finfish Total			**25**	**15**

Taxa[a]	Common Name	Life Stage[b]	Composition of Entrained Organisms (%)	
			Year 1	Year 2
Shellfish				
Callinectes sapidus	blue crab	juvenile	<1	<1
Callinectes sapidus	blue crab	megalopae	<1	<1
Callinectes sapidus	blue crab	adult	–	<1
Corbicula fluminea	Asian clam	juvenile	<1	–
Crangon septemspinosa	sand shrimp	juvenile	<1	–
Crangon species	crangonid shrimp	juvenile	<1	<1
Geukensia demissa	ribbed mussel	juvenile	1	1
Litopenaeus setiferus	white shrimp	adult	–	<1
Lucifer species	lucifer shrimp	juvenile	<1	<1
Mulinia lateralis	dwarf surf clam	juvenile	<1	<1
Mysida species	**mysid shrimp**	**juvenile**	**9**	**13**
Mysida species	mysid shrimp	zoea	2	–
Mysida species	mysid shrimp	adult	<1	–
Mytilopsis leucophaeata	dark falsemussel	juvenile	<1	<1
Mytilus edulis	blue mussel	juvenile	<1	–
Ovalipes ocellatus	lady crab	zoea	<1	–
Palaemonetes species	grass shrimp species	juvenile	2	1
Palaemonidae species	palaemonid shrimp	zoea	6	3
Palaemonidae species	palaemonid shrimp	juvenile	<1	<1
Palaemonidae species	palaemonid shrimp	megalopae	–	<1
Panopeidae species	**mud crabs (Panopeidae)**	**zoea**	**39**	**33**
Panopeidae species	mud crabs (Panopeidae)	megalopae	5	1
Panopeidae species	mud crabs (Panopeidae)	juvenile	<1	<1
Penaeidae species	penaeid shrimp	juvenile	<1	<1
Pinnotheres species	pea crabs	zoea	<1	–
Pinnotheres species	pea crabs	juvenile	–	<1
Pteriomorphia species	sea mussel	juvenile	<1	<1
Sergestidae species	sergestid shrimp	juvenile	–	<1
Tellinidae species	**tellin clams**	**juvenile**	**35**	**8**
***Uca* species**	**fiddler crab**	**zoea**	**2**	**39**
unidentified shellfish	unidentified shellfish	juvenile	<1	–
unidentified shellfish	unidentified shellfish	megalopae	<1	–
unidentified shellfish	unidentified shellfish	zoea	<1	–
Shellfish Total			**75**	**85**

[a] Taxa appear in alphabetical order. Blue, bolded taxa are those that constituted an average of >5% composition over the 2-year study period.

[b] YSL = yolk sac larvae; PYSL = post-yolk sac larvae; UIDL = unidentified larvae

Source: VEPC 2019a

Best Technology Available Standard for Entrainment

Under Section 316(b) of the Clean Water Act, BTA for entrainment is site-specific (40 CFR 125.94(d)). Rather than establishing a single nationally applicable entrainment performance standard, the EPA or the State must determine the technology that reflects the maximum reduction in entrainment warranted at each facility on a site-specific basis according to specific factors spelled out in 40 CFR 125.98(f)(2). The EPA did not establish a BTA standard for entrainment in its final rule because it 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 48299).

As described above under "Best Technology Available Standard for Impingement Mortality," the VDEQ has not evaluated or made conclusions on BTA for Surry under the 2014 final rule implementing Section 316(b) of the Clean Water Act. Under the 2016 VPDES permit (VDEQ 2016), the VDEQ requires Dominion to implement interim BTA measures (Condition E.1.) and to prepare and submit to the VDEQ impingement and entrainment information as specified at 40 CFR 122.21(r) (Condition E.3.). Following its review of Dominion's submittal, which is due June 3, 2020, the VDEQ will make a BTA determination for entrainment at Surry. Based on the results of its review, the VDEQ may impose additional requirements to reduce impingement or entrainment at the facility in a future renewed VPDES permit. While it is ultimately the VDEQ's responsibility (and not the NRC's) to determine Clean Water Act 316(b) BTA for entrainment at Surry, the NRC staff considers the BTA standards in this SEIS to draw conclusions under NEPA regarding the impacts of entrainment at Surry on the surrounding aquatic environment. The NRC staff's NEPA conclusions are separate from the BTA determination that the VDEQ will make in the future. The NRC staff's conclusions should not be construed as either constituting a BTA determination for Surry's cooling water intake structure or ultimately evaluating Dominion's compliance with Section 316(b) of the Clean Water Act.

Surry's intake structure includes several features or technologies that reduce entrainment. These include variable speed pumps and Ristroph traveling screens. Surry's variable pumps reduce intake flow, which reduces entrainment. However, as explained previously in the section under "Cooling Water Intake Design," Dominion varies pump operation in response to generation demand and maintenance activities rather than to specifically reduce impingement and entrainment. Nevertheless, because the variable pump operation results in a reduced intake flow as compared to maximum design intake flow, a proportional reduction in entrainment can be expected. Potential entrainment reductions resulting from Surry's Ristroph traveling screens are also discussed previously in this section under "Cooling Water Intake Design." Notably, Surry's traveling screen mesh has an opening size of 1/8-inch (0.32-cm) by ½-inch (1.3-cm) mesh, which equates to diagonal openings slightly smaller than the 0.56-inch (1.4-cm) standard that the EPA uses to differentiate between impingeable and entrainable organisms. Because of this, Surry's traveling screens exclude more organisms from entrainment than would otherwise be excluded with larger mesh. While the NRC staff recognizes that the above-described factors likely reduce potential entrainment at Surry, the NRC staff has identified no way to meaningfully evaluate the findings of the available entrainment studies against the BTA standard for entrainment in the absence of VDEQ's site-specific determination.

Entrainment Study Conclusion

The NRC staff finds this line of evidence, considered alone, to be inconclusive with respect to the impact of entrainment on the local aquatic community. HDR Engineering has not completed its final entrainment characterization report that will interpret the 2015–2017 sampling results, and the VDEQ has not made a site-specific BTA determination for entrainment at Surry. In the absence of this information, the available entrainment information alone does not provide a complete enough picture for the NRC staff to evaluate whether entrainment is measurably affecting the local aquatic community.

Aquatic Population Abundance Trends

In the fourth line of evidence, the NRC staff considered whether trends in local and regional fish and shellfish populations may be attributable to operation of Surry's cooling water intake structure.

In its Comprehensive Demonstration Study for Surry, CH2M HILL (CH2M 2006) compared results of EA Engineering's 2005-2006 James River ambient sampling data with historic data from studies performed during the 1974–1983 period. CH2M HILL compared seine and trawl data from the two periods and found that many species were collected at similar levels (10 of 16 species in seine sampling and 14 of 21 species in trawl sampling). CH2M HILL observed the following major differences in the two data sets.

- decrease in abundance of *Alosa* species and hogchoker
- increase in abundance of silversides
- appearance of blue crab, sand perch, American harvestfish, blue catfish, and white catfish

Decrease in Abundance of Alosa Species and Hogchoker

Two of the four *Alosa* species present in the James River near Surry decreased in abundance between the 1974–1983 and 2005–2006 haul seine surveys (CH2M 2006). Blueback herring comprised 6.25 percent of the historic haul seine catch. In 2005–2006, it comprised only 0.22 percent of the catch. Atlantic menhaden comprised 10.42 percent of the historic catch but did not appear in haul seine collections in 2005-2006. Although the status of these species relative to their historic levels specifically in the James River is unknown, these declines mirror population-wide stock assessments of Atlantic menhaden and river herring reported by the Atlantic States Marine Fisheries Commission over the same period (ASFMC 2017c, ASFMC 2017b). HDR Engineering (HDR 2017) calculated a high impingement survival rate (83.1 percent) for blueback herring. Impingement survival for Atlantic menhaden, although low (40.1 percent), is higher than the EPA-assumed survival rate of less than 30 percent (HDR 2017), and this species makes up a very small percentage (1.4 percent) of the total estimated annual impingement under maximum design intake flows. HDR Engineering collected blueback herring (juveniles and adults) and Atlantic menhaden (post yolk-sac larvae and juveniles) in 2015–2017 entrainment samples, but these species accounted for zero, less than 1 percent, or 1 percent of total entrainment collections in each of the two sample years (VEPC 2019a).

Hogchoker was the dominant finfish species in historic trawl samples (37.4 percent of total catch), but it comprised only 14.5 percent of the trawl catch in 2005–2006 (EA Engineering 2006). Hogchoker abundance in the immediate vicinity of Surry is likely to vary with salinity as this species tends to prefer low salinity, especially in winter months (Peterson 1996). While no stock assessments are available for this species, the Chesapeake Bay Program reports it as stable in the Chesapeake Bay watershed (CBP 2019b). In the 2015–

2016 impingement study, HDR Engineering (HDR 2017) calculated a high impingement survival rate (95.1 percent) for hogchoker. In 2015-2017, HDR Engineering collected yolk-sac larvae, juveniles, and adults in entrainment samples, but each of these life stages accounted for less than 1 percent of total entrainment collections in each of the two sample years (VEPC 2019a).

The available information does not indicate that impingement and entrainment at Surry is exerting pressure on the local or regional blueback herring, Atlantic menhaden, or hogchoker populations to a degree that would explain the observed decreases in these species' prevalence between the 1974–1983 and 2005–2006 ambient fish surveys. These differences are more likely due to population-wide dynamics, salinity fluctuations, or a combination of other environmental factors.

Increase in Abundance of Silversides

Inland and Atlantic silversides comprised 91.08 percent of the 2005–2006 total haul seine catch (CH2M 2006). Historically, these species collectively accounted for 10.42 percent of total catch. Although no stock assessments are available for silversides, annual commercial landing information indicates that silverside populations may exhibit high interannual fluctuations (NOAA 2019c). The silversides exhibited moderate impingement survival at Surry and were entrained in very small numbers at several life stages during entrainment sampling. However, the observed increase in abundance of silversides over the period indicates that impingement and entrainment does not result in observable adverse effects on these species.

Appearance of Blue Crab, Sand Perch, American Harvestfish, Blue Catfish, and White Catfish

Blue crab and sand perch (*Diplectrum formosum*) did not appear in historic haul seine collections but were collected in 2005 and 2006. Both appeared in low numbers in only one 2005–2006 seine collection (November 2005) (EA Engineering 2006). Blue catfish did not appear in historic trawl collections, but it was the dominant species, comprising 35.28 percent of the total catch, in 2005–2006 collections. This species was introduced in the James River, among other Chesapeake Bay tributaries, as a stocked sportfish from the mid-1970s through early 1980s (Connelly 2001). Appearance of the species in the 2005–2006 collection indicates its continued persistence in the region.

In addition to blue catfish, blue crab, sand perch, American harvestfish, and white catfish were collected by trawl in 2005–2006 although they did not appear in historic trawl collections. The appearance of these species may be related to sampling effort or local environmental conditions at the time of sampling (e.g., salinity, temperature) and does not provide any information on the impacts of impingement and entrainment at Surry on the local or regional populations of these species.

Aquatic Population Abundance Trends Conclusion

While several trends in the relative abundances of certain fish and shellfish were observed between James River ambient sampling conducted from 1974–1983 and from 2005–2006, none of the available information indicates a clear correlation between these changes and Surry operations, or in particular, impingement and entrainment of aquatic organisms. The local aquatic community remains a diverse assemblage of freshwater, estuarine, and marine species typical of the transition zone of a tidally influenced river. Notably, no taxa or species have wholly disappeared from the region based on the NRC's review of the available aquatic studies. Accordingly, the NRC staff finds that impingement and entrainment at Surry has likely not exerted pressures on the aquatic community to an extent that has resulted in measurable or noticeable impacts on the abundances of local or regional fish or shellfish populations over time.

Summary of Impingement and Entrainment Line of Evidence Conclusions

Previously within this section, the NRC staff evaluated four lines of evidence and made the following conclusions with respect to the effects of impingement and entrainment at Surry.

- A combination of EPA-identified approaches, including flow reduction, gentle exclusion or collection and return of organisms without harm, and reduction in intake velocity, likely reduce the potential impact of impingement and entrainment on the local aquatic community to some measurable degree. The amount or extent to which these approaches affect impingement mortality and entrainment has not been specifically quantified.
- Impingement sampling data indicate that impingement mortality at Surry is so low that impingement of aquatic organisms, considered alone, is unlikely to measurably impact or noticeably alter the local aquatic community.
- Interpretations of recent entrainment sampling data are lacking for the NRC staff to make a conclusion with respect to the effect of entrainment on the local aquatic community.
- Abundance trends indicate that impingement and entrainment at Surry has likely not exerted pressures on the aquatic community to an extent that has resulted in measurable or noticeable impacts on the abundances of local or regional fish or shellfish populations over time.

Impingement and Entrainment Conclusion

The NRC staff’s line-of-evidence analysis yielded no evidence of noticeable or detectable ecological impairment resulting from impingement or entrainment of aquatic organisms at Surry. During the proposed license renewal term, the NRC staff expects that impacts would be similar (i.e., not noticeable or detectable) because continued operation would neither intensify existing effects nor introduce any new effects. Further, prior to the beginning of the proposed license renewal period, the VDEQ is likely to make BTA determinations for impingement and entrainment at Surry pursuant to Section 316(b) of the Clean Water Act. As explained previously in this section, conditions in the current VPDES permit require Dominion to submit to the VDEQ certain impingement and entrainment information, including results of impingement and entrainment sampling, consideration of impingement and entrainment reduction technologies and operating modes, and the chosen method(s) of compliance with the impingement mortality BTA standard, as specified at 40 CFR 122.21(r), by June 2020. Based on the results of its review, the VDEQ will make BTA determinations for Surry and may impose additional requirements to reduce impingement or entrainment at the facility. The VDEQ would impose any additional requirements as conditions in a future renewed VPDES permit that would be issued and take effect prior to the renewed operating license period. The NRC staff assumes that any additional requirements that the VDEQ imposes would further reduce the impacts of impingement and entrainment over the course of the proposed license renewal term. For these reasons, the NRC staff concludes that the impacts of impingement and entrainment of aquatic organisms resulting from the proposed subsequent license renewal of Surry would be SMALL.

4.7.1.2 Thermal Impacts on Aquatic Organisms (Plants with Once-Through Cooling Systems or Cooling Ponds)

For plants with once-through cooling systems such as Surry, the NRC has determined in the GEIS (NRC 2013a) that thermal impacts on aquatic organisms is a Category 2 issue that requires site-specific evaluation. In 2002, the NRC evaluated the thermal impacts of the initial Surry license renewal on aquatic organisms under the issue "heat shock." The NRC staff determined that the impacts of continued operation of Surry would be SMALL during the initial license renewal term (i.e., 2012–2032 for Unit 1 and 2013–2033 for Unit 2) (NRC 2002b). In 2013, the NRC issued Revision 1 of the GEIS (NUREG-1437) (NRC 2013a). In the revised 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 evaluates thermal impacts as they apply to continued operation of Surry during the proposed subsequent license renewal term (i.e., 2032–2052 for Unit 1 and 2033–2053 for Unit 2).

The primary form of thermal impacts that would be of concern at Surry is heat shock, which the NRC staff defines as occurring when the water temperature meets or exceeds the thermal tolerance of a species for some duration of exposure (NRC 2013a). In most situations, fish are capable of moving out of an area that exceeds their thermal tolerance limits, although some aquatic species lack such mobility. Heat shock is typically observable only for fish, particularly those that 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. Heat shock can also alter aquatic habitat characteristics that could have cascading effects on the local aquatic community.

Ambient James River water temperatures near Surry are relatively warm and range from a low of approximately 53.6 °F (12 °C) in winter to a high of 82.4 °F (28 °C) in summer. The water column stratifies near the top 6 ft (0.3 m) such that water deeper than 6 ft (0.3 m) from the surface is typically 1.1 °F (0.6 °C) cooler than the surface in summer. Surry discharges heated effluent through a discharge tunnel and into a discharge canal that flows into the James River at RM 37 (RKM 60). The discharge canal is 2,900 ft (884 m) in length, of which approximately 1,200 ft (366 m) extends into the James River (Dominion 2018b). Rock-filled groins along each side of the discharge canal control sedimentation and exit velocity. Section 3.1.3.1, "River Water Intake and Discharge," of this SEIS further describes the characteristics of Surry's effluent discharge.

<u>Thermal Study Results</u>

Fang and Parker (1976) conducted a three-year study of Surry's thermal plume after Surry began operating. The river exhibited the greatest temperature differences in June and September or October when surface water temperatures across eight river transects were 5–7 °F (1.1-3.9 °C) higher under post-operational conditions compared to pre-operational conditions. Isotherm plots indicated that waters surrounding the discharge canal exceeded 86 °F (30 °C) in July and August of each year. Within the discharge canal, temperatures reached 99.9 °F (37.7 °C). However, temperatures this high did not occur in the river itself because temperatures rapidly decreased once canal water mixed with river water. While the spatial extent of the thermal plume varied with the tides, the plume at no point extended to a depth of more than 6 ft (1.8 m) or more than half the width of the river at its narrowest point. Fang and Parker (1976) observed that the plume stayed close to shore; it extended approximately 2,000 ft (610 m) around Gravel Neck Peninsula during flood and ebb tides and pooled near the discharge outfall during slack tides. Temperatures were rarely greater than 5 °F (2.8 °C) above ambient river temperatures at a distance of 3,000 ft (914 m) from the discharge outfall.

During the NRC's environmental review for the initial license renewal review, the NRC staff reviewed the above-described study as well as the results of pre- and post-operational ambient sampling of the aquatic community, which included fish, benthic invertebrates, plankton, and ichthyoplankton. The NRC (NRC 2002b) concluded that the discharge of heated effluent associated with Surry operations caused no appreciable harm to the local aquatic community. No additional thermal modeling or studies have been undertaken since the NRC's initial license renewal review.

Dominion (Dominion 2019a) reports that heat rejected to the river has not appreciably changed since the initial license renewal. During the 2010 measurement uncertainty recapture uprate, which authorized an increase in thermal power of the Surry units from 2,546 MWt to 2,587 MWt per unit, Dominion undertook certain plant component upgrades and modifications that increased the heat rejection efficiency of the systems. The upgrades and modifications resulted in a calculated net decrease in heat rejection load from 12.26×10^9 BTU/hr to 12.11×10^9 BTU/hr following the uprate. Since the uprate, Dominion has observed reduced heat rejection to the James River during periods of cooling intake water temperatures (i.e., ambient river temperatures of less than 70 °F (less than 21 °C)). In the summer months when ambient river water temperatures are greater than or equal to 70 °F (greater than or equal to 21 °C), Dominion has observed similar or slightly higher heat rejection than prior to the uprate (up to an additional 0.2×10^9 BTU/hr for a total of 12.32×10^9 BTU/hr), which equates to a discharge temperature rise of approximately 0.25 °F (0.14 °C) at the outfall. At all times since the uprate, heat rejection has remained well within the 12.6×10^9 BTU/hr VPDES permit limit, which is described in more detail below (Dominion 2019a).

Because the heat rejected to the river has not appreciably changed since the NRC's thermal analysis associated with the initial license renewal review, the NRC staff finds that its 2002 thermal analysis and conclusions remains a relevant characterization of the impacts of Surry's thermal effluent on the aquatic environment. The NRC staff incorporates this analysis (NRC 2002b; Section 4.1.3 on pages 4-14 through 4-15) into this SEIS by reference.

Aquatic Population Abundance Trends

In the previous section of this SEIS, the NRC staff reviewed aquatic population abundance trends as part of its impingement and entrainment analysis. Based on a comparison of historic (1974-1983) and more recent (2005-2006) ambient finfish and shellfish sampling in the James River near Surry, the relative abundances of *Alosa* species and hogchoker in the local aquatic community have decreased and the relative abundance of silversides has increased. Additionally, several species (e.g., blue crab, sand perch, American harvestfish, blue catfish, and white catfish) appeared in 2005-2006 sampling that had not appeared in the 1970s and early 1980s. Notably, no taxa or species wholly disappeared from the region. The local aquatic community remains a diverse assemblage of freshwater, estuarine, and marine species typical of the transition zone of a tidally influenced river. While the NRC staff recognizes that the community has exhibited observable changes in relative species abundances over the past several decades, none of the available information indicates a clear correlation between these changes and Surry operations, including thermal effects on aquatic organisms.

State-Imposed Thermal Effluent Limitations

Under 316(a) of the Clean Water Act, the EPA or the State may impose thermal effluent limitations to assure protection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife in and on the body of water into which the discharge is being made. The VDEQ (VDEQ 2016) limits the discharge of heated effluent at Surry under the site's VPDES permit to a daily maximum of 12.6×10^9 BTU/hr. The VDEQ has established this limit to protect the aquatic environment from impacts related to the thermal plume. Surry typically rejects 12.11×10^9 BTU/hr of heat to the river in non-summer months and up to 12.32×10^9 BTU/hr of heat to the river in summer months when ambient river water temperatures are greater than or equal to 70 °F (≥21 °C), as described above under "Thermal Study Results."

Dominion (2019a) is currently performing thermal plume modeling to update previous thermal demonstrations completed pursuant to Section 316(a) of the Clean Water Act. As part of its updated demonstration, Dominion will also prepare a biothermal assessment that will evaluate the potential effects of Surry's thermal plume on critical biological functions of representative important species. Dominion will submit a final report of the updated demonstration to the VDEQ with its next VPDES permit renewal application, which is currently due on September 1, 2020. Based on the results of its review, the VDEQ may impose additional requirements related to Surry's thermal effluent to assure the protection of a balanced, indigenous aquatic community. The VDEQ would impose any additional requirements as conditions in a future renewed VPDES permit that would be issued and take effect prior to the renewed operating license period. The NRC staff assumes that any additional requirements would further reduce thermal impacts on aquatic organisms over the course of the proposed license renewal term.

Thermal Impacts Conclusion

Based on the preceding analysis, the NRC staff concludes that thermal impacts on aquatic organisms resulting from the proposed subsequent license renewal would be SMALL.

4.7.2 No-Action Alternative

If Surry were to cease operating, impacts to the aquatic environment would decrease or stop following reactor shutdown. Some withdrawal of water from the James River 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 these purposes 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 wholly cease following transfer of spent fuel to dry storage. Effects from cold shock would be unlikely given the small area of the James River that the thermal plume occupies under normal operating conditions and the phased reductions in withdrawal and discharge of river water that would occur following shutdown.

The NRC staff concludes that the impacts of the no-action alternative on aquatic resources during the subsequent license renewal term would be SMALL.

4.7.3 Replacement Power Alternatives: Common Impacts

Construction impacts for any of the new replacement power plants would be qualitatively and quantitatively similar. Construction activities for a new replacement power plant and associated mechanical draft cooling towers could affect the aquatic environment in several ways, including 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 the James River and its nearby creek and stream tributaries by introducing pollutants and increasing sedimentation and turbidity. Dredging and other in-water work associated with a new power plant 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 would be further minimized by the new power plant's use of some of the existing infrastructure of Surry's intake and discharge systems, as well as use of the existing transmission lines, roads, parking areas, and use of certain other existing buildings and structures on the site. Aquatic habitat alteration and loss could be minimized by siting the plant father from the river and away from drainages and other onsite 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 the applicant to follow best management practices or take certain mitigation measures if adverse impacts were expected. For instance, the USACE oversees Section 404 permitting for dredge and fill activities, and the VDEQ oversees VPDES permitting and general stormwater permitting. Dominion would be required to obtain each of these permits to construct a new replacement power plant on the Surry site. Notably, the EPA final rule under Phase I of the Clean Water Act 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 125.83). Any new replacement power plant would be required to comply with the technology standards in this rule.

With respect to operation of a new replacement power plant, construction impacts for any of the new replacement power plants would be qualitatively similar but would vary in intensity based on each alternative's water use and consumption. The NRC staff analyzed the impacts of operation of cooling tower plants on the aquatic environment in the GEIS (NRC 2013a) and determined that many of the potential ecological impacts from operation of a fossil energy plant alternative would essentially be similar to those for a nuclear facility. 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, due to the relatively low volume of makeup water withdrawal for plants with a cooling tower system and the minimal heated effluent that would be discharged (NRC 2013a). Thus, impacts of operation of any of the new replacement power plant alternatives would likely be similar. Additionally, water use conflicts would be unlikely given that any new power plant alternative would be sited on the existing Surry site and would consume a small fraction of the river's flow past the plant.

4.7.4 New Nuclear (Small Modular Reactor) Alternative

The types of impacts that the aquatic environment would experience from a new nuclear (small modular reactor) alternative 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 this alternative. Based on that discussion, the NRC staff finds that impacts of construction would be SMALL because construction effects would be of limited duration, the new plant would use some of the existing site infrastructure and buildings, and required Federal and State water quality permits would likely include conditions requiring best management practices and mitigation strategies to minimize environmental effects.

With respect to operation, the new nuclear alternative would likely result in the highest intensity of impacts on the aquatic environment among the various replacement power alternatives because it would require the largest amount of makeup water and would result in the most consumptive water use. Federal and State water quality permits would control and mitigate many of the potential effects on the aquatic environment, such that water withdrawals and discharges would be unlikely to noticeably alter or destabilize any important attribute of the aquatic environment. The NRC staff finds that the impacts of operation would be SMALL.

The NRC staff concludes that the impacts to aquatic resources from construction and operation of a new nuclear (small modular reactor) alternative would be SMALL.

4.7.5 Natural Gas Combined-Cycle Alternative

The types of impacts that the aquatic environment would experience from a natural gas combined-cycle alternative 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 this alternative. Based on that discussion, the NRC staff finds that impacts of construction would be SMALL because construction effects would be of limited duration, the new plant would use some of the existing site infrastructure and buildings, and required Federal and State water quality permits would likely include conditions requiring best management practices and mitigation strategies to minimize environmental effects.

With respect to operation, the natural gas combined-cycle alternative would likely result in a lower intensity of impacts on the aquatic environment than the new nuclear (small modular reactor) alternative because it would require less makeup water and would result in less consumptive water use. Federal and State water quality permits would control and mitigate many of the potential effects on the aquatic environment, such that water withdrawals and discharges would be unlikely to noticeably alter or destabilize any important attribute of the aquatic environment. The NRC staff finds that the impacts of operation would be SMALL.

The NRC staff concludes that the impacts to aquatic resources from construction and operation of a natural gas combined-cycle alternative would be SMALL.

4.7.6 Combination Alternative (Natural Gas Combined-Cycle, Solar, and Demand-Side Management)

The types of impacts that the aquatic environment would experience from the natural gas combined-cycle component of this alternative are characterized in the previous sections discussing impacts common to all replacement power alternatives and impacts of the natural gas combined-cycle alternative. Construction and operation impacts of this component of the combination alternative would be qualitatively and quantitatively similar and, therefore, SMALL. Impacts of constructing the solar photovoltaic component of this alternative are also addressed in the previous sections discussing impacts common to all replacement power alternatives. These effects 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 photovoltaic component would have no discernable effects on the aquatic environment. The demand-side management component would also have no discernable effects on the aquatic environment.

The NRC staff concludes that the impacts to aquatic resources from construction and operation of a combination alternative would be SMALL to MODERATE during construction and SMALL during operation.

4.8 Special Status Species and Habitats

This section describes the potential impacts of the proposed action (license renewal) and alternatives to the proposed action on special status species and habitats.

4.8.1 Proposed Action

Table 4-2 identifies one site-specific (Category 2) issue applicable to special status species and habitats during the Surry license renewal term. This issue is analyzed below.

4.8.1.1 Endangered Species Act: Federally Listed Species and Critical Habitats under U.S. Fish and Wildlife Jurisdiction

In Section 3.8.1.2, "Endangered Species Act: Species and Habitats under U.S. Fish and Wildlife Service Jurisdiction," the NRC staff establishes that one listed species may occur in the action area: the northern long-eared bat (*Myotis septentrionalis*). Section 3.8.1.2 includes relevant information on the habitat requirements, life history, and regional occurrence of this species. In the sections below, the NRC staff analyzes the potential impacts of the proposed Surry subsequent license renewal on this species. Table 4-7 identifies the NRC staff's Endangered Species Act effect determination that resulted from the staff's analysis.

Table 4-7 Effect Determinations for Federally Listed Species Under U.S. Fish and Wildlife Service Jurisdiction

Species	Federal Status[a]	Potentially Present in the Action Area?	Effect Determination[b]
Northern long-eared bat	FT	Yes	May affect, but is not likely to adversely affect

[a] Under the Endangered Species Act, species may be designated as federally endangered (FE) or federally threatened (FT).

[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's Endangered Species Consultation Handbook (FWS and NMFS 1998).

Northern Long-Eared Bat (Myotis septentrionalis)

In Section 3.8.1.2 in the subsection titled "Northern Long-Eared Bat (*Myotis septentrionalis*)," the NRC staff concludes that northern long-eared bats may occur in the action area's forests in spring, summer, and fall. If present, northern long-eared bats would occur occasionally and in low numbers.

The potential stressors that northern long-eared bats could experience from operation of a nuclear plant (generically) are as follows.

- mortality or injury from collisions with 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. The NRC staff did not identify any indirect, interrelated, or interdependent effects of license renewal.

Mortality or Injury from Collisions with Plant Structures and Vehicles

Several studies have documented bat mortality or injury resulting from collisions with man-made structures. Saunders (1930) reported that five bats of three species—eastern red bat (*Lasiurus borealis*), hoary bat (*L. cinereus*), and silver-haired bat (*Lasionycteris noctivagans*)—were killed when they collided with a lighthouse in Ontario, Canada. In Kansas, Van Gelder (1956) documented five eastern red bats that collided with a television tower. In Florida, Crawford and Baker (1981) collected 54 bats of seven species that collided with a television tower over a 25-year period; Zinn and Baker (1979) reported 12 dead hoary bats at another television tower in the state over an 18-year period; and Taylor and Anderson (1973) reported 1 dead yellow bat (*Lasiurus intermedius*) at a third Florida television tower. Bat collisions with communications towers have been reported in North Dakota, Tennessee, and Saskatchewan, Canada; with convention center windows in Chicago, IL; and with power lines, barbed wire fences, and vehicles in numerous locations (Johnson and Strickland 2003).

More recently, bat collisions with wind turbines have been of concern in North America. Bat fatalities have been documented at most wind facilities throughout the United States and Canada (USGS 2015b). For instance, during a 1996–1999 study at the Buffalo Ridge wind power development project in Minnesota, Johnson et al. (2003) reported 183 bat fatalities, most of which were hoary bats and eastern red bats. The U.S. Geological Survey's Fort Collins Science Center estimates that tens to hundreds of thousands of bats die at wind turbines in North America each year (USGS 2015b).

Bat collisions with man-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 2014a) noted that four dead bats were collected at the plant during bird mortality studies conducted from 1972 through 1979. Two red bats (*Lasiurus borealis*) were collected at the cooling tower, and one big brown bat and one tri-colored bat were collected near other plant structures. The NRC (NRC 2014a) 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 plant site provides. The FWS (FWS 2014b) concurred with this determination. In a 2015 assessment associated with Indian Point Nuclear Generating Units 2 and 3, in New York, the NRC (NRC 2015) determined that bat collisions were less likely to occur at Indian Point than at Davis-Besse 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) concluded that the likelihood of bats colliding with these and other plant structures on the Indian Point site during the license renewal period was extremely unlikely to occur and, therefore, discountable. The FWS concurred with this determination (FWS 2015b). Most recently, the NRC (NRC 2018b) determined that the likelihood of bats colliding with site buildings or structures on the Seabrook Station, Unit 1, 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 2018d) again concurred with the NRC's determination.

On the Surry site, the tallest site structures are the reactor containment buildings, each of which is 159 ft (48 m) high (Dominion 2018b). The turbine buildings and transmission lines are also prominent features on the site. To date, Dominion has reported no incidents of injury or mortality of any species of bat on the Surry site associated with site buildings or structures. Accordingly, the NRC staff finds the likelihood of future northern long-eared 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) indicates that bat species do not seem to be particularly susceptible to vehicle collisions. However, the 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). In most cases, the FWS expects that roads of increasing size decrease the likelihood of bats crossing the roads and, therefore, reduce collision risk (FWS 2016). During the proposed Surry subsequent license renewal term, vehicle traffic from truck deliveries, site maintenance activities, and personnel commuting to and from the site would continue throughout the license renewal 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 Surry site. Additionally, most vehicle activity would occur during daylight hours when bats are less active. To date, Dominion has reported no incidents of injury or mortality of any species of bat on the Surry 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 established in this SEIS, the Surry action area includes 403 ac (163 ha) of forested habitat, and northern long-eared bats may occur in these areas in spring, summer, and fall. In its final rule listing the northern long-eared bat (80 FR 17974), the FWS states that forest conversion and forest modification from management are two of the most common causes of habitat loss, degradation, disturbance, or fragmentation affecting the species. Forest conversion is the loss of forest to another land use type, such as cropland, residential, or industrial. Forest conversion can affect bats in the following ways (80 FR 17974):

- loss of suitable roosting or foraging habitat
- fragmentation of remaining forest patches, leading to longer flights between suitable roosting and foraging habitat
- removal of travel corridors, which can fragment bat colonies and networks
- direct injury or mortality during active forest clearing and construction

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, such as (80 FR 17974):

- maintaining or increasing suitable roosting and foraging habitat within the species' home range (positive)
- removing trees or small areas of forest outside of the species' summer home range or away from hibernacula (neutral)
- removing potential roost trees within the species' summer home range (negative)
- performing management activities near hibernacula that could disturb hibernating bats (negative)
- direct injury or mortality during forest clearing (negative)

Concerning forest conversion and its effects, the proposed action would not involve forest conversion or other activities that could result in similar impacts. Accordingly, bats would not experience the effects identified above and associated with forest conversion from the proposed action.

Concerning forest management, the proposed action would not involve forest management specifically. However, Dominion would continue to perform vegetation maintenance on the site over the course of the proposed license renewal 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. Dominion would continue to maintain onsite transmission line rights-of-way in accordance with North American Electric Reliability Corporation standards. Less-developed areas and forested areas would be largely unaffected during the subsequent license renewal term. Dominion (Dominion 2019_ER) does not intend to expand the existing facilities or otherwise perform construction or maintenance activities within these areas. 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 to 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 Dominion personnel would follow company guidance, as explained below, to minimize potential impacts to bats.

Dominion requires its personnel and contractors to consider potential impacts to northern long-eared bats prior to site maintenance activities involving tree clearing. Dominion maintains company-wide guidance that specifies how its personnel should proceed depending on the type of tree clearing or site maintenance being performed. This guidance is summarized below for hazardous tree removal, existing right-of-way maintenance and expansion, clearing of less than or equal to 10 ac (4 ha) of trees, and clearing of greater than 10 ac (4 ha) of trees that are not in or adjacent to an existing right-of-way.

<u>Hazardous Tree Removal</u>. The FWS's Endangered Species Act 4(d) rule for the northern long-eared bat (81 FR 1900) does not prohibit or restrict hazardous tree removal to protect human life or property. Prior to undertaking hazardous tree removal, Dominion (Dominion 2019a) documents its determination that the action meets the FWS's definition of hazardous tree removal. Dominion (Dominion 2019a) does not specifically coordinate with the

FWS for such activities, but Dominion avoids clearing hazardous trees during the brooding season in June and July.

<u>Existing Right-of-Way Maintenance and Expansion</u>. The FWS's northern long-eared bat 4(d) rule does not prohibit routine maintenance and expansion of up to 100 ft (30 m) from either edge of an existing right-of-way as long as the project does not occur within 0.25 mi (0.4 km) of a known hibernaculum, does not involve cutting of known maternity roost trees in June or July, and does not involve clear-cutting within 0.25 mi (0.4 km) of known maternity roost trees in June or July. Prior to undertaking existing right-of-way maintenance and expansion, Dominion (Dominion 2019a) personnel review previously conducted bat surveys in the project area. If no surveys have been conducted in the project area, Dominion (Dominion 2019a) coordinates with the applicable FWS field office or the State resource agency, as appropriate. If known roost trees or hibernacula occur within 0.25 mi (0.4 m) of the project area, Dominion (2019a) does not perform clearing in June or July without prior coordination with the FWS. If surveys have been conducted and those surveys identify no maternity roost trees, Dominion (Dominion 2019a) does not coordinate with the FWS prior to undertaking the activity.

<u>Clearing of Less Than or Equal to 10 Acres of Trees</u>. The FWS's Gloucester, VA, field office interprets the northern long-eared bat 4(d) rule to not prohibit projects resulting in less than or equal to 10 ac (4 ha) of tree clearing if those projects are outside of certain location restrictions. For such projects, Dominion (Dominion 2019a) follows the process described above for existing right-of-way maintenance and expansion prior to undertaking tree clearing.

<u>Clearing of Greater Than 10 Acres of Trees That Are Not In or Adjacent to an Existing Right-of-Way</u>. The FWS's Gloucester, VA, field office interprets the NLEB 4(d) rule to prohibit all projects not occurring in or adjacent to an existing right-of-way and resulting in greater than 10 ac (4 ha) of tree clearing that may affect the species. For such projects, Dominion (Dominion 2019a) requires its personnel to coordinate with the FWS prior to undertaking such a project. The company recognizes that the FWS will likely require habitat surveys or acoustic or mist net bat surveys for such projects with clearing planned between April 15 and September 15 if such surveys have not been completed within the past 5 years. If surveys do not identify suitable bat habitat or bats on the project site, and the FWS agrees with the survey results, Dominion (Dominion 2019a) does not restrict clearing to a particular time of year. If surveys identify bats on the project site, Dominion (Dominion 2019a) restricts clearing to between September 16 and April 14. Alternately, Dominion (Dominion 2019a) may coordinate with the FWS to determine if there are options that would allow clearing in the spring and summer. Dominion (Dominion 2019a) recognizes that State resource agencies may have additional requirements related to surveys or development of habitat conservation plans for which coordination may be necessary.

The NRC staff finds that the measures summarized above, in addition to the infrequency with which hazardous trees would likely be removed in forested areas, would not measurably affect any potential spring staging, summer roosting, or fall swarming habitat in the action area. Direct injury or mortality to bats during tree removal is also unlikely because Dominion company guidance would ensure that personnel take the appropriate measures to avoid this potential impact. For instance, Dominion 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 subsequent license renewal term would result in positive impacts to northern long-eared bats, if 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 (FWS 2016). 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, Table 4-1). Increased noise may also affect foraging success. Schaub et al. (2003) found that 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 Surry 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 Surry 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). 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 (U.S. Army 2014). Northern long-eared bats would likely respond similarly.

Continued operation of Surry during the subsequent license renewal term would not include major construction or refurbishment and would involve no other maintenance or infrastructure repair activities other than those 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 subsequent license renewal term would be similar to ongoing conditions since Surry 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 northern long-eared bats, if present in the action area, have already acclimated to regular site disturbances. Thus, continued disturbances during the subsequent license renewal 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.

Summary of Effects

The potential stressors evaluated in this section are unlikely to result in effects on the northern long-eared bat that could be meaningfully measured, detected, or evaluated or 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 Surry. Vehicle collisions attributable to the proposed action are also unlikely, and none have been reported at Surry.
- 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 to 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 subsequent license renewal term, such disturbances and activities would continue at current rates and would be limited to the industrial-use portions of the site.

Conclusion for Northern Long-eared Bat

All potential effects on the northern long-eared 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 northern long-eared bat.

In a letter dated April 9, 2019, the FWS concurred with this determination based on the premise that activities associated with the proposed license renewal with the potential to affect the northern long-eared bat are consistent with the activities analyzed in the FWS's January 5, 2016, programmatic biological opinion (FWS 2016, FWS 2019b).

4.8.1.2 Endangered Species Act: Federally Listed Species and Critical Habitats under National Marine Fisheries Service Jurisdiction

In Section 3.8.1.3, "Endangered Species Act: Species and Habitats under National Marine Fisheries Service Jurisdiction," the NRC staff establishes that two listed species occur in the action area: the shortnose sturgeon (*Acipenser brevirostrum*) and Atlantic sturgeon (*A. oxyrinchus oxyrinchus*). Section 3.8.1.3 includes relevant information on the habitat requirements, life history, and regional occurrence of these species. Additionally, designated critical habitat of the Chesapeake Bay distinct population segment (DPS) of Atlantic sturgeon occurs in the action area. In the sections below, the NRC staff analyzes the potential impacts of the proposed Surry subsequent license renewal on these species and critical habitats. Table 4-8 identifies the NRC staff's Endangered Species Act effect determinations that resulted from the staff's analysis.

Table 4-8 Effect Determinations for Federally Listed Species and Critical Habitats Under National Marine Fisheries Service Jurisdiction

	Federal Status[a]	Present in the Action Area?	Effect Determination[c]
shortnose sturgeon	FE	Yes	May affect, but is not likely to adversely affect
Atlantic sturgeon	FE, FT[b]	Yes	May affect, but is not likely to adversely affect
critical habitat of the Chesapeake DPS of Atlantic sturgeon	FD	Yes	May affect, but is not likely to destroy or adversely modify

[a] Under the Endangered Species Act, species may be designated as federally endangered (FE) or federally threatened (FT). For critical habitat, "FD" indicates federally designated.
[b] The NMFS listed five distinct population segments (DPSs) of the Atlantic sturgeon. Some DPSs are federally endangered and some are federally threatened.
[c] The NRC staff makes its effect determinations for federally listed species in accordance with the language and definitions specified in the FWS and NMFS's *Endangered Species Consultation Handbook* (FWS and NMFS 1998).

In Section 3.8.1.3 in the subsections titled "Shortnose Sturgeon (*Acipenser brevirostrum*)," and "Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*)," the NRC staff concludes that adult shortnose sturgeon and subadult and adult Atlantic sturgeon may occur in the action area seasonally during spring and fall migratory periods. Both species have been documented in the action area, although the occurrence of shortnose sturgeon in the James River is very rare according to current survey data.

The potential stressors that sturgeon could experience from operation of a nuclear power plant (generically) are as follows.

- impingement and entrainment
- thermal effects
- exposure to radionuclides and other contaminants
- reduction in available food resources due to impingement and entrainment or thermal effects to prey species
- effects from maintenance dredging

This section addresses each of these stressors below. The NRC staff identified one interdependent effect (maintenance dredging) that would not occur but for the proposed license renewal because it would have no independent utility apart from license renewal. This effect is analyzed below. The NRC staff did not identify any indirect or interrelated effects of license renewal.

Impingement and Entrainment

Impingement occurs when organisms are trapped against the outer part of a screening device of an intake structure and the force of intake water traps the organisms against the screen such that they are unable to escape (79 FR 48299). Entrainment occurs when organisms pass through the screening device and travel through the entire cooling system (79 FR 483299). In Section 4.7.1.1, "Impingement and Entrainment of Aquatic Organisms (Plants with Once-Through Cooling Systems or Cooling Ponds," of this SEIS, the NRC staff evaluates the collective effects of impingement and entrainment for all James River aquatic organisms and concludes that impacts would be SMALL over the course of the license renewal term. This section evaluates the species-specific impacts of impingement and entrainment on shortnose and Atlantic sturgeon.

Impingement. To investigate impingement, the NRC staff first considered the velocity at which Surry's low-level intake structure withdraws river water in relation to sturgeon swimming ability. Swimming speed is an important factor that influences a species' ability to avoid impingement. Fish are likely to become impinged in situations where a facility's intake velocity is greater than a species' burst swimming speeds. Fish naturally exhibit burst swimming behavior when navigating short-term fast currents, capturing prey, and avoiding predators. Burst swimming behavior also helps individuals avoid the draw of water into a cooling water intake system.

As established in Section 3.1.3, "Cooling and Auxiliary Water Systems," and in the subsection of Section 4.7.1.1 titled, "Cooling Water Intake System Design," intake flow at Surry's low-level intake structure trash racks is 0.98 fps (0.3 m/s), and the through-rack velocity is 1.12 fps (0.34 m/s) (HDR 2016b). Based on these velocity parameters, fish capable of burst swimming speeds of 0.98 fps (0.3 m/s) or greater are likely capable of avoiding the draw of water into the intake structure and would not be impinged. Fish that do not initially swim away from the intake and that are drawn closer to the trash racks would experience increased velocities and would need to exhibit burst swimming capabilities of up to 1.12 fps (0.34 m/s) to escape impingement. Fish size and age, water temperature, level of fatigue, ability to remain in a head-first orientation into current, and whether the fish is sick or injured would also affect susceptibility to impingement.

In an experiment involving yearling (11.0–12.8 inches (280–324 mm) total length), juvenile (20.3–22.9 inches (516–581 mm) total length), and adult (23.6–27.6 inches (600–700 mm) total length) shortnose sturgeon, Kynard et al. (2006) tested impingement and entrainment in relation to a vertical bar rack with 2-inch (5.08-cm) spacing. Researchers observed that after yearlings contacted the bar rack, they could control swimming at 1 and 2 fps (0.3 and 0.6 m/s), but many could not control swimming at 3 fps (0.9 m/s) velocity. Juveniles and adults were able to control swimming and move along the rack after contact with it at all three velocities. During these tests, no adults or juveniles were impinged or entrained at any approach velocity. No yearlings were impinged at velocities of 1 fps (0.3 m/s), but 7.7 to 12.5 percent of yearlings were impinged at 2 fps (0.6 m/s), and 33.3 to 40.0 percent were impinged at 3 fps (0.9 m/s). Yearlings were also entrained (measured as passage through the rack) during trials at the following rates: 4.3 to 9.1 percent at 1 fps (0.3 m/s), 7.1 to 27.8 percent at 2 fps (0.6 m/s), and 66.7 to 80.0 percent at 3 fps (0.9 m/s). From this study, the NMFS (NMFS 2013) concluded in a 2013 biological opinion that shortnose sturgeon of at least 11 inches (280 mm) fork length, which is inclusive of yearlings and all older age classes, would have sufficient swimming ability to avoid impingement at an intake with velocities of 1 fps (0.2 m/s) or less as long as conditions are similar to those in the study (e.g., fish are healthy and no other environmental factors in the field, such as heat stress, pollution, and/or disease, operate to adversely affect their swimming ability).

Deslauriers and Kieffer (2012) investigated the swimming speed that causes juvenile shortnose sturgeon to experience fatigue. Researchers exposed juvenile shortnose sturgeon (7.7 inches (19.5 cm) average total length) to increasing current velocities in a laboratory flume to determine the velocity that caused fatigue. Fish were first acclimated for 30 minutes to a current velocity of 0.16 fps (0.05 m/s) and then exposed to increasing current velocities at 0.16-fps (0.05-m/s) increments for 30 minutes per increment until fish exhibited fatigue. Fish were considered fatigued when they were impinged on the downstream plastic screen for a period of 5 seconds. The current velocity that induced fatigue was reported as the critical swimming speed, and the effect of water temperature on critical swimming speed was tested at five temperatures: 41, 50, 59, 68, and 77 °F (5, 10, 15, 20, and 25 °C). Deslauriers and Kieffer (2012) reported that tested juvenile shortnose sturgeon swam at a maximum of 2.7 body lengths per second at velocities of 1.47 fps (45 cm/s).

Boysen and Hoover (2009) conducted swimming performance trials in a laboratory swim tunnel with hatchery-reared juvenile white sturgeon (*Acipenser transmontanus*) to evaluate entrainment risk in cutterhead dredges. The authors observed that 80 percent of individuals, regardless of size, strongly oriented themselves into the current but that endurance was highly variable. Small juveniles (less than 3.2 inches (less than 82 mm) total length) exhibited lower escape speeds (less than 1.31 fps (less than 0.4 m/s)) than medium (3.2–3.6 inches (82–92 mm) total length) and large (greater than 3.7 inches (greater than 93 mm) total length) fish (1.47 fps (0.42–0.45 m/s)). The authors concluded that the probability of entrainment of juvenile white sturgeon could be minimized by maintaining dredge head flow fields at less than 1.47 fps (0.45 m/s).

Finally, Hoover et al. (2011) used a Blazka-type swim tunnel to quantify head-first orientation into flowing water, endurance (time to fatigue), and behavior of juvenile sturgeon in water velocities ranging from 0.3–3.0 fps (0.1–0.9 m/s). Researchers tested lake (*Acipenser fulvescens*) and pallid (*Scaphirhynchus albus*) sturgeon from two different U.S. populations. The authors concluded that entrainment was unlikely at distances where velocity had decreased to 1.31 fps (0.40 m/s).

Based on its review of the scientific literature summarized above, the NRC staff assumes for the purposes of its analysis that shortnose and Atlantic sturgeon of at least 11 inches (280 mm) fork length, which includes all life stages of sturgeon that would occur in the action area, would have sufficient swimming ability to avoid impingement at intake velocities of 1 fps (0.2 m/s) or less. Larger sturgeon, such as subadults and adults, are likely capable of withstanding higher intake velocities. Further, the NRC staff assumes that sturgeon are capable of exhibiting higher burst swimming speeds for short periods of time. Thus, the staff expects that shortnose and Atlantic sturgeon in the action area should have sufficient swimming ability to escape the initial intake trash rack approach velocity of 0.98 fps (0.3 m/s) and avoid impingement. This assumption is further supported by the absence of shortnose or Atlantic sturgeon in impingement collections during both historic and recent impingement studies at Surry (see Section 4.7.1.1 of this SEIS) as well as conclusions made by the NMFS regarding the potential impacts of Surry operations on Atlantic sturgeon during a previous Endangered Species Act Section 7 consultation with the NRC. In that consultation and based on the impingement and entrainment studies completed at Surry at that time, the NMFS (NMFS 2012) concluded that impingement of Atlantic sturgeon is extremely unlikely to occur. In conclusion, the NRC staff finds that impingement of shortnose or Atlantic sturgeon represents a discountable effect because it is extremely unlikely to occur during the proposed license renewal period.

<u>Entrainment</u>. Entrainable life stages of shortnose and Atlantic sturgeon (e.g., eggs and larvae) do not occur in the action area, as established previously in this SEIS and summarized in Table 3-12, “Occurrences of Federally Listed Species and Critical Habitats in the Action Area Under National Marine Fisheries Service Jurisdiction.” Sturgeon eggs are adhesive and demersal and occur only on spawning grounds. Larvae would not be expected to travel as far downstream as the Surry action area before progressing to a more advanced life stage. Thus, the proposed action would not result in entrainment of either sturgeon species.

Thermal Effects

Ambient water temperatures in the Surry action area are relatively warm and range from a low of approximately 53.6 °F (12 °C) in winter and a high of 82.4 °F (28 °C) in summer. The water column stratifies near the top 6 ft (0.3 m) such that water deeper than 6 ft (0.3 m) from the surface is typically 1.1 °F (0.6 °C) cooler than the surface in summer. Surry discharges heated effluent through a discharge tunnel and into a discharge canal that flows into the James River at RM 37 (RKM 60). While the spatial extent of Surry's thermal plume varies with the tides, the plume at no point extends to a depth of more than 6 ft (1.8 m) or more than half the width of the river at its narrowest point. Section 3.1.3.1, "River Water Intake and Discharge," and Section 4.7.1.2, "Thermal Impacts on Aquatic Organisms (Plants with Once-Through Cooling Systems or Cooling Ponds)," of this SEIS further describe the characteristics of Surry's thermal effluent discharge.

Most organisms can acclimate to temperatures above or below those to which they are normally subjected. Bull (1936) demonstrated with a range of marine species that fish could detect and respond to a temperature front of 0.05–0.13 °F (0.3–0.7 °C) by avoiding the stressful temperatures and actively seeking refuge in water of preferred temperatures. While the thermal preference of shortnose sturgeon is unknown, the species has been found to occupy waters with temperatures as low as 35.6–37.4 °F (2–3 °C) (Dadswell et al. 1984) and as high as 93.2 °F (34 °C) (Heidt and Gilbert 1978). Shortnose sturgeon will forage at temperatures greater than 44.6 °F (7 °C) (Dadswell 1979). At temperatures of 82.4–86 °F (28–30 °C), sturgeon in the Altamaha River in Georgia move to deeper cool water refuges (NMFS 2013).

Ziegeweid et al. (Ziegeweid et al. 2008a) conducted studies to determine critical and lethal thermal maxima for young-of-the-year shortnose sturgeon acclimated to temperatures of 67.1–75.4 °F (19.5–24.1 °C). The authors found the lethal thermal maxima to be 94.6 °F and 97 °F (34.8 °C and 36.1 °C) for fish acclimated to 67.1 °F and 75.4 °F (19.5 °C and 24.1 °C), respectively. The authors also used thermal maximum data to estimate upper limits of safe temperature, final thermal preferences, and optimum growth temperatures for young-of-the-year shortnose sturgeon. Fish exhibited similar behaviors with increasing temperature regardless of acclimation temperature: as temperatures increased, fish activity increased, and approximately 9–11 °F (5–6 °C) prior to the lethal endpoint, fish began frantically swimming around the tank, presumably looking for an escape route. As fish began to lose equilibrium, their activity level decreased dramatically, and at about 0.54 °F (0.3 °C) before the lethal endpoint, most fish were completely incapacitated. From these experiments, Ziegeweid et al. (Ziegeweid et al. 2008a) determined the upper limits of safe temperature to range from 83.7–88 °F (28.7–31.1 °C) and to vary with acclimation temperature and measured endpoint. Final thermal preference ranged from 79.2–82.9 °F (26.2–28.3 °C) regardless of acclimation temperature. Critical thermal maxima (the point at which fish lost equilibrium) ranged from 92.7 (±0.54) °F to 97 (±0.36) °F (33.7 (±0.3) °C to 36.1 (±0.2) °C) and varied with acclimation temperature.

In another study, Ziegeweid et al. (Ziegeweid et al. 2008b) used data from laboratory experiments to examine the individual and interactive effects of salinity, temperature, and fish weight on the survival of young-of-year shortnose sturgeon. Sturgeon survival in freshwater declined as temperature increased, but temperature tolerance increased with body size. The authors concluded that temperatures above 84.2 °F (29 °C) substantially reduce survival probability for young-of-year shortnose sturgeon. However, previous studies indicate that juvenile sturgeons achieve optimum growth at temperatures close to their upper thermal survival limits (Mayfield and Cech 2004; Allen et al. 2006; Ziegeweid et al. 2008a), suggesting that shortnose sturgeon may seek out a narrow temperature window. Ziegeweid (2006) examined thermal tolerances of young-of-the-year shortnose sturgeon in a lab. The author observed mortality at 86.2–88.7 °F (30.1–31.5 °C) depending on fish size and test conditions. Dissolved oxygen also seems to play a role in temperature tolerance such that shortnose sturgeon can withstand higher temperatures in high-dissolved-oxygen conditions better than high temperatures in low-dissolved-oxygen conditions (Niklitchek 2001).

Limited information on the thermal tolerances of Atlantic sturgeon is available. Atlantic sturgeon have been observed in water temperatures above 86 °F (30 °C) in the south (Damon-Randall et al. 2010). In the laboratory, Niklitchek (2001) observed negative behavioral and bioenergetics responses (related to food consumption and metabolism) in juvenile Atlantic sturgeon after prolonged exposure to temperatures greater than 82.4 °F (28 °C). As with shortnose sturgeon, Atlantic sturgeon's tolerance to temperature likely increases with age and body size (Jenkins et al. 1993; Ziegeweid et al. 2008a). However, no information on the lethal thermal maximum or stressful temperatures for subadult or adult Atlantic sturgeon is available. For purposes of considering effects of thermal tolerances, the NRC staff assumes that the shortnose sturgeon is a reasonable surrogate for Atlantic sturgeon given similar geographic distribution and known biological similarities.

The NMFS (NMFS 2012) analyzed the potential for Surry's thermal plume to affect Atlantic sturgeon during a 2012 Endangered Species Act Section 7 consultation with the NRC. Since that time, Dominion has not undertaken any additional thermal studies, and no operational changes at Surry have occurred that would affect the characteristics of the thermal plume or its effects on the aquatic environment. The NMFS did not specifically consider thermal impacts on shortnose sturgeon because this species was not known to occur in the James River until recently. However, the NRC staff assumes that the two species of sturgeon have similar thermal tolerances, as established previously in this section. Therefore, the NRC staff finds the NMFS's 2012 analysis and findings, as summarized below, relevant to the proposed action.

The NMFS (NMFS 2012) assumes that sturgeon will exhibit behavioral avoidance at temperatures of 82.4 °F (28 °C). James River ambient temperatures are typically at or above this temperature during peak summer heat. During this time, shortnose sturgeon subadults and adults and Atlantic sturgeon juveniles, subadults, and adults may occupy the action area. In these conditions, sturgeon are likely to seek refuge in deep, cool-water areas outside of the action area based on documented behavior of tagged Atlantic sturgeon in the James River. Surry's thermal plume only extends 6 ft (1.8 m) from the river's surface and does not extend more than halfway across the river even during summer months. Because sturgeon are benthic fish, individuals would rarely inhabit the upper portion of the water column influenced by the thermal plume. Any sturgeon that encounters thermally influenced waters would likely swim away from the plume by traveling deeper into the water column or by swimming around the plume. The thermal plume would not affect either sturgeon species' ability to carry out essential life functions (i.e., foraging, migrating, resting) in the action area because only small areas of elevated temperatures above 82.4 °F (28 °C) would occur, such areas would only exist for short periods on a seasonal basis, and the lower portion of the water column would be unaffected. Behavioral avoidance of individuals that encounter the thermal plume would not affect the fitness of those individuals or increase energy expenditures to an extent that would measurably or detectably affect those individuals' physiology or affect future growth, reproduction, or general health.

With respect to the potential for sturgeon to be exposed to temperatures that could result in mortality (greater than or equal to 91.4 °F (greater than or equal to 33 °C)), the NMFS (NMFS 2012) found it would be extremely unlikely for sturgeon to swim through waters with temperatures greater than 82.4 °F (28 °C) to reach areas where the water is warm enough to result in mortality. Given that fish are known to avoid areas with unsuitable conditions and that sturgeon, specifically, actively avoid heated areas and move to deep cool-water areas during the summer months, sturgeon would avoid areas where temperatures are greater than tolerable. Thus, it would be extremely unlikely for any sturgeon to remain in areas where surface temperatures are elevated to 91.4 °F (33 °C) or higher and exposure to potentially lethal temperatures is possible. Such risk is further reduced by (a) the exclusion of sturgeon from the discharge canal where effluent temperatures are highest, (b) the limited amount of time sturgeon spend near the surface of the water column, (c) the small area of the thermal plume, and (d) the gradient over which warm waters extend from the discharge. Any sturgeon present in the action area would likely begin avoiding waters at 82.4 °F (28 °C) and are unlikely to either remain in these waters or swim towards the outfall and be exposed to higher temperatures that could cause mortality.

Based on the preceding analysis, the NRC staff finds that thermal effects of the proposed license renewal on shortnose and Atlantic sturgeon represents an insignificant effect because such effects would not be able to be meaningfully measured, detected, or evaluated and would never reach the level of take.

Exposure to Radionuclides and Other Contaminants

In the GEIS (NRC 2013a), the NRC staff evaluates the effects that radionuclides and other contaminants contained in nuclear plant effluent discharges may have on the aquatic environment under two categories: effects of nonradiological contaminants on aquatic organisms and exposure of aquatic organisms to radionuclides. The NRC determined in the GEIS that these impacts would be SMALL during the license renewal period of a nuclear power plant, such that environmental effects would not be detectable or would be so minor that they would neither destabilize nor noticeably alter any important attribute of the aquatic environment. Because these potential effects apply to all nuclear plants, the NRC staff bases this conclusion on factors that apply at all nuclear plants. For instance, with respect to nonradiological contaminants, a primary factor that led to the staff's conclusion of SMALL is that in order to operate a nuclear plant, licensees must comply with the Clean Water Act, including requirements imposed by the EPA or the State as part of the NPDES program under Section 402 of the Act and State water quality certification requirements under Section 401 of the Act. If these water quality criteria are not violated, the NRC assumes that nonradiological contaminant discharges would not significantly affect the aquatic environment.

With respect to radionuclides, the NRC staff uses U.S. Department of Energy (DOE) guidelines to evaluate the potential effects of exposure of aquatic organisms to radionuclides during a nuclear plant license renewal term (DOE 2019a). The DOE developed and published a screening methodology that includes biota concentration guides (BCGs) for surface water, sediment, and soil. The DOE developed its BCGs to be conservatively protective of nonhuman biota for radionuclides, including tritium (H-3), based on limiting the potential radiological dose rate to the most sensitive receptors. For each radionuclide and exposure pathway (i.e., surface water, sediment, and soil), the most sensitive receptor (or reference organism) may be an aquatic, terrestrial, or riparian animal, or a terrestrial plant. Specific to aquatic animal reference organisms, the DOE uses a dose rate criterion of less than or equal to 1 rad per day (rad/d) of absorbed dose. This dose rate criterion can be applied within the DOE's graded approach to determine whether radionuclide concentrations at a specific site are likely to result in doses exceeding DOE guidelines. If the graded approach demonstrates that the absorbed dose would be less than or equal to 1 rad/d, aquatic biota would not experience negative population-level effects. In the GEIS, the NRC uses the DOE's dose rate criterion of less than or equal to 1 rad/d and the DOE's graded approach to conclude that the impacts of exposure of aquatic organisms to radionuclides resulting from license renewal of a nuclear plant would be SMALL.

Specific to the proposed Surry license renewal, the NRC staff adopted the GEIS's conclusions of SMALL for the effects of nonradiological or radiological contaminants on aquatic organisms because the staff did not identify any new and significant information during its review related to these issues (see Section 4.7.1 of the SEIS). This section evaluates the species-specific impacts of nonradiological and radiological contaminants on shortnose and Atlantic sturgeon.

Nonradiological Contaminants. Nonradiological contaminants discharged in Surry's thermal effluent are regulated by the VDEQ under the site's VPDES permit. The VDEQ limits the concentration of pollutants in effluent when required for a specific type of facility or when analysis indicates that there is a reasonable potential for an excursion from a water quality standard. The VPDES permit also regulates thermal discharges, total residual chlorine, pH, total phosphorus, fecal coliform, total organic carbon, and total petroleum hydrocarbons. The VPDES permit establishes allowable pollutant discharge concentrations at levels at or below EPA's (EPA 2019g) national recommended aquatic life criteria for acute (short-term) and chronic (long-term) exposure. Under these criteria, the EPA considers "unacceptable acute effects" to be those effects that are lethal or immobilize an organism during short-term exposure to a pollutant. "Unacceptable chronic effects" are those effects that will impair growth, survival, and reproduction of an organism following long-term exposure to a pollutant. Thus, the EPA aquatic life criteria are designed to ensure that aquatic species exposed to pollutants in compliance with these levels will not experience any impairment of growth, survival or reproduction.

Data on toxicity as it relates to shortnose or Atlantic sturgeon are extremely limited. In the absence of species-specific acute and chronic toxicity data, the NMFS (NMFS 2012) has adopted the EPA aquatic life criteria as the best available scientific information. The NMFS (NMFS 2012) finds it is reasonable to consider that these criteria are applicable to federally listed species under its jurisdiction because these criteria are derived from data using the most sensitive species and life stages for which information is available. For Surry, the relevant water quality criteria are the Virginia water quality criteria, which must be certified by the EPA every 3 years. This certification process is designed to ensure that the Virginia water quality standards are consistent with, or more protective than, the EPA national recommended aquatic life criteria.

Based on the reasoning outlined above, the NMFS (NMFS 2012) determined during its 2012 consultation with the NRC that nonradiological pollutants that are discharged with no reasonable potential to cause excursions in water quality standards will not cause effects that impair growth, survival, or reproduction of listed species. The NMFS (NMFS 2012) concluded that effects on Atlantic sturgeon would be insignificant because the VDEQ has established pollutant discharge concentrations at levels at or below the EPA aquatic life criteria through Surry's VPDES permit.

Since the NMFS made the above-described conclusions, the presence of shortnose sturgeon was discovered in the James River and the VDEQ issued a new VPDES permit for Surry, both of which occurred in 2016. Toxicity data on shortnose sturgeon are extremely limited. In the absence of species-specific information, the NRC staff assumes that the EPA aquatic life criteria represent the best available scientific information based on the reasoning presented above. Like the previously issued permit, the 2016 VPDES permit establishes allowable pollutant discharge concentrations for Surry at levels at or below the EPA aquatic life criteria. The NRC staff assumes that the VDEQ would continue to set such limits in any future VPDES permits issued for Surry during the proposed license renewal term. Thus, the NRC staff finds that the effects of nonradiological contaminants on shortnose and Atlantic sturgeon would be insignificant because exposure would not measurably impair the growth, survival, or reproduction of either species within the action area.

Radionuclide Exposure. With respect to the potential impacts of radiological contaminants on sturgeon in the action area, the radionuclide that would be of concern is tritium because of its ability to assimilate into aquatic environments and behave like water. Tritium is a radioactive isotope of hydrogen that has two neutrons. It occurs both naturally and as a by-product of nuclear reactor operation. In water, tritium binds with oxygen to form tritiated water (H_3O), which behaves in the environment identical to a normal water molecule (H_2O). Tritium is a relatively weak source of beta radiation; the beta particle itself does not have enough energy to penetrate human skin, but tritium molecules can enter humans and other organisms through inhalation or ingestion. Tritium has a half-life of 12.3 years. However, if ingested, the human body excretes half the ingested tritium within 10 days (NRC 2019a). For tritium in drinking water, the EPA (EPA 2002) has established a maximum contaminant level of 20,000 picocuries per liter (pCi/L), which is equivalent to 4 millirems per year (mrem/yr) or 2.7×10^6 rad/d. Because the EPA drinking water standard is significantly lower than the DOE's previously described dose rate criterion of less than or equal to 1 rad/d for aquatic organisms, the NRC staff assumes that even the most sensitive aquatic receptors, including listed species, would be protected if tritium concentrations remain below 20,000 pCi/L.[3]

During operation, Surry may discharge tritium through one of two pathways: (1) as liquid through effluent releases to the James River or (2) as gas through the air. Based on the NRC staff's review of annual reports on Dominion's radiological environmental monitoring program for the period 2012−2018 (VEPC 2013a, VEPC 2014b, VEPC 2015a, VEPC 2016a, VEPC 2017a, VEPC 2018a), Dominion has not detected tritium or any other radionuclides attributable to Surry in aquatic exposure pathway samples. These samples include well and river water, silt and shoreline sediments, crabs, fish, clams, and oysters. Dominion (Dominion 2018b) has only detected naturally occurring radionuclides, such as potassium-40, thorium-228, and thorium-232, at expected background levels. Thus, shortnose and Atlantic sturgeon in the action area are extremely unlikely to be exposed to radionuclides during Surry operations. In 2012, the NMFS (NMFS 2012) made the same conclusion based on its review of Dominion's annual radiological environmental monitoring program reports for the period 2009-2011. The NRC staff assumes that even if future releases of tritium or other radionuclides were to occur, sturgeon would remain protected as long as release concentrations remain below 20,000 pCi/L, as explained above. In conclusion, the NRC staff finds that sturgeon in the action area would experience no effects from exposure to radiological contaminants resulting from Surry operation.

Reduction in Available Food Resources Due to Impingement and Entrainment or Thermal Effects to Prey Species

Shortnose and Atlantic sturgeons' ability to successfully forage within the action area could be affected through impingement and entrainment of potential prey organisms or through thermal effects on those prey. Shortnose and Atlantic sturgeon feed on small benthic invertebrates and, thus, these are the organisms relevant to this discussion. Section 3.8.1.3 of this SEIS discusses the diets of sturgeon in more detail within the subsections titled, "Shortnose Sturgeon (*Acipenser brevirostrum*)," and "Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*)."

Impingement and Entrainment of Prey Species. Benthic invertebrate prey of sturgeon would be susceptible to entrainment but not impingement due to these organisms' small sizes. Many benthic organisms avoid impingement through sessile or burrowing behaviors, which keeps them out of the water column where they would otherwise be susceptible to the draw of water into Surry's low-level intake structure. The primary sturgeon prey in the action area that would

[3] In addition to the EPA drinking water standard, the NRC also regulates radiological releases, including tritium, through its regulations at 10 CFR Part 20 and Appendix I to 10 CFR Part 50.

be expected to occur within the water column are various shrimps. In Surry entrainment studies, unidentified shrimp, primarily *Mysida* species, comprised 66.5 percent of 2005–2006 samples and 12-13 percent of 2015–2017 samples (see Section 4.7.1.1 for detailed discussions of study methods and results). However, mysid shrimp produce up to three generations per year and are both prolific and abundant in the region. Losses of mysid shrimp to entrainment represent a small percentage of available biomass. This assumption is supported by the fact that the NRC staff found no observable changes in the benthic or aquatic community attributable to Surry's cooling water intake structure in its assessment of the overall impacts of impingement and entrainment on aquatic organisms in Section 4.7.1.1 of this SEIS.

Any loss of benthic invertebrates to entrainment at Surry represents a potential loss of sturgeon prey that could affect sturgeon in the action area. However, these losses are unlikely to result in measurable effects to foraging shortnose and Atlantic sturgeon given the insusceptibility of many sturgeon prey to either impingement or entrainment, the small loss in percentage of total available biomass of those susceptible prey, and the lack of observable changes or impairment in the overall aquatic community over several decades of Surry operations.

Thermal Effects on Prey Species. With respect to thermal effects on sturgeon prey, no additional thermal studies have been undertaken and no operational changes have taken place at Surry that would affect the characteristics of the thermal plume or its effects on the aquatic environment since the NRC's 2012 Endangered Species Act consultation with the NMFS. During that consultation, the NMFS (NMFS 2012) found that Surry's thermal plume is unlikely to affect benthic invertebrates outside of the discharge canal because the thermal plume is largely contained at the river's surface and does not extend to the lower reaches of the water column. As previously established in this section under the NRC staff's discussion of thermal effects on sturgeon, sturgeon are likely to avoid the discharge canal due to higher-than-preferred temperatures. Thus, benthic invertebrates in the discharge canal that might be displaced or otherwise affected by thermal effluent generally do not represent potential prey. For these reasons, the potential impacts on sturgeon resulting from thermal effects on its prey species would be insignificant.

Effects from Maintenance Dredging

Dominion periodically performs maintenance dredging in the intake canal and would continue to do so if Surry were to continue operating under the proposed license renewal. Dominion (Dominion 2018b, Dominion 2019d) has typically performed dredging of this area (a distance of approximately 5,700 ft (1,737 m)) every 3 to 4 years to maintain a depth of approximately 13 ft (4 m). For instance, Dominion most recently proposed to hydraulically dredge 150,000 yds^3 (115 m^3) to a depth of 12 ft (3.7 m) below mean lower low water within a 2,000-ft (610-m) long by 150-ft (46-m) wide channel (USACE 2018b). Prior to dredging, Dominion must obtain appropriate permits from the U.S. Army Corps of Engineers (USACE) under Section 404 of the Clean Water Act. Although the NRC does not authorize or permit dredging, the NRC staff considers dredging in its analysis because it is an interdependent effect that would not occur but for the proposed license renewal because it has no independent utility apart from license renewal. The NRC staff assumes that the method of dredging that Dominion would perform during the proposed license renewal period would be hydraulic (or "cutterhead") dredging because this is the type of dredging that Dominion has undertaken in the past.

During cutterhead dredging, the dredge head is buried in the sediment, which produces a suction flow field. The amount of suction is a function of the diameter of the dredge pipe and the linear flow rates inside the pipe (Clausner and Jones 2004). Large pipes and higher flow rates create greater suction velocities and a wider flow field. The suction produced decreases exponentially with distance from the dredge head (Boysen and Hoover 2009). Cutterhead dredge heads do not begin operating until they are placed within dredge site sediments, which limits exposure of sturgeon to the suction. However, impingement or entrainment into the dredge head is possible, especially for sturgeon engaging in foraging or overwintering behavior. Impingement or entrainment could result in injury or mortality of sturgeon. However, studies indicate that small, juvenile sturgeon less than 0.6 ft (1.8 m) fork length need to be within 4.9-6.6 ft (1.5-2.0 m) of the dredge head for there to be any potential entrainment (Boysen and Hoover 2009). Sturgeon of this size only occur well upriver of the action area and are not expected to occur in the action area, as previously established. Sturgeon in the action area would be too large to be impinged or entrained during dredging. Additionally, individuals in the action area are unlikely to exhibit behavioral changes (either avoidance or attraction to the dredge vessel or head) according to a study performed in the James River at RM 36 (RKM 58) where movement patterns of tagged Atlantic sturgeon were observed during dredging operations (USACE 2014). Based on this information, it is extremely unlikely that a sturgeon would be impinged or entrained in a cutterhead dredge; therefore, these effects are discountable.

Dredging also has the potential to impact sturgeon indirectly through impacts on prey, forage, or other habitat features. Dredging results in the direct removal of soft bottom substrates along with infaunal and epifaunal organisms of limited mobility inhabiting those substrates. Thus, dredging can be expected to cause short-term reductions in biomass of benthic organisms. Dredging also creates sediment plumes that increase water turbidity, which can adversely affect aquatic biota and create short-term decreases in habitat quality during and after dredging. Turbidity primarily affects liquid-breathing organisms, such as fish and shellfish, as well as aquatic plants, because turbid conditions typically decrease photosynthetic capabilities. Turbidity levels associated with the sediment plumes of cutterhead dredges typically range from 11.5 to 282.0 mg/L with decreasing concentrations at greater distance from the dredge head (Nightingale and Simenstad 2001). Studies of benthic community recovery following dredging indicate that species abundance and diversity can recover within several years of dredging (Michel et al. 2013). Specifically, within temperate, shallow water regions containing a combination of sand, silt, or clay substrate, benthic communities can recover in 1 to 11 months, according to studies reviewed by Wilbur and Clarke (2007).

Because sturgeon prey on small benthic invertebrates, dredging could affect prey and forage availability within the action area. Smaller prey items, such as mollusks and crustaceans, may be susceptible to entrainment into the dredge head. Larger benthic individuals or those that are farther from the dredge head could move away from the suction flow field to avoid being entrained. All prey in the dredge area could also be affected by other factors, such as sedimentation and turbidity. However, as explained above, the local benthic community would likely recover within 1 year or less such that any local reductions in benthic biomass or other observable impacts would be relatively short term. Additionally, because maintenance dredging has been occurring at Surry since it began operating, sturgeon in the action area and the local benthic community have likely adapted to periodic dredging, such that continued dredging during the proposed license renewal term would not introduce any new or additional effects.

With respect to turbidity and sedimentation caused by dredging, studies of the effects of turbid waters on fish suggest that concentrations of suspended solids can reach thousands of milligrams per liter before an acute toxic reaction occurs (Burton 1993). In a literature review, Burton (1993) demonstrated that lethal effects on fish due to turbid waters can occur at levels between 580 mg/L and 700,000 mg/L, depending on the species. Studies on striped bass, an anadromous species, showed that prespawners did not avoid concentrations of 954 to 1920 mg/L to reach spawning sites (Summerfelt and Moiser 1976; Combs 1979). While no studies are available on the effects of suspended solids on Atlantic and shortnose sturgeon, juveniles and adults are often documented in turbid water (Dadswell et al. 1984). Thus, sturgeon are at least as tolerant to suspended sediment as other estuarine fish, such as striped bass, and would be able to swim through or around a sediment plume without experiencing adverse effects. Sedimentation could also affect benthic prey. However, these individuals could avoid the plume or uncover themselves from any sedimentation experienced during dredging such that these impacts would be negligible and short term and would not measurably affect the available prey base within the dredged area. Based on the above discussion, the NRC staff concludes that turbidity and sedimentation associated with dredging would not noticeably or measurably affect sturgeon or their prey or forage.

The NRC staff expects that all effects associated with periodic maintenance dredging on shortnose and Atlantic sturgeon would be too small to be meaningfully measured or detected and would, therefore, be insignificant. Additionally, because Dominion must obtain a Section 404 permit from the USACE prior to conducting dredging, the USACE, as a Federal agency, would be required to consult with the NMFS under Section 7 of the Endangered Species Act. Any potential adverse effects identified at that stage would be addressed in consultation between these two agencies.

Summary of Effects

The potential stressors evaluated in this section are unlikely to result in effects on shortnose or Atlantic sturgeon that could be meaningfully measured, detected, or evaluated or such stressors are otherwise unlikely to occur for the following reasons.

- Impingement of shortnose and Atlantic sturgeon is extremely unlikely to occur during the proposed license renewal term because the life stages of sturgeon in the action area would be of sufficient size and swimming capability to resist the flow of water into Surry's low-level intake structure. Additionally, impingement studies performed over the course of Surry operations report no impingement of either species of sturgeon.
- Entrainment does not pose a risk to sturgeon because entrainable life stages do not occur in the action area.
- Thermal effects on sturgeon would be insignificant because Surry's thermal plume is relatively small and confined to the surface of the water column, and sturgeon could easily avoid any areas of higher temperatures that they encounter.
- The effects of nonradiological contaminants on sturgeon would be insignificant because the VDEQ, through Surry's VPDES permit, has established pollutant discharge concentration limits at levels at or below the EPA aquatic life criteria, which ensures that the level of exposure would not measurably impair the growth, survival, or reproduction of either sturgeon species.
- Sturgeon would experience no radiological effects because Dominion has not detected tritium or any other radionuclides attributable to Surry in aquatic exposure pathway samples based on reports from 2011 through present.
- All potential effects on sturgeon prey, including impingement, entrainment, and thermal effects, would be insignificant and would not result in measurable effects on the two sturgeon species' ability to successfully forage in the action area.
- Periodic maintenance dredging in the James River is extremely unlikely to result in injury or mortality of shortnose and Atlantic sturgeon because individuals in the action area would be too large to be susceptible to impingement or entrainment into the dredge head. All other potential effects associated with dredging would

be short term and insignificant. Additionally, consultation between the USACE and the NMFS during the Section 404 permitting process would ensure that any adverse impacts on sturgeon identified at that stage would be addressed.

Conclusion for Shortnose Sturgeon

All potential effects on the shortnose sturgeon 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 shortnose sturgeon.

Conclusion for Atlantic Sturgeon

All potential effects on the Atlantic sturgeon 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 Atlantic sturgeon.

<u>Designated Critical Habitat of the Atlantic Sturgeon</u>

In Section 3.8.1.3 in the subsection titled, “Designated Critical Habitat of the Atlantic Sturgeon,” the NRC staff concludes that the entirety of the James River within the Surry action area is designated critical habitat within the unit designated as Chesapeake Bay Critical Habitat Unit 5. In the following sections, the NRC staff considers the potential effects of the proposed Surry license renewal on each of the four physical and biological features (PBFs) of the critical habitat below. Table 3-11 contains the complete regulatory descriptions of each PBF; the headings below are paraphrased.

PBF 1: Hard Bottom Substrate in Low Salinity Waters for Growth and Development of Early Life Stages

The first feature is hard bottom substrate (e.g., rock, cobble, gravel, limestone, boulder) in low salinity waters (i.e., 0.0–0.5 ppt) for settlement of fertilized eggs, refuge, growth, and development of early life stages (82 FR 39160). As previously established in Section 3.8.1.3 of this SEIS within the subsection titled, “Designated Critical Habitat of the Atlantic Sturgeon” the Surry action area does not contain the appropriate environmental conditions to support spawning or rearing of early life stages of Atlantic sturgeon. Current literature reports that Atlantic sturgeon spawning in the James River takes place from RM 56-59 (RKM 90-95) in the spring (Balazik and Musick 2015) and from RM 65 (RKM 105) and the fall line near Richmond, VA, to RM 96 (RKM 155) in the fall (Balazik et al. 2012). Because the regions of the river containing the features of this PBF are well upriver of the action area, the proposed action would not affect this feature.

PBF 2: Aquatic Habitat with a Gradual Downstream Salinity Gradient and Soft Substrate for Juvenile Foraging and Development

The second feature is aquatic habitat with a gradual downstream salinity gradient of 0.5 ppt up to as high as 30 ppt and soft substrate (e.g., sand, mud) between the river mouth and spawning sites for juvenile foraging and physiological development (82 FR 39160). The Surry action area contains both the salinity gradient and soft substrates associated with this PBF.

The proposed action would not affect river salinity. With respect to soft substrates, Surry’s continued withdrawal of cooling water would not affect the surrounding substrates. Discharge of the heated effluent may limit access to soft bottom substrates within the action area in those areas exceeding the Atlantic sturgeon’s thermal tolerance. As established previously in this section under “Shortnose (*Acipenser brevirostrum*) and Atlantic (*Acipenser oxyrinchus oxyrinchus*) Sturgeon,” sturgeon are likely to avoid waters at temperatures of 82.4 °F (28 °C) or greater. Because the thermal plume is largely confined to the upper 6 ft (1.8 m) of the water column, and the plume does not extend more than halfway across the river even during summer months, temperatures exceeding 82.4 °F (28 °C) would rarely be present at the bottom of the water column where sturgeon are most likely to occur. If present, elevated temperatures would occur only seasonally for short periods of time. Therefore, while there may be times when Atlantic sturgeon would not be able to access some portions of the action area that contain PBF 2, these instances would be limited spatially and temporally. Similarly, benthic prey inhabiting soft substrates may be displaced or otherwise affected by the thermal plume, but such effects would be insignificant, as previously established in this section within the NRC staff’s analysis of shortnose and Atlantic sturgeon.

Dominion performs maintenance dredging in the intake canal every 3 to 4 years and would continue to do so during the proposed license renewal term, as discussed previously. Dredging would result in the direct removal of soft bottom substrates along with benthic sturgeon prey organisms of limited mobility inhabiting those substrates. Dredging would also create sediment plumes and short-term increases in water turbidity. While these effects would be limited spatially and temporally, because dredging would directly affect the soft bottom substrates associated with PBF 2, potential adverse effects to the critical habitat could result. Prior to dredging, the USACE, as a Federal agency, would be required to consult with the NMFS under Section 7 of the Endangered Species Act as part of the Section 404 permitting process. Any potential adverse effects to critical habitat identified at that stage would be addressed in consultation between these two agencies, and the NRC staff assumes that consultation would require the USACE or Dominion to implement mitigation or minimization strategies during dredging that would ensure that dredging would not meaningfully or measurably affect the value of the habitat to the conservation of the species.

Because the proposed action is extremely unlikely to affect the value of the habitat to the conservation of the species, the NRC staff concludes that any effects to this feature are discountable.

PBF 3: Water of Appropriate Depth and Absent Physical Barriers to Passage to Support Staging, Resting, Holding, and Migration of Juveniles, Subadults, and Adults

The third feature is water of appropriate depth and absent physical barriers to passage (e.g., locks, dams, thermal plumes, turbidity, sound, reservoirs, gear) between the river mouth and spawning sites necessary to support:

(i) Unimpeded movement of adults to and from spawning sites;

(ii) Seasonal and physiologically dependent movement of juvenile Atlantic sturgeon to appropriate salinity zones within the river estuary; and

(iii) Staging, resting, or holding of subadults or spawning condition adults. Water depths in main river channels must also be deep enough (e.g., at least 1.2 meters) to ensure continuous flow in the main channel at all times when any sturgeon life stage would be in the river (82 FR 39160).

Thermal effluent from nuclear plant discharges can create a physical barrier if the thermal plume creates environmental conditions that impede passage. As explained previously in the discussion of PBF 2, continued discharge of thermal effluent could limit Atlantic sturgeons' access to the area of the river exceeding the species' thermal tolerance. However, sturgeon would rarely encounter temperatures exceeding their thermal tolerance because Surry's thermal plume is largely confined to the surface and does not extend more than halfway across the river even during summer months. Because there would always be a large zone of passage, the thermal plume would not be a barrier to sturgeon moving between the river mouth and spawning sites. Therefore, it is extremely unlikely that habitat alterations associated with Surry's thermal effluent would impact the ability of any adult Atlantic sturgeon to move through the action area to reach the upstream spawning grounds; affect the seasonal movements of juveniles; or affect staging, resting, or holding of subadults or spawning condition adults. Because the proposed action is extremely unlikely to affect the value of the habitat to the conservation of the species, the NRC staff concludes that any effects to this feature are discountable.

PBF 4: Water with Temperature, Salinity, and Oxygen Values that Support Spawning, Growth, Development, Recruitment, and Survival

The fourth feature is water, between the river mouth and spawning sites, especially in the bottom meter of the water column, with the temperature, salinity, and oxygen values that, combined, support:

(i) Spawning;

(ii) Annual and interannual adult, subadult, larval, and juvenile survival; and

(iii) Larval, juvenile, and subadult growth, development, and recruitment (e.g., 13 to 26 °C for spawning habitat and no more than 30 °C for juvenile rearing habitat, and 6 milligrams per liter (mg/L) or greater dissolved oxygen for juvenile rearing habitat) (82 FR 39160).

The water quality conditions of this feature are interactive, such that both temperature and salinity influence the dissolved oxygen content in a particular area. As previously established, the proposed action affects water temperature through discharge of heated effluent, but it does not affect salinity. Because the action area is tidally influenced, salinity varies significantly with tides and seasons; thus, the dissolved oxygen content of the water within the action area is also highly variable. For instance, during 2015–2016 impingement sampling, dissolved oxygen ranged from 5.2 to 13.9 mg/L (HDR 2017). Monthly average dissolved oxygen was highest in February at 12.7 mg/L and lowest in August at 6.0 mg/L (HDR 2017). Based on the preceding analyses of PBF 2 and PBF 3, the NRC staff does not expect that thermal discharges alone would affect Atlantic sturgeon growth, development, recruitment, or survival. As previously established, spawning does not take place in the action area; therefore, the features of this PBF relevant to the early life stages of Atlantic sturgeon do not apply to the Surry action area. With respect to the proposed action's effect on dissolved oxygen, because the area influenced by Surry's thermal plume is small and largely confined to the surface, dissolved oxygen in the action area is unlikely to be substantially affected by continued operation of the plant. The NRC (NRC 2013a) has previously determined that effects on aquatic biota due to low dissolved oxygen levels are not expected to extend beyond the thermal mixing zone. Therefore, it is extremely unlikely that habitat alterations associated with Surry's thermal effluent would impact the growth, development, recruitment, or survival of Atlantic sturgeon in the action area. Because the proposed action is extremely unlikely to affect the value of the habitat to the conservation of the species, the NRC staff concludes that any effects to this feature are discountable.

Summary of Effects

The proposed Surry license renewal will result in habitat alterations that may affect PBFs 2, 3, and 4 of designated critical habitat of Atlantic sturgeon in the James River. These habitat alterations will primarily result from continued discharge of thermal effluent. However, any effects on the value of the habitat to the conservation of the species, including its ability to support juvenile foraging and development; allow for upstream and downstream passage of juveniles, subadults, and adults; and otherwise support growth, development, recruitment, and survival of the life stages of the species present in the action area, are either extremely unlikely to occur or would be so small that they could not be meaningfully measured, detected, or evaluated. Therefore, effects to the proposed critical habitat for the Chesapeake Bay DPS of Atlantic sturgeon resulting from continued operations at Surry are insignificant or discountable.

Periodic maintenance dredging within the intake channel in the James River would affect PBF 2 through direct removal of soft bottom substrates along with benthic prey of sturgeon within those substrates. Any potential adverse effects to critical habitat resulting from dredging would be addressed during consultation between the USACE and the NMFS as part of the Section 404 permitting process. The NRC staff assumes that such consultation would require mitigation or minimization strategies during dredging to ensure that dredging activities would not meaningfully or measurably affect the value of the habitat to the conservation of the species.

Conclusion for Designated Critical Habitat of the Atlantic Sturgeon

All potential effects on designated critical habitat 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 destroy or adversely modify* the designated critical habitat of the Chesapeake Bay DPS of Atlantic sturgeon.

4.8.1.3 Endangered Species Act: Cumulative Effects

The Endangered Species Act regulations at 50 CFR 402.12(f)(4) 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). 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 the National Environmental Policy Act (see Section 4.16, “Cumulative Impacts”).

When formulating biological opinions under formal Endangered Species Act Section 7 consultation, the FWS and NMFS (FWS and NMFS 1998) 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 2014a). Because the NRC staff concluded earlier in this section that the proposed license renewal 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.

4.8.1.4 Magnuson–Stevens Act: Essential Fish Habitat

In Section 3.8.1.4, "Magnuson–Stevens Act: Essential Fish Habitat," of this SEIS, the NRC staff establishes that the Fishery Management Councils and the NMFS have designated essential fish habitat (EFH) for four federally managed species of fish (herein referred to as "EFH species") across multiple life stages within the James River near the Surry site. These species are: summer flounder (*Paralichthys dentatus*), Atlantic butterfish (*Peprilus triacanthus*), bluefish, and windowpane flounder (*Scopthalmus aquosus*). Additionally, adults of little skate (*Leucoraja erinacea*) and winter skate (*L. ocellata*) consume diadromous prey that may occur in the James River near Surry. In the sections below, the NRC staff analyzes the potential impacts of the proposed Surry subsequent license renewal on the EFH and prey of these species. Table 4-9 identifies the NRC staff's Magnuson–Stevens Act conclusions for each of the EFH species and life stages that resulted from the staff's analysis.

In Section 3.8.1.4 of this SEIS, the NRC staff also considered EFH of black sea bass (*Centropristis striata*), Atlantic herring (*Clupea harengus*), clearnose skate (*Raja eglanteria*), and red hake (*Urophycis chuss*), but the staff determined that the James River near Surry does not provide the physiological requirements for any life stages of these species to be present in the area. Accordingly, the NRC staff has determined that designated EFH of these species would experience no adverse effects from the proposed action. The staff has excluded these species from further analysis. The NRC staff's findings of "no adverse effects" for these species is reflected in Table 4-9 below and in the conclusion of this section.

Table 4-9 Effect Determinations for Federally Managed Species with Designated Essential Fish Habitat Under the Magnuson–Stevens Act

Species	Common Name	Relevant Life Stages for EFH Analysis[a]	EFH Effect Determination[b]
Centropristis striata	black sea bass	—	No adverse effects
Clupea harengus	Atlantic herring	—	No adverse effects
Leucoraja erinacea	little skate	(P)	Minimal adverse effects
Leucoraja ocellata	winter skate	(P)	Minimal adverse effects
Paralichthys dentatus	summer flounder	L, J, A	Minimal adverse effects
Peprilus triacanthus	Atlantic butterfish	J, A	Minimal adverse effects
Pomatomus saltatrix	bluefish	J	Minimal adverse effects
Raja eglanteria	clearnose skate	—	No adverse effects
Scopthalmus aquosus	windowpane flounder	J, A	Minimal adverse effects
Urophycis chuss	red hake	—	No adverse effects

[a] E = eggs; L = larvae; J = juveniles; A = adults; (P) = prey of EFH species.

[b] The NRC staff makes its effect determinations for EFH in accordance with the language prescribed in the regulations implementing the Magnuson–Stevens Act at 50 CFR 600, Subpart K, "EFH Coordination, Consultation, and Recommendations."

Fish habitat includes the substrate and benthic resources (e.g., submerged aquatic vegetation, shellfish beds, salt marsh wetlands), as well as the water column and prey species. In

Section 3.8.1.4, “Magnuson–Stevens Act: Essential Fish Habitat,” of this SEIS, the NRC staff establishes the species-specific habitat requirements of each federally managed species included in this analysis. The proposed license renewal could adversely affect this habitat through Dominion’s continued operation of the Surry cooling water intake and discharge systems and through the associated withdrawals from and discharges to the James River. The NMFS defines “adverse effects” under the Magnuson–Stevens Act as (50 CFR 600.810):

> … any impact that reduces quality and/or quantity of EFH. Adverse effects may include direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality and/or quantity of EFH. Adverse effects to EFH may result from actions occurring within EFH or outside of EFH and may include site specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions.

Further, in 50 CFR 600.815(a)(7), adverse effects to EFH resulting from prey loss is defined as follows.

> Loss of prey may be an adverse effect on EFH and managed species because the presence of prey makes waters and substrate function as feeding habitat, and the definition of EFH includes waters and substrate necessary to fish for feeding. Therefore, actions that reduce the availability of a major prey species, either through direct harm or capture, or through adverse impacts to the prey species’ habitat that are known to cause a reduction in the population of the prey species, may be considered adverse effects on EFH if such actions reduce the quality of EFH.

The proposed Surry license renewal has the potential to cause the following (generic) adverse effects on EFH in the area. In the sections below, the NRC staff evaluates each potential adverse effect as it relates to the proposed license renewal.

- physical removal of habitat through cooling water withdrawals
- physical alteration of habitat through heated effluent discharges
- chemical alteration of habitat through radionuclides and other contaminants in heated effluent discharges
- physical removal of habitat through maintenance dredging
- reduction in the prey base of the habitat
- effects from maintenance dredging

Physical Removal of Habitat Through Cooling Water Withdrawals

Surry continuously withdraws James River water to cool the reactor cores and to serve other auxiliary functions. All water withdrawals represent a loss of fish habitat because withdrawal physically removes the water (habitat) from the river. However, most losses are temporary because Surry’s once-through cooling system returns most of the water it withdraws through a discharge canal that lies 6 RM (10 RKM) upstream of the intake. At maximum design flow, Surry’s circulating water system pumps can withdraw up to 2,534.4 MGD (1,760,000 gpm or

111 m^3/s) of water (Dominion 2018b). This volume represents approximately 3 percent of the James River's tidal flow (Dominion 2018b). Of this 3 percent, 1 percent (or 0.0003 percent of tidal flow) is consumed through evaporation (Dominion 2018b). Because Surry consumes such a small percentage of river flow past the plant, the physical removal of habitat through cooling water withdrawals would have negligible impacts on the quality or quantity of fish habitat. Accordingly, the NRC staff concludes that this potential impact would result in no more than minimal adverse effects on the habitat of summer flounder, Atlantic butterfish, bluefish, and windowpane flounder designated as EFH in the James River near Surry.

Physical Alteration of Habitat Through Heated Effluent Discharges

Surry continuously discharges heated effluent to the James River following its use for cooling and other auxiliary functions at the plant. Because discharges are of higher temperatures than the ambient river water, discharges represent a physical alteration to fish habitat. Ambient water temperatures in the Surry action area are relatively warm and range from a low of approximately 53.6 °F (12 °C) in winter and a high of 82.4 °F (28 °C) in summer. The water column stratifies near the top 6 ft (0.3 m) such that water deeper than 6 ft (0.3 m) from the surface is typically 1.1 °F (0.6 °C) cooler than the surface in summer. The area affected by the plume varies depending on season, tides, and other conditions. However, the plume generally stays close to shore. During flood and ebb tides, it extends approximately 2,000 ft (610 m) around Gravel Neck Peninsula, and during slack tides, it pools near the discharge (Fang and Parker 1976). The plume at no point extends to a depth of more than 6 ft (1.8 m) or more than half the width of the river at its narrowest point (Fang and Parker 1976).

None of the four EFH species occupy the epipelagic region of the water column where effects of the thermal plume would be experienced. Summer flounder larvae are pelagic; juveniles and adults are demersal. Atlantic butterfish juveniles and adults are mesopelagic or semi-demersal. Bluefish juveniles are pelagic. Windowpane flounder juveniles and adults are benthic. Thus, it would be extremely unlikely that individuals of these species would encounter the thermal plume, and the continued discharge of heated effluent would not affect the quality or quantity of these species' habitats. Accordingly, the NRC staff concludes that this potential impact would result in no adverse effects on the habitat of summer flounder, Atlantic butterfish, bluefish, and windowpane flounder designated as EFH in the James River near Surry.

Chemical Alteration of Habitat Through Radionuclides and Other Contaminants in Heated Effluent Discharges

With heated effluent, Surry discharges certain nonradiological chemical pollutants. The VDEQ limits the allowable concentrations of these pollutants through the site's VPDES permit. The VPDES permit establishes allowable pollutant discharge concentration limits for total residual chlorine, pH, total phosphorus, fecal coliform, total organic carbon, and total petroleum hydrocarbons at levels at or below the EPA (EPA 2019g) national recommended aquatic life criteria for acute (short-term) and chronic (long-term) exposure. Under these criteria, the EPA considers "unacceptable acute effects" to be those effects that are lethal or immobilize an organism during short-term exposure to a pollutant. "Unacceptable chronic effects" are those effects that will impair growth, survival, and reproduction of an organism following long-term exposure to a pollutant. Thus, the EPA aquatic life criteria are designed to ensure that aquatic species exposed to pollutants in compliance with these levels will not experience any impairment of growth, survival, or reproduction. The NRC staff assumes that because nonradiological pollutants that are discharged at levels at or below the EPA aquatic life criteria would not impair the ability of fish to carry out essential life functions, such discharges would also not impair the quality or quantity of the habitat itself. Accordingly, the NRC staff concludes that the potential impacts of nonradiological pollutant discharges would result in no more than minimal adverse effects on the habitat of summer flounder, Atlantic butterfish, bluefish, and windowpane flounder designated as EFH in the James River near Surry.

With respect to the potential impacts of radiological contaminants on fish habitat, the primary radionuclide of concern is tritium. During operation, Surry may discharge tritium through one of two pathways: (1) as liquid through effluent releases to the James River or (2) as gas through the air. Dominion has not detected tritium or any other radionuclides attributable to Surry in aquatic exposure pathway samples based on the NRC staff's review of annual reports on Dominion's radiological environmental monitoring program from 2012–2018 (VEPC 2013a, VEPC 2014b, VEPC 2015a, VEPC 2016a, VEPC 2017a, VEPC 2018a). These samples include well and river water, silt and shoreline sediments, crabs, fish, clams, and oysters. Thus, the quality of fish habitat in the area is extremely unlikely to be affected by radiological contamination.[4] Accordingly, the NRC staff concludes that radionuclide discharges would result in no adverse effects on the habitat of summer flounder, Atlantic butterfish, bluefish, and windowpane flounder designated as EFH in the James River near Surry.

<u>Physical Removal of Habitat Through Maintenance Dredging</u>

Dominion periodically performs maintenance dredging in the intake canal and would continue to do so if Surry were to continue operating under the proposed license renewal. Dredging results in the direct removal of bottom habitats along with infaunal and epifaunal organisms of limited mobility inhabiting the affected substrates. Dredging also creates sediment plumes that increase water turbidity. Thus, dredging affects both the quantity and quality of fish habitat. The direct removal of substrates, sediments, and benthic organisms represent effects to habitat quantity. The resulting short-term reductions in biomass of benthic organisms and increased water turbidity represent effects on habitat quality.

The NRC staff addresses the effects of maintenance dredging (specific to the federally listed shortnose and Atlantic sturgeons) in Section 4.8.1.2 in the subsection titled, "Effects from Maintenance Dredging." In that section, the NRC staff explains that Dominion must obtain a Section 404 permit from the USACE prior to conducting dredging. Prior to issuing such a permit, the USACE, as a Federal agency, is required to consider potential impacts to EFH and to consult with the NMFS under the Magnuson–Stevens Act if adverse effects are anticipated.

During the USACE's review of Dominion's most recent joint application for Federal and State permits related to maintenance dredging, the USACE (USACE 2018b) determined that impacts to EFH resulting from dredging would be minor and temporary. Although dredging equipment and pipelines used for transport of dredged material would result in temporary turbidity, the USACE (USACE 2018b) determined that the project would not have substantial adverse effects on EFH because direct impacts would be short term in nature, increases in turbidity would be minimal, no impacts on tidal wetlands would result, and no submerged aquatic vegetation is present in the affected area. Additionally, Dominion would not dredge between February 15 and June 30, of any year, to minimize impacts on EFH, anadromous fish, and federally managed species. The NRC adopts the USACE's conclusion that impacts to fish habitat quantity and

[4] For a more detailed discussion of how radioactive pollutants interact with the aquatic environment and how the NRC evaluates exposure of aquatic organisms to radionuclides, see the subsection titled, "Exposure to Radionuclides and Other Contaminants," in Section 4.8.1.2, "Endangered Species Act: Species and Habitats under National Marine Fisheries Service Jurisdiction," of this SEIS.

quality resulting from the physical removal of that habitat during maintenance dredging would result in no more than minimal adverse effects. The NRC staff recognizes that if adverse effects on EFH from dredging are identified, such effects would be addressed in a future consultation between the USACE and the NMFS at the time that dredging is proposed and that such a consultation would not involve the NRC.

Reduction in the Prey Base of the Habitat

Reduction in the prey base, or loss of prey, represents a potential impact to the quality of fish habitat. Section 4.7.1.1, "Impingement and Entrainment of Aquatic Organisms (Plants with Once-Through Cooling Systems or Cooling Ponds," and Section 4.7.1.2, "Thermal Impacts on Aquatic Organisms (Plants with Once-Through Cooling Systems or Cooling Ponds)," of this SEIS address the impacts of impingement, entrainment, and thermal discharges at the resource-wide level. In those sections, the NRC staff does not identify significant impacts to any of the planktonic or benthic prey species of the four EFH species (summer flounder, Atlantic butterfish, bluefish, and windowpane flounder). Of particular note is the fact that shellfish collected in impingement studies (primarily grass shrimp (*Palaemonetes* species), mud crabs (Xanthoidea species), decapod shrimp (Decapoda species) and blue crab) exhibited high impingement survival rates. Mud crab (Panopeidae species) zoea, tellin clam (Tellinidae species) juveniles, and mysid shrimp (Mysida species) made up a significant portion of the most recent entrainment sampling conducted in 2015−2017. However, the final report, including interpretive results, of this sampling is not yet available. Nonetheless, based on its analysis, the NRC staff does not expect impingement or entrainment to noticeably alter the availability of planktonic or benthic organisms as prey of EFH species.

Although EFH for little skate and winter skate does not occur near Surry, adults of these species consume anadromous prey, including various *Alosa* species, including alewife and blueback herring and Atlantic menhaden. Winter skate also consume the catadromous American eel (*Anguilla rostrate*). These diadromous prey species migrate between the James River, its tributaries, the Chesapeake Bay, and the Atlantic Ocean. Surry's continued operation during the subsequent license renewal term has the potential to reduce the availability of these prey fish through impingement, entrainment, and thermal effects. If these effects individually or cumulatively were to result in a reduction in the population abundances of these prey, an adverse impact on little skate or winter skate EFH could result even though the EFH is not within the direct vicinity of the plant. Surry impinges all the prey species identified in the above paragraph (e.g., Atlantic menhaden, alewife, blueback herring, and American eel). Impingement survival for these species is estimated at 40.0 percent, 80.0 percent, 83.1 percent, and 100.0 percent, respectively (see Table 4-5). Early life stages of each of these species are also entrained in Surry's cooling water intake system in extremely small numbers (less than 1 to 1 percent composition of entrained organisms; see Table 4-6). However, the NRC staff does not expect impingement or entrainment to noticeably alter the abundance of these prey species' populations based on its analysis in Section 4.7.1.1 of this SEIS.

All other potential impacts to the prey base of EFH species, such as physical and chemical alteration of the aquatic environment from effluent discharges, have already been addressed previously in this section. The NRC staff did not identify any unique impacts of these effects that would affect the prey of EFH species but not the EFH itself.

The NRC staff concludes that the reduction in the prey base of the habitat resulting from the proposed Surry license renewal would result in no more than minimal adverse effects on the habitat of summer flounder, Atlantic butterfish, bluefish, and windowpane flounder designated as EFH in the James River near Surry. Additionally, the NRC staff expects no more than minimal adverse effects on the availability of diadromous prey of little or winter skate, species with EFH in the Chesapeake Bay.

Summary of Effects

The potential stressors evaluated in this section are unlikely to result in more than minimal adverse effects on designated EFH of federally managed species for the following reasons.

- Cooling water withdrawals are temporary and represent an extremely small percent (0.0003 percent) of the James River's tidal flow past the plant.
- Surry's thermal plume is largely confined to the river's surface and does not affect the pelagic and demersal habitats of the EFH species.
- Discharges of chemical (nonradiological) pollutants meet or are below the EPA aquatic life criteria designed to ensure that aquatic species are not exposed to levels that would cause impairment of growth, survival, or reproduction.
- The USACE has determined that impacts to EFH related to maintenance dredging would be minor and temporary. Any potential adverse effects on EFH resulting from dredging would be addressed during consultation between the USACE and the NMFS as part of the Section 404 permitting process at the time that dredging is proposed, and such a consultation would not involve the NRC.
- Continued operation of Surry's cooling water intake system, including continued impingement and entrainment of aquatic organisms and all other potential effects on the aquatic environment, would not noticeably alter the availability of planktonic or benthic organisms, the abundances of prey fish populations, or otherwise create effects that would reduce the available prey base of the habitat.

Conclusions for Designated Essential Fish Habitat

The NRC staff concludes that the proposed action would result in no more than minimal adverse effects on the designated EFH of the summer flounder (larvae, juveniles, and adults), Atlantic butterfish (juveniles and adults), bluefish (juveniles), and windowpane flounder (juveniles and adults) or on the prey base of the little skate (adults) or winter skate (adults), whose designated EFH lies downstream in the Chesapeake Bay. The proposed action would result in no adverse effects on the designated EFH for any life stages of the black sea bass, Atlantic herring, clearnose skate, or red hake.

4.8.2 No-Action Alternative

Under the no-action alternative, the NRC would not issue a renewed license, and Surry would shut down on or before the expiration of the current renewed facility operating licenses. The Endangered Species Act action area and the EFH area of potential effect under the no-action alternative would most likely be the same or similar to those areas described in Section 3.8.1.1, "Endangered Species Act: Action Area," and Section 3.8.1.4, "Magnuson–Stevens Act: Essential Fish Habitat." Upon shutdown, the plant would require substantially less cooling water and would produce little to no discernable thermal effluent. Thus, the potential for impacts to all aquatic species related to cooling system operation would be significantly reduced. Overall, the effects on federally listed species and critical habitats and EFH would likely be smaller 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.

4.8.3 Replacement Power Alternatives: Common Impacts

The replacement power alternatives would each entail construction and operation of a new energy-generating facility at the existing Surry site. This section addresses the qualitatively similar impacts to special status species and habitats that would result from implementation of one of the replacement power alternatives (e.g., new nuclear, natural gas, or the combination alternative). One alternative would entail offsite construction (the solar photovoltaic component of the combination alternative). Effects of offsite construction are addressed separately below within Section 4.8.3.3, “Combination Alternative (Natural Gas Combined-Cycle, Solar, and Demand-side Management).”

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 Surry continues to operate until the end of the current license terms (2032 for Unit 1 and 2033 for Unit 2) 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 4.6.3 and 4.7.3, both titled, “Replacement Power Alternatives: Common Impacts,” 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.

4.8.4 New Nuclear (Small Modular Reactor) Alternative

The impacts of the new nuclear (small modular reactor) 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 Endangered Species Act and Magnuson–Stevens Act would require the NRC to consult with the FWS and NMFS, as applicable, prior to issuing a license for construction and operation of a new small modular reactor. 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 reactors required a Clean Water Act, Section 404 permit, the USACE may be a cooperating agency for required consultations, or the 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, plant design, plant operations, and the special status species and habitats present in the area when the alternative is implemented.

4.8.5 Natural Gas Combined-Cycle Alternative

The NRC staff did not identify any impacts to special status species and habitats for the natural gas combined-cycle alternative beyond those discussed in the impacts common to all replacement power alternatives. Unlike the proposed action of Surry subsequent license renewal or the licensing of a new nuclear alternative, the NRC does not license natural gas facilities; therefore, the NRC would not be responsible for initiating Endangered Species Act Section 7 consultation or EFH consultation if special status species or habitats might be adversely affected under this alternative. Other Federal agencies could be responsible for addressing impacts on special status species and habitats depending on the specific permits or licenses that the new plant would require. For instance, if the new natural gas plant required a Clean Water Act, Section 404 permit, the USACE would be required to consider impacts on federally listed species, designated critical habitats, and EFH. If no Federal permits were required, the companies or entities implementing this alternative would be responsible for ensuring that their actions do not jeopardize the continued existence of federally listed species because the take prohibitions in Section 9 of the Endangered Species Act apply to both Federal and non-Federal entities. The Magnuson–Stevens Act only requires EFH consultation for Federal actions. Therefore, EFH consultation would be required if a Federal agency, such as the USACE, is involved in permitting or licensing components of this alternative and adverse effects are possible. Ultimately, the magnitude and significance of adverse impacts on special status species and habitats would depend on the site location and layout, plant design, plant operations, and the special status species and habitats present in the area when the alternative is implemented.

4.8.6 Combination Alternative (Natural Gas Combined-Cycle, Solar, and Demand-Side Management)

The NRC staff did not identify any impacts to special status species and habitats for the combination alternative beyond the common impacts for all replacement power alternatives as described in Section 4.8.3. The NRC does not license natural gas or solar facilities or play a role in energy-planning decisions; therefore, the NRC would not be responsible for Endangered Species Act Section 7 or EFH consultation. The Federal and private responsibilities for addressing impacts on special status species and habitats under this alternative would be similar to those described for the natural gas combined-cycle alternative in Section 4.8.3.2. 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, plant design, plant operations, and the special status species and habitats present in the area when the alternative is implemented.

4.9 Historic and Cultural Resources

This section describes the potential historic and cultural resources impacts of the proposed action (license renewal) and alternatives to the proposed action.

4.9.1 Proposed Action

Table 4-2 identifies one site-specific (Category 2) issue related to historic and cultural resources applicable to Surry during the license renewal term. This issue is analyzed below.

4.9.1.1 Category 2 Issue Related to Historic and Cultural Resources: Historic and Cultural Resources

The National Historic Preservation Act of 1966, as amended (54 U.S.C. 300101 et seq.) (NHPA), 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 National Register of Historic Places (NRHP). The criteria for eligibility are listed in Title 36, *Parks, Forests, and Public Property*, of the *Code of Federal Regulations* (36 CFR) Section 60.4, "Criteria for evaluation," and include (a) association with significant events in history, (b) association with the lives of persons significant in the past, (c) embodiment of distinctive characteristics of type, period, or construction, and (d) sites or places that have yielded, or are likely to yield, important information.

The historic preservation review process (NHPA Section 106) is outlined in regulations issued by the Advisory Council on Historic Preservation (ACHP) in 36 CFR Part 800, "Protection of Historic Properties." In accordance with NHPA provisions, the NRC is required to make a reasonable effort to identify historic properties included in, or eligible for inclusion in, the National Register of Historic Places in the area of potential effect (APE). The area of potential effect for a license renewal action includes the power plant site, the transmission lines up to the first substation, and immediate environs that may be affected by the license renewal decision and land disturbing activities associated with continued reactor operations during the license renewal term.

If historic properties are present within the area of potential effect, the NRC is required to contact the State historic preservation officer (SHPO), assess the potential impact, and resolve any possible adverse effects of the undertaking (license renewal) on historic properties. In addition, the NRC is required to notify the State historic preservation officer if historic properties would not be affected by license renewal or if no historic properties are present. The State historic preservation officer is in the Virginia Department of Historic Resources.

4.9.1.2 Consultation

In accordance with 36 CFR 800.8(c), "Coordination with the National Environmental Policy Act," on January 24, 2019, the NRC initiated written consultations with the Advisory Council on Historic Preservation and the Virginia State historic preservation officer (see Appendix C.3). Also, on January 24, 2019, the NRC initiated consultation with the following federally recognized Tribes (see Appendix C.3):

- Absentee-Shawnee Tribe
- Catawba Indian Nation
- Cheroenhaka (Nottoway) Tribe
- Cherokee Nation of Oklahoma
- Chickahominy Indian Tribe
- Chickahominy Indians – Eastern Division
- Delaware Nation
- Delaware Tribe of Indians
- Eastern Band of Cherokee Indians
- Eastern Shawnee Tribe of Oklahoma
- Mattaponi Tribe

- Meherrin Nation
- Monacan Indian Nation
- Nansemond Indian Tribe
- Nottoway Tribe
- Pamunkey Indian Tribe
- Patawomeck Tribe
- Rappahannock Tribe
- Shawnee Tribe Oklahoma
- Tuscarora Nation
- United Keetoowah Band of Cherokee Indians in Oklahoma
- Upper Mattaponi Indian Tribe

In these letters, the NRC provided information about the proposed action, defined the area of potential effect, and indicated that the NRC would comply with Section 106 of the National Historic Preservation Act through the National Environmental Policy Act process, in accordance with 36 CFR 800.8(c). The NRC invited participation in the identification and possible decisions concerning historic properties and invited participation in the scoping process.

The NRC received responses from two Tribes with historic ties to Surry County: the Delaware Nation and the Eastern Shawnee Tribe of Oklahoma. The Delaware Nation indicated, "According to our files, the location of the proposed project does not endanger cultural, or religious sites of interest to the Delaware Nation. Please continue with the project as planned…." The Eastern Shawnee Tribe of Oklahoma also indicated "…after further research and review of our records, we find that No Known Properties of Historical and/or Cultural significance to the Tribe will be impacted by this project." In addition, during scoping, the Upper Mattaponi Indian Tribe indicated they had no questions about the Surry plant license renewal.

4.9.1.3 Findings

As described in Section 3.9, there is one previously surveyed archaeological site located within the Surry site boundaries and two archaeological sites located outside and adjacent to the southern boundary. Dominion has administrative procedures and a site-specific cultural resource management plan in place to manage and protect cultural resources at Surry. There are also no planned physical changes or ground-disturbing activities at Surry to support license renewal (Dominion 2018b). The Virginia Department of Historic Resources responded to a notice of Dominion's intention to pursue renewal of Surry Units 1 and 2 operating licenses that they did "not object to the renewal of these licenses and find that the continued operation of the facility is unlikely to adversely affect historic properties" (Dominion 2018b).

Based on the location of historic properties within and near the area of potential effect, Tribal input, Dominion's administrative procedures and a site-specific cultural resource management plan, and no planned physical changes or ground-disturbing activities, the proposed action (license renewal) would not adversely affect historic properties (36 CFR 800.4(d)(1)).

4.9.2 No-Action Alternative

Known historic properties and cultural resources at Surry would be unaffected if the NRC does not renew the operating license, and Dominion terminates reactor operations. As stated in the decommissioning GEIS (NUREG-0586, Supplement 1), the NRC concluded that impacts to cultural resources would be SMALL at nuclear plants where decommissioning activities would only occur within existing industrial site boundaries. Impacts cannot be predicted generically if decommissioning activities would occur outside of the previously disturbed industrial site boundaries, because impacts depend on site-specific conditions. In these instances, impacts could only be determined through site-specific analysis (NRC 2002).

In addition, 10 CFR 50.82, “Termination of license,” requires power reactor licensees to submit a post-shutdown decommissioning activities report (PSDAR) to the NRC. The post-shutdown decommissioning activities report provides a description of planned decommissioning activities at the nuclear plant. Until the post-shutdown decommissioning activities report is submitted, the NRC cannot determine whether historic properties would be affected outside the existing industrial site boundary after the nuclear plant ceases operations.

4.9.3 Replacement Power Alternatives: Common Impacts

If construction and operation of replacement power alternatives require a Federal license or permit (i.e., Federal undertaking), a Federal agency would need to make a reasonable effort to identify historic properties within the area of potential effect. The agency would then need to consider the effects of the undertaking on historic properties in accordance with NHPA Section 106. Identified historic and cultural resources would need to be recorded and evaluated for eligibility for listing in the NRHP. If it is determined that historic properties are present and could be affected by the undertaking, any adverse effects would need to be assessed and mitigated in consultation with the Virginia SHPO and any affected Indian Tribe through the Section 106 process.

Construction

The potential impact on historic properties and other cultural resources during the construction of replacement power facilities would vary depending on the degree of ground disturbance. 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.

Operation

Historic properties and cultural resources could be affected by ground-disturbing maintenance activities when operating the replacement power plant.

4.9.4 New Nuclear (Small Modular Reactor) Alternative

Potential impacts on historic properties and other cultural resources during construction and operation of a new small modular nuclear reactor unit would include those common to all replacement power alternatives. The extent of impact to historic properties would depend on the land chosen for the new nuclear facility and other relocated buildings. Some structures such as the power block may be visible offsite. Avoidance of historic and cultural material may not be possible but could be managed. The impact determination of this alternative would depend on the specific location of the new facility. The Virginia Department of Historic Resources would need to be consulted prior to any ground-disturbing activities in undisturbed land areas at Surry.

4.9.5 Natural Gas Combined-Cycle Alternative

Potential impacts on historic properties and other cultural resources during construction and operation of a new natural gas power plant would include those common to all replacement power alternatives. Some infrastructure upgrades may be required. Impacts from the construction and operation of a new natural gas facility would be similar to, but less than, the impacts described for the new nuclear facility. The extent of impact to historic properties would depend on the land chosen for the new natural gas facility. Some structures such as exhaust stacks may be visible offsite. Avoidance of historic and cultural material may not be possible but could be managed. The impact determination of this alternative would depend on the specific location of the new facility. The Virginia Department of Historic Resources would need to be consulted prior to any ground-disturbing activities in undisturbed land areas at Surry.

4.9.6 Combination Alternative (Natural Gas Combined-Cycle, Solar, and Demand-Side Management)

Potential impacts on historic properties and other cultural resources during construction and operation of a new natural gas and solar photovoltaic power generating facilities would include those common to all replacement power alternatives. Some infrastructure upgrades could be required. The extent of impact to historic properties would depend on the land chosen for the new natural gas facility. Some structures such as exhaust stacks may be visible offsite. Avoidance of historic and cultural material may not be possible but could be managed. Activities associated with the demand-side management would not likely have any direct impact on historic properties and other cultural resources. The impact determination of this alternative would depend on the specific location of new facilities. The Virginia Department of Historic Resources would need to be consulted prior to any ground-disturbing activities in undisturbed land areas at Surry or elsewhere.

4.10 Socioeconomics

This section describes the potential socioeconomic impacts of the proposed action (license renewal) and alternatives to the proposed action.

4.10.1 Proposed Action

Socioeconomic effects of ongoing reactor operations at Surry have become well established as regional socioeconomic conditions have adjusted to the presence of the nuclear power plant. Any changes in employment and tax revenue caused by license renewal and any associated refurbishment activities could have a direct and indirect impact on community services and housing demand, as well as traffic volumes in the communities around the nuclear power plant.

Dominion indicated in its environmental report that it has no plans to add non-outage workers during the license renewal term and that increased maintenance and inspection activities could be managed using the current workforce (Dominion 2018b). Consequently, people living near Surry Units 1 and 2 would not experience any changes in socioeconomic conditions during the license renewal term beyond what is currently being experienced. Therefore, the impact of continued reactor operations during the renewal term would not exceed the socioeconomic impacts predicted in the 2013 GEIS. For these issues, the GEIS predicted socioeconomic impacts would be SMALL for all nuclear plants.

4.10.2 No-Action Alternative

4.10.2.1 Socioeconomics

Under the no-action alternative, the NRC would not renew the operating license, and Surry Units 1 and 2 would shut down on or before the expiration of the current facility operating license. This would have a noticeable impact on socioeconomic conditions in the counties and communities near Surry Units 1 and 2. The loss of jobs, income, and tax revenue would have an immediate socioeconomic impact. As jobs are eliminated, some, but not all, of the over 940 workers could leave. Income from the buying and selling of goods and services needed to maintain the power plant would also be reduced. In addition, loss of tax revenue could affect the availability of public services.

If workers and their families move away, increased vacancies and reduced demand for housing would likely cause property values to fall. The greatest socioeconomic impact would be experienced in the communities located nearest to Surry Units 1 and 2, in Isle of Wight and Surry counties. However, the loss of jobs, income, and tax revenue, may not be as noticeable in large communities due to the time and steps required to prepare the nuclear plant for decommissioning. Therefore, depending on the jurisdiction, socioeconomic impacts from not renewing the operating license and terminating reactor operations at Surry Units 1 and 2 could range from SMALL to MODERATE.

4.10.2.2 Transportation

Traffic volume on roads near Surry Units 1 and 2 may be noticeably reduced during shift changes after the termination of reactor operations. Any reduction in traffic volume would coincide with workforce reductions at Surry. The number of truck deliveries and shipments would also be reduced until active decommissioning. Therefore, due to the time and steps required to prepare the nuclear plant for decommissioning, traffic-related transportation impacts would be SMALL.

4.10.3 Replacement Power Alternatives: Common Impacts

Workforce requirements for replacement power alternatives were evaluated to measure their possible effects on current socioeconomic and transportation conditions. Table 4-10 summarizes socioeconomic and transportation impacts of replacement power alternatives. The following provides a discussion of the common socioeconomic and transportation impacts during construction and operations of replacement power generating facilities.

4.10.3.1 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 power plant could affect regional employment, income, and tax revenue. 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.

While the selection of a replacement power alternative could create opportunities for employment and income and generate tax revenue in the local economy; employment, income, and tax revenue would be greatly reduced or eliminated in communities located near Surry Units 1 and 2. These impacts are described in the “No-Action Alternative” (Section 4.10.2).

Construction

The relative economic effect of an influx of workers on the local economy and tax base would vary, with the greatest impacts occurring in the communities where the majority of construction workers would reside and spend their income. As a result, some local communities could experience an economic boom during construction from increased tax revenue and income generated by expenditures for goods and services and increased demand for temporary (rental) housing. After construction, local communities would likely experience a return to preconstruction economic conditions.

Operation

Prior to the commencement of startup and operations, local communities would see an influx of operations workers and their families and 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 power plant. Consequently, power plant operations would have a greater potential than power plant construction for effecting permanent, long-term socioeconomic impacts on the region.

4.10.3.2 Transportation

Transportation impacts are defined in terms of changes in level of service conditions on local roads. Additional vehicles during construction and operations could lead to traffic congestion and level of service impacts on local roadways and delays at intersections.

Construction

Transportation impacts would consist of commuting workers and truck deliveries of equipment and material to the construction site. Traffic volumes would increase substantially during shift changes. Trucks would deliver equipment and material to the construction site and remove waste material, thereby increasing the amount of traffic on local roads. The increase in traffic volumes could result in level of service impacts and delays at intersections during certain hours of the day. In some instances, construction material could also be delivered and removed by rail or barge.

Operation

Traffic volumes would be greatly reduced after construction had been completed because of the smaller size of the operations workforce. Transportation impacts would consist of commuting operations workers and truck deliveries of equipment and material and removal of waste material.

Table 4-10 Socioeconomic and Transportation Impacts of Replacement Power Alternatives

Alternative	Resource Requirements	Impacts	Discussion
New Nuclear	Construction: 2,200 workers[(a)] Operations: 1,000 workers[(a)]	MODERATE to LARGE SMALL to MODERATE	Some nuclear workers could transfer from Surry Units 1 and 2 to the new nuclear power plant.
Natural Gas Combined-Cycle	Construction: 1,300 workers[(b)] Operations: 170 workers[(b)]	MODERATE to LARGE SMALL to MODERATE	Because natural gas fuel is transported by pipeline, local roads would experience little to no increased traffic during power plant operations.
Combination, NGCC, Solar Photovoltaic, and Demand-Side Management	Construction: 1,300 (NGCC) and 550 (Solar) workers[(c)] Operations: 170 (NGCC) and 25 (Solar) workers[(C)]	SMALL to MODERATE 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. The demand-side management component would not cause an increase in traffic volumes on local roads and would therefore have no transportation impacts.

[(a)] NRC 2018c.
[(b)] NRC 2016a.
[(c)] NRC 2016a and DOE 2011b.

Source: DOE 2011b; NRC 2016a, NRC 2018c.

4.11 Human Health

This section describes the potential human health impacts of the proposed action (license renewal) and alternatives to the proposed action.

4.11.1 Proposed Action

According to the GEIS (NRC 1996 and NRC 2013a), the generic issues related to human health as identified in Table 4-1 would have SMALL impacts resulting from license renewal. As discussed in Chapter 3, the NRC staff identified no new and significant information for these issues. Thus, as concluded in the GEIS, the impacts of those generic issues related to human health would be SMALL.

Table 4-2 identifies one uncategorized issue (chronic exposure to electromagnetic fields) and two site-specific (Category 2) issues (electric shock hazards and microbiological hazards to the public) related to human health applicable to Surry subsequent license renewal. These issues are analyzed below.

4.11.1.1 Microbiological Hazards to the Public

In the GEIS (NRC 2013a), the NRC determined that the effects of thermophilic microorganisms on the public for plants using cooling ponds, lakes, or canals, or cooling towers, or that discharge to a river is a Category 2 issue that requires site-specific evaluation during each license renewal review.

The NRC staff considered several factors to determine whether Surry operations during the proposed license renewal term could promote increased growth of thermophilic microorganisms and result in an adverse health effect on the public. These factors included the thermophilic microorganisms of concern, Surry's thermal effluent characteristics, recreational use of the James River, and reports and input from the Virginia Department of Health.

Section 3.11.3 describes the thermophilic microorganisms that the 2013 GEIS identified to be of potential concern at nuclear power plants and summarizes data from the Centers for Disease Control and Prevention (CDC) on the prevalence of waterborne diseases associated with these microorganisms that have been linked to recreational water use in the past 10 available data years. CDC data indicate no infections or outbreaks from *Salmonella*, *Shigella*, or *Pseudomonas aeruginosa* associated with recreational water use in the United States (CDC 2018b, CDC 2018c). From 1962 through 2017, the CDC reports an average of 7.3 cases of primary amebic meningoencephalitis caused by the free-living amoeba *Naegleria fowleri* annually in the United States (CDC 2018a). In this period, seven cases total were in Virginia, none of which were associated with the James River. Public exposure to aerosolized *Legionella* from nuclear plant operations is generally not a concern because such exposure would be confined to a small area of the site to which the public would not have access.

The circulating water system's discharge of thermal effluent to the James River is also unlikely to create a thermal environment that would enhance the survival of thermophilic organisms, if already present in the river. The Virginia Department of Environmental Quality (VDEQ) limits waste heat rejected to the river through the site's VPDES permit to 12.6×10^9 Btu per hour. Although the permit does not require reporting of actual discharge temperatures, during a 5-year pre- and post-operational thermal demonstration conducted pursuant to Section 316(a) of the Clean Water Act, researchers recorded the highest surface water temperature in the Surry discharge canal at 99.9 °F (37.7 °C) (Fang and Parker 1976). However, temperatures this high did not occur in the river itself because temperatures rapidly decreased once canal water mixed with river water. Within the immediate vicinity of the discharge, these temperatures could reasonably enhance survival or growth of *Shigella* (optimum growth at 98.6 °F (37 °C) but are unlikely to enhance survival or growth of *N. fowleri* (optimum growth at 115 °F (46.1 °C). However, discharge canal temperatures this high would be of short duration, would only occur in the height of summer, and would dissipate rapidly once mixed with ambient river water such that heightened temperatures are unlikely to produce a measurable effect on the *Shigella* population, if present in the river. Dominion (Dominion 2018b) reports that temperatures decrease 1 to 2 °F (0.6 to 1.2 °C) with every 1,000 ft (300 m) from the mouth of the discharge canal and that temperatures are rarely more than 5 °F (2.8 °C) above ambient river temperatures at distances of 3,000 ft (900 m) from the discharge outfall. Thus, thermal additions to the James River resulting from Surry operations are unlikely to enhance the growth or survival of thermophilic organisms.

Chlorine is an effective disinfectant for water containing the microorganisms of concern. The EPA (EPA 1999) reports that chlorination at concentrations of 1 to 2 mg/L in water at a pH of 6.0 to 8.0 can effectively eliminate health hazards caused by bacteria, including *Shigella*. The CDC

(CDC 2017) reports that chlorine at a concentration of 1 ppm (1 mg/L) added to 77 °F (25 °C) clear water at a pH of 7.5 will reduce the number of viable *N. fowleri* trophozoites by 99.99 percent in 12 minutes. Dominion (Dominion 2018b) treats water entering the cooling and auxiliary water systems with sodium hypochlorite to minimize biofouling of cooling system components. The VDEQ (VDEQ 2016) allows instantaneous maximum total residual chlorine concentrations of up to 1.0 mg/L under the site's VPDES permit. This level of chlorination is likely to eliminate thermophilic microorganisms, if present in cooling water, such that thermal effluent discharged into the river would not contain any of the microorganisms of concern.

The James River near Surry is used for several recreational purposes, including fishing, boating, and water sports. However, the discharge canal and majority of the James River encompassing the thermal plume are restricted from public access (Dominion 2019a). Restricted access minimizes the potential for human exposure to the microorganisms of concern, if present in the river. Thus, exposure of recreational James River users to elevated concentrations of the microorganisms of concern is unlikely given the unlikelihood of the water to create conditions favorable to thermophilic microorganisms, the small area of thermally altered waters, and the restricted access of the public to these areas.

The environmental standard review plan for license renewal (NRC 2013e) directs the NRC staff to consult with the state public health department—in this case, the Virginia Department of Health (VDEH)—regarding concerns about the potential for waterborne disease outbreaks associated with license renewal. In communications between Dominion and the VDEH related to the proposed Surry subsequent license renewal, the VDEH stated that no known risk exists, nor is risk likely given the long-term existence of the Surry discharge and the lack of known issues relating to the thermophilic microorganisms of concern on the lower James River (VDH 2019). Accordingly, the NRC staff did not separately contact the VDEH during its subsequent license renewal review.

<u>Conclusion</u>

The thermophilic microorganisms *Shigella* and *N. fowleri* have been linked to waterborne outbreaks in recreational waters within the United States. However, based on these microorganisms' temperature tolerances, *Shigella* and *N. fowleri* are unlikely to be present near Surry. Additionally, the small thermal mixing zone and Dominion's chlorination of cooling water make exposure of recreational water users to elevated levels of these microorganisms unlikely. The NRC staff concludes that the impacts of thermophilic microorganisms on the public are SMALL for the proposed Surry license renewal.

4.11.1.2 Uncategorized Issue Relating to Human Health: Chronic Effects of Electromagnetic Fields

The GEIS (NRC 2013 GEIS) does not designate the chronic effects of 60-Hz electromagnetic fields (EMFs) from power lines as either a Category 1 or 2 issue. Until a scientific consensus is reached on the health implications of electromagnetic fields, the NRC will not include them as Category 1 or 2 issues.

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 U.S. Department of Energy (DOE).

The report by the National Institute of Environmental Health Sciences (NIEHS 1999) 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 non-cancer health outcomes provide sufficient evidence of a risk to currently warrant concern.

This statement was not sufficient to cause the NRC to change its position with respect to the chronic effects of electromagnetic fields. The NRC staff considers the GEIS finding of "UNCERTAIN" still appropriate and will continue to follow developments on this issue.

4.11.1.3 Category 2 Issue Related to Human Health: Electric Shock Hazards

Based on the GEIS (NRC 2013a), the Commission found that electric shock resulting from direct access to energized conductors or from induced charges in metallic structures has not been identified to be a problem at most operating 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 Surry license renewal review.

As discussed in Section 3.11.4, there are no offsite transmission lines that are in scope for this SEIS. Therefore, there are no potential impacts to members of the public.

As discussed in Section 3.11.5, Surry maintains an occupational safety program in accordance with the Occupational Safety & Health Administration 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 license renewal term would be SMALL.

4.11.1.4 Environmental Consequences of Postulated Accidents

The GEIS (NRC 2013a) 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 **Error! Reference source not found.**, the GEIS (NRC 2013a) 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.

As shown in Table 4-2, the GEIS (NRC 2013a) designates severe accidents as a Category 2 issue requiring site-specific analysis. Based on information in the 2013 GEIS, the NRC determined in 10 CFR Part 51, 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:

> 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 2013a)

Dominion's 2001 environmental report submitted as part of its initial license renewal application included an assessment of SAMAs for Surry (Dominion 2001b). The NRC staff at that time reviewed Dominion's 2001 analysis of SAMAs for Surry and documented this review in its SEIS for the initial license renewal, which the NRC published in 2002, as Supplement 6, "Regarding Surry Power Station, Units 1 and 2," to NUREG-1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (NRC 2002b). Because the NRC staff has previously considered SAMAs for Surry, Dominion is not required to perform another SAMA analysis for its subsequent license renewal application (10 CFR 51.53(c)(3)(ii)(L)).

However, the NRC's regulations at 10 CFR Part 51, which implement Section 102(2) of the National Environmental Policy Act of 1969, as amended (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)). This includes new and significant information that could affect the environmental impacts related to postulated severe accidents or that could affect the results of a previous SAMA assessment. Accordingly, in its subsequent license renewal application environmental report, Dominion evaluated areas of new and potentially significant information that could affect the environmental impact of postulated severe accidents during the subsequent license renewal period. The NRC staff provides a discussion of new information pertaining to SAMAs in Appendix F, "Environmental Impacts of Postulated Accidents," in this SEIS.

Based on the NRC staff's review and evaluation of Dominion'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 SEIS, the staff finds that there is no new and significant information for Surry related to SAMAs.

4.11.2 No-Action Alternative

Under the no-action alternative, the NRC would not issue subsequent renewed licenses, and Surry would shut down on or before the expiration of the current renewed licenses. Human health risks would be smaller following 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 plant (radiological or industrial) would be reduced to a limited set associated with shutdown events and fuel handling and storage. In Section 4.11.1, "Proposed Action," the NRC staff concluded that the impacts of continued plant operation on human health would be SMALL, except for "Chronic effects of electromagnetic fields (EMFs)," for which the impacts are UNCERTAIN. In Section 4.11.1.3, "Environmental Consequences of 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 plant shutdown would be SMALL.

4.11.3 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 the U.S. Environmental Protection Agency and Virginia State agencies, base air emission standards and requirements on human health impacts. These agencies also impose site-specific emission limits to protect human health.

4.11.4 New Nuclear (Small Modular Reactor) Alternative

The construction impacts of the new nuclear alternative would include those identified in Section 4.11.3 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 two new nuclear units would be SMALL.

The human health effects from the operation of the new nuclear alternative would be similar to those of operating the existing Surry Units 1 and 2. Small modular reactor designs would use the same type of fuel (i.e., form of the fuel, enrichment, burnup, and fuel cladding) as those plants considered in the NRC staff's evaluation in the GEIS (NRC 2013a). As such, their impacts would be similar to Surry Units 1 and 2. As presented in Section 4.11.1, impacts on human health from the operation of Surry 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.

4.11.5 Natural Gas Combined-Cycle Alternative

The construction impacts of the natural gas alternative would include those identified in Section 4.11.3, "Replacement Power Alternatives: Common Impacts," as common to the construction of all replacement power alternatives. Since 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 natural gas alternative would be SMALL.

The human health effects from the operation of the natural gas alternative would include those identified in Section 4.11.3 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 2013a). Given the regulatory oversight exercised by the EPA and State agencies, the NRC staff concludes that the human health impacts from the natural gas alternative would be SMALL.

4.11.6 Combination Alternative (Natural Gas Combined-Cycle, Solar, and Demand-Side Management)

Impacts on human health from construction of the combination natural gas and solar alternative would include those identified in Section 4.11.3 as common to the construction of all replacement power alternatives. Since 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 natural gas and solar alternative would be SMALL.

Construction impacts for the demand-side management portion of this alternative would be minimal and localized to activities such as weatherization efficiency of an end-user's home or facility (NRC 2013a). Impacts on human health from the construction activities involved in the demand-side management portion of this alternative would be SMALL.

Operational hazards at a natural gas facility are discussed in Section 4.11.5, "Natural Gas Combined-Cycle Alternative."

Solar photovoltaic 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 will be released into the environment. In the event of a fire, hazardous particulate matter could be released to the atmosphere. Given the short duration of fires and the high melting points of the materials found in the solar photovoltaic panels, the impacts from inhalation are minimal. Also, the risk of fire at ground mounted solar installations is minimal due to precautions taken during site preparation, such as the removal of fuels and the lack of burnable materials contained in the solar photovoltaic panels. Another potential risk associated with photovoltaic 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 (OIPP 2010).

Photovoltaic solar panels do not produce electromagnetic fields at levels considered harmful to human health as established by the International Commission on Non-Ionizing Radiation Protection. These small electromagnetic fields diminish significantly with distance and are indistinguishable from normal background levels within several yards (OIPP 2010).

Operational hazards impacts for the demand-side management portion of this alternative would be minimal and localized to activities such as weatherization efficiency of an end-user's home or facility. The GEIS notes that the environmental impacts are likely to center on indoor air quality (NRC 2013a). This is because of increased weatherization of the home in the form of extra insulation and reduced air turnover rates from the reduction in air leaks. However, the actual impact is highly site-specific and not yet well established. Impacts on human health from the construction activities involved in the demand-side management portion of this alternative would be SMALL.

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 natural gas combined-cycle, solar photovoltaic generation, and demand-side management alternative would be SMALL.

4.12 Environmental Justice

This section describes the potential human health and environmental effects of the proposed action (license renewal) and alternatives to the proposed action on minority and low-income populations.

4.12.1 Proposed Action

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 to 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.

Figures 3-31 and 3-32 show the location of predominantly minority and low-income population block groups residing within a 50-mi (80-km) radius of Surry Units 1 and 2. This area of impact is consistent with the 50-mi (80-km) impact analysis for public and occupational health and safety. This chapter (Chapter 4) of the SEIS 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 license renewal 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 license renewal term are expected to continue at current levels, and they would remain within regulatory limits. Section 4.11.1.4 discusses the environmental impacts from postulated accidents that might occur during the license renewal 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 plants are designed and operated to successfully 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, there would be no disproportionately high and adverse human health and environmental effects on minority and low-income populations from the continued operation of Surry Units 1 and 2 during the renewal term.

Subsistence Consumption of Fish and Wildlife

As part of addressing environmental justice concerns associated with license renewal, 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, including the subsistence consumption of fish and wildlife 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 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, such as migrant workers or Native Americans. The results of this analysis are presented here.

Section 4–4 of Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations" (1994) (59 FR 7629), 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 SEIS, the NRC considered whether there were any means for minority or low-income populations to be disproportionately affected by examining impacts on American Indian, Hispanics, migrant workers, and other traditional lifestyle special pathway receptors. The assessment of special pathways considered the levels of radiological and nonradiological contaminants in fish, sediments, water, milk, and food products on or near Surry Units 1 and 2.

Radionuclides released to the atmosphere may deposit on soil and vegetation and may therefore eventually be incorporated into the human food chain. To assess the impact of reactor operations on humans from the ingestion pathway, Dominion collects and analyzes samples of air, water, silt, shoreline sediment, milk, aquatic biota (e.g., fish, crabs, clams, and oysters), food products, and direct exposure for radioactivity as part of its ongoing comprehensive radiological environmental monitoring program.

To assess the impact of nuclear power plant operations, samples are collected annually from the environment and analyzed for radioactivity. A plant 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 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 levels.

Dominion collects samples from the aquatic and terrestrial environment near Surry Units 1 and 2. The aquatic environment includes well and river water, groundwater, fish, crabs, clams, oysters, and shoreline sediment. Aquatic monitoring results for 2018 showed only naturally occurring radioactivity and radioactivity associated with fallout from past atmospheric nuclear weapons testing and were consistent with levels measured before Surry Units 1 and 2 began operating. Dominion detected no radioactivity greater than the minimum detectable activity in any aquatic sample during 2018 and identified no adverse long-term trends in aquatic monitoring data (VEPC 2019b).

The terrestrial environment includes airborne particulates, milk, and food products (e.g., corn, peanuts, and soybeans). Terrestrial monitoring results for 2018 showed only naturally occurring radioactivity. The radioactivity levels detected were consistent with levels measured prior to the operation of Surry Units 1 and 2. Dominion detected no radioactivity greater than the minimum detectable activity in any terrestrial samples during 2018. The terrestrial monitoring data also showed no adverse trends in the terrestrial environment (VEPC 2019b).

Analyses performed on all samples collected from the environment at Surry, in 2018, showed no significant measurable radiological constituent above background levels. Overall, radioactivity levels detected in 2018 were consistent with previous levels as well as radioactivity levels measured prior to the operation of Surry Units 1 and 2. Radiological environmental monitoring program (REMP) sampling in 2018 did not identify any radioactivity above background or the minimum detectable activity (VEPC 2019b).

Based on the radiological environmental monitoring data, the NRC finds that no disproportionately high and adverse human health impacts would be expected in special pathway receptor populations in the region because of subsistence consumption of water, local food, fish, or wildlife. In addition, the continued operation of Surry Units 1 and 2 would not have disproportionately high and adverse human health and environmental effects on these populations.

4.12.2 No-Action Alternative

Under the no-action alternative, the NRC would not renew the operating licenses, and Surry Units 1 and 2 would shut down on or before the expiration of the current facility operating license. Impacts on minority and low-income populations would depend on the number of jobs and the amount of tax revenues lost in communities located near the power plant after reactor operations cease. Not renewing the operating licenses and terminating reactor operations could have a noticeable impact on socioeconomic conditions in the communities located near Surry Units 1 and 2. The loss of jobs and income could have an immediate socioeconomic impact. Some, but not all, of the over 940 employees could leave the area. In addition, less tax revenue could reduce the availability of public services. This could disproportionately affect minority and low-income populations that may have become dependent on these services. See also Appendix J, “Socioeconomics and Environmental Justice Impacts Related to the Decision to Permanently Cease Operations,” of NUREG-0586, Supplement 1, Volume 1, “Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities: Regarding the Decommissioning of Nuclear Power Reactors” (the Decommissioning GEIS, NRC 2002), for additional discussion of these impacts.

4.12.3 Replacement Power Alternatives: Common Impacts

<u>Construction</u>

Potential impacts to minority and low-income populations from the construction of a replacement power plant would mostly consist of environmental and socioeconomic effects (e.g., noise, dust, traffic, employment, and housing impacts). The extent of the effects experienced by these populations is difficult to determine because it would depend on the location of the power plant units and transportation routes. Noise and dust impacts from construction would be short term and primarily limited to onsite activities. Minority and low-income populations residing along site access roads would be affected by increased truck and commuter vehicle traffic during construction, especially during shift changes. However, these effects would be temporary, limited to certain hours of the day, and would not likely be high and adverse. Increased demand for rental housing during construction could disproportionately affect low-income populations reliant on low-cost housing. However, given the proximity of the Surry site to the Norfolk metropolitan area, construction workers could commute to the site, thereby reducing the potential demand for rental housing.

Operation

Low-income populations living near the new power plant that rely on subsistence consumption of fish and wildlife could be disproportionately affected. Emissions during power plant operations could also disproportionately affect nearby minority and low-income populations, depending on the type of replacement power. However, permitted air emissions are expected to remain within regulatory standards during operations.

Conclusion

Based on this information and the analysis of human health and environmental impacts presented in this SEIS, it is not likely that the construction and operation of a new replacement power plant and energy savings from demand-side management would have any disproportionately high and adverse human health and environmental effects on minority and low-income populations. However, this determination would depend on the location, plant design, and operational characteristics of new replacement power plants. Therefore, the NRC cannot determine whether any of the replacement power alternatives would result in disproportionately high and adverse human health and environmental effects on minority and low-income populations.

4.12.4 New Nuclear (Small Modular Reactor) Alternative

Potential impacts to minority and low-income populations during the construction and operation of new nuclear power plant units would be similar to the construction impacts described above. Potential impacts during operations would mostly consist of radiological effects; however, radiation doses would be well within regulatory limits.

4.12.5 Natural Gas Combined-Cycle Alternatives

Potential impacts to minority and low-income populations from the construction and operation of a new power plant would be similar to the construction and operation impacts described above in Section 4.12.3.

4.12.6 Combination Alternative (Natural Gas Combined-Cycle, Solar, and Demand-Side Management)

Potential impacts to minority and low-income populations from the construction and operation of new natural gas and the installation of solar photovoltaic units would be similar to the construction and operation impacts described above in Section 4.12.3. Low-income populations could benefit from weatherization and insulation programs in a demand-side management energy conservation program. This could have a greater effect on low-income populations than the general population, as low-income households generally experience greater home energy burdens than the average household. Conversely, more costly utility bills due to increasing power costs could disproportionately affect low-income populations. However, programs such as the Federal Low Income Home Energy Assistance Program and the Virginia Energy Assistance Program are available to assist low-income families in paying for electricity.

4.13 Waste Management

This section describes the potential waste management impacts of the proposed action (subsequent license renewal) and alternatives to the proposed action.

4.13.1 Proposed Action

According to the GEIS (NRC 1996, NRC 2013a), the generic issues related to waste management as identified in Table 4-1 would not be affected by continued operations associated with license renewal. As discussed in Chapter 3, the NRC staff identified no new and significant information for these issues. Thus, as concluded in the GEIS, the impacts of those generic issues related to waste management would be SMALL.

As shown in Table 4-2, the NRC staff did not identify any Surry site-specific (Category 2) waste management issues resulting from issuing a renewed license for an additional 20 years of operations.

4.13.2 No-Action Alternative

If the NRC chooses the no-action alternative, it would not issue renewed licenses, and Surry would cease operation at the end of the term of the current operating licenses or sooner and enter decommissioning. After entering decommissioning, the 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 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.

4.13.3 Replacement Power Alternatives: Common Impacts

Impacts from waste management common to all analyzed replacement power alternatives would be from construction-related non-radiological debris generated during construction activities. This waste would be recycled or disposed of in approved landfills.

4.13.4 New Nuclear (Small Modular Reactors) Alternative

Impacts from the waste generated during the construction of the new nuclear alternative would include those identified in the previous paragraph, Section 4.13.3, as common to all replacement power alternatives.

During normal plant operations, routine plant maintenance and cleaning activities would generate radioactive low-level waste, spent nuclear fuel, high-level waste, and nonradioactive waste. Sections 3.1.4 and 3.1.5 of this SEIS discuss radioactive and nonradioactive waste management at Surry. Small modular reactor designs would use the same type of fuel (i.e., form of the fuel, enrichment, burnup, and fuel cladding) as those plants considered in the NRC staff's evaluation in the GEIS (NRC 2013a), and as such all wastes generated would be similar to those generated at Surry Units 1 and 2. According to the GEIS, the NRC does not expect the generation and management of solid radioactive and nonradioactive waste during the subsequent license renewal term to result in significant environmental impacts. Based on this information, the waste impacts would be SMALL for the new nuclear alternative.

4.13.5 Natural Gas Combined-Cycle Alternative

Impacts from the waste generated during construction of the natural gas alternative would include those identified in Section 4.13.3, "Replacement Power Alternatives: Common Impacts," of this SEIS 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 (used 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 (NRC 2013a). Overall, the NRC staff concludes that waste impacts from the natural gas alternative would be SMALL.

4.13.6 Combination Alternative (Natural Gas Combined-Cycle, Solar, and Demand-Side Management).

Impacts from the waste generated during the construction of the natural gas combined-cycle (NGCC) plant and solar photovoltaic (PV) alternative would include those identified in Section 4.13.3 of this SEIS as common to the construction of all replacement power alternatives. The combination alternative consists of a natural gas plant and solar PV facility that provide generation equivalent to Surry's 1,676 MWe. The natural gas plant would be located at the Surry site. Solar PV facility would be sited at an alternate site with existing transmission,

During the construction of the natural gas plant and solar PV facility, land clearing and other construction activities would generate waste that could be recycled, disposed of onsite, or shipped to an offsite waste disposal facility.

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 nonhazardous waste (NUREG-1437, Volume 1, Revision 1, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants," NRC 2013a). Overall, the NRC staff concludes that waste impacts from the natural gas portion of the combination alternative would be SMALL.

Impacts on waste management from the construction and operation of the natural gas plant and pipeline component of the combination alternative would be similar to those associated with the natural gas alternative.

The construction of the solar PV facility would create sanitary and industrial waste, although it would be of smaller quantity as compared to the natural gas plant. This waste could be recycled, disposed of onsite, or shipped to an offsite waste disposal facility. All the waste would be handled in accordance with appropriate Virginia Department of Environmental Quality (VDEQ), the Virginia Waste Management Board, and the U.S. Environmental Protection Agency (EPA) (VDEQ 2016) regulations. Impacts on waste management resulting from the construction and operation of the solar PV facility of the combination alternative would be minimal, and of a smaller quantity as compared to the natural gas plant. In summary, the waste management impacts resulting from the construction and operation of the PV facilities 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. Impacts from the demand-side management portion of this alternative would be SMALL.

Overall, the NRC staff concludes that waste impacts for the natural gas, solar PV, and demand-side management combination alternative would be SMALL.

4.14 Evaluation of New and Significant Information

As stated in Section 4.1 of this SEIS, for Category 1 (generic) issues, the NRC staff can rely on the analysis in the GEIS (NRC 2013a) unless otherwise noted. Table 4-1 lists the Category 1 issues that apply to Surry during the proposed license renewal period. For these issues, the NRC staff did not identify any new and significant information during its review of the applicant's environmental report, the site audits, or the scoping period that would change the conclusions presented in the GEIS.

New and significant information must be new based on a review of the GEIS (NRC 2013a) as codified in Table B-1 of Appendix B to Subpart A of 10 CFR Part 51. Such information must also bear on the proposed action or its impacts, presenting a seriously different picture of the impacts from those envisioned in the GEIS (i.e., impacts of greater severity than impacts considered in the GEIS, considering their intensity and context).

The NRC defines new and significant information in Regulatory Guide (RG) 4.2, Supplement 1, "Preparation of Environmental Reports for Nuclear Power Plant License Renewal Applications," (NRC 2013d), as (1) information that identifies a significant environmental impact issue that was not considered or addressed in the GEIS and, consequently, not codified in Table B-1, in Appendix B to Subpart A of 10 CFR Part 51; or (2) information not considered in the assessment of impacts evaluated in the GEIS leading to a seriously different picture of the environmental consequences of the action than previously considered, such as an environmental impact finding different from that codified in Table B-1. Further, a significant environmental issue includes, but is not limited to, any new activity or aspect associated with the nuclear power plant that can act upon the environment in a manner or with an intensity and/or scope (context) not previously recognized.

In accordance with 10 CFR 51.53(c), "Operating License Renewal Stage," the applicant's environmental report must analyze the Category 2 (site-specific) issues in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B. Additionally, the applicant's environmental report must discuss actions to mitigate any adverse impacts associated with the proposed action and environmental impacts of alternatives to the proposed action. In accordance with 10 CFR 51.53(c)(3), the applicant's environmental report does not need to analyze any Category 1 issue unless there is new and significant information on a specific issue.

NUREG-1555, Supplement 1, Revision 1, "Standard Review Plans for Environmental Reviews for Nuclear Power Plants for Operating License Renewal," describes the NRC process for identifying new and significant information (NRC 2013e). The search for new information includes:

- review of an applicant's environmental report (Dominion 2018b) and the process for discovering and evaluating the significance of new information
- review of public comments
- review of environmental quality standards and regulations
- coordination with Federal, State, and local environmental protection and resource agencies
- review of technical literature as documented through this SEIS

New information that the staff discovers is evaluated for significance using the criteria set forth in the GEIS. For Category 1 issues in which new and significant information is identified, reconsideration of the conclusions for those issues is limited in scope to assessment of the relevant new and significant information; the scope of the assessment does not include other facets of an issue that the new information does not affect.

The NRC staff reviewed the discussion of environmental impacts associated with operation during the renewal term in the GEIS and has conducted its own independent review, including a public involvement process (e.g., public meetings and comments) to identify new and significant issues for the Surry license renewal application environmental review. The assessment of new and significant information for each resource is addressed within each resource area discussion.

4.15 <u>Impacts Common to All Alternatives</u>

This section describes the impacts that the NRC staff considers common to all alternatives discussed in this SEIS, including the proposed action and replacement power alternatives. The continued operation of a nuclear power plant and replacement fossil fuel power plants both involve mining, processing, and the consumption of fuel that result in comparative impacts (NRC 2013a). In addition, the following sections discuss termination of operations, the decommissioning of both a nuclear power plant and replacement fossil fuel power plants, and greenhouse gas emissions.

4.15.1 Fuel Cycle

This section describes the environmental impacts associated with the fuel cycles of both the proposed action and all replacement power alternatives. Most replacement power alternatives employ a set of steps in the use of their fuel sources, which can include extraction, transformation, transportation, and combustion. Emissions generally occur at each stage of the fuel cycle (NRC 2013a).

4.15.1.1 Uranium Fuel Cycle

The uranium fuel cycle includes uranium mining and milling, the production of uranium hexafluoride, isotopic enrichment, fuel fabrication, reprocessing of irradiated fuel, transportation of radioactive materials, and management of low-level wastes and high-level wastes related to uranium fuel cycle activities. The 2013 GEIS describes in detail the generic potential impacts of the radiological and nonradiological environmental impacts of the uranium fuel cycle and transportation of nuclear fuel and wastes (NRC 1996, 2013a). The GEIS does not identify any site-specific (Category 2) uranium fuel cycle issues.

As stated in the GEIS (NRC 1996, 2013a), the generic issues related to the uranium fuel cycle as identified in Table 4-1 would not be affected by continued operations associated with license renewal. As discussed in Chapter 3, the NRC staff identified no new and significant information for these issues. Thus, as concluded in the GEIS, the impacts of generic issues related to the uranium fuel cycle would be SMALL.

4.15.1.2 Replacement Power Plant Fuel Cycles

<u>Fossil Fuel Energy Alternatives</u>

Fuel cycle impacts for a fossil fuel-fired 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 solid wastes from fuel combustion. These impacts are discussed in more detail in Section 4.12.1.2 of the GEIS (NRC 2013a) 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 coalbed methane into the atmosphere
- noise impacts
- geology and soil impacts due to 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 coal and industrial wastes

<u>New Nuclear Energy Alternatives</u>

Uranium fuel cycle impacts for a nuclear 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 discussed above in Section 4.15.1.1.

<u>Renewable Energy Alternatives</u>

The fuel cycle for renewable energy facilities is difficult to define for different technologies because these natural resources exist regardless of any effort to harvest them for electricity production. Impacts from the presence or absence of these renewable energy technologies are often difficult to determine (NRC 2013 GEIS).

4.15.2 Terminating Power Plant Operations and Decommissioning

This section describes the environmental impacts associated with the termination of operations and the decommissioning of a nuclear power plant and replacement power alternatives. All operating 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 Surry, subsequent license renewal would delay this eventuality for an additional 20 years beyond the current license period, which ends in 2032 (Unit 1), and 2033 (Unit 2).

4.15.2.1 Existing Nuclear Power Plant

Decommissioning would occur whether Surry is shut down at the end of its current renewed license or at the end of the subsequent license renewal term. NUREG-0586, Supplement 1, "Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities: Regarding the Decommissioning of Nuclear Power Reactors" (the Decommissioning GEIS), evaluates the environmental impacts from the activities associated with the decommissioning of any reactor before or at the end of an initial or renewed license (NRC 2002 GEIS). Additionally, the GEIS (NRC 2013 GEIS) discusses the incremental environmental impacts associated with decommissioning activities resulting from continued plant operation during the renewal term. As noted in Table 4-1, there is one Category 1 issue, "Termination of plant operations and decommissioning," applicable to Surry decommissioning following the subsequent license renewal term. The License Renewal GEIS did not identify any site-specific (Category 2) decommissioning issues.

4.15.2.2 Replacement Power Plants

<u>Fossil Fuel Energy Alternatives</u>

The environmental impacts from the termination of power plant operations and decommissioning of a fossil fuel-fired plant are dependent on the facility's decommissioning plan. General elements and requirements for a fossil fuel plant decommissioning plan are discussed in Section 4.12.2.2 of the License Renewal GEIS and can include the removal of structures to at least 3 ft (1 m) below grade; removal of all coal, combustion waste, and accumulated sludge; removal of intake and discharge structures; and the cleanup and remediation of incidental spills and leaks at the facility. The decommissioning plan outlines the actions necessary to restore the site to a condition equivalent in character and value to the site on which the facility was first constructed (NRC 2013 GEIS).

The environmental consequences of decommissioning are discussed in Section 4.12.2.2 of the License Renewal GEIS and 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 due to decommissioning the workforce and the long-term loss of jobs
- elimination of health and safety impacts on operating personnel and the general public

New Nuclear Alternatives

Termination of operations and decommissioning impacts for a nuclear plant include all activities related to 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 (NRC 2013 GEIS). The environmental impacts of the uranium fuel cycle are discussed in Section 4.15.1.1, “Uranium Fuel Cycle”.

Renewable Alternatives

Termination of power plant operation and decommissioning for renewable energy facilities would be similar to the impacts discussed for fossil fuel-fired plants above. Decommissioning would involve the removal of facility components and operational wastes and residues to restore the site to a condition equivalent in character and value to the site on which the facility was first constructed (NRC 2013 GEIS).

4.15.3 Greenhouse Gas Emissions and Climate Change

The following sections discuss greenhouse gas emissions and climate change impacts. Section 4.15.3.1 evaluates greenhouse gas emissions associated with operation of Surry Units 1 and 2 and replacement power alternatives. Section 4.15.3.2 discusses the observed changes in climate and the potential future climate change during the subsequent license renewal term based on climate model simulations under future global greenhouse gas emission scenarios. In Section 4.16, “Cumulative Impacts,” of this SEIS, the NRC staff considers the potential cumulative, or overlapping, impacts from climate change on environmental resources where there are incremental impacts of the proposed action (subsequent license renewal).

4.15.3.1 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 greenhouse gases (GHGs). GHGs include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), water vapor (H_2O), and fluorinated gases, such as hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). 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 these gases in the atmosphere generally increase the Earth’s surface temperature. Atmospheric concentrations of carbon dioxide, methane, and nitrous oxide have significantly increased since 1750 (IPCC 2007, IPCC 2013). Carbon dioxide, methane, nitrous oxide, and fluorinated gases (termed long-lived greenhouse gases) are well mixed throughout the Earth’s atmosphere, and their impact on climate is long lasting and cumulative in nature as a result of their long atmospheric lifetime (EPA 2016a). 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. Climate change research indicates that the cause of the Earth’s warming over the last 50 years is due to the buildup of GHGs in the atmosphere resulting from human activities (IPCC 2013; USGCRP 2014, USGCRP 2017, USGCRP 2018). The EPA has determined that greenhouse gases “may reasonably be anticipated both to endanger public health and to endanger public welfare” (74 FR 66496).

Proposed Action

The operation of Surry results in both direct and indirect GHG emissions. Dominion has calculated direct (i.e., from stationary and portable combustion sources) and indirect (i.e., from workforce commuting) GHG emissions, which are reported in Table 4-12. Dominion does not maintain an inventory of GHG emissions resulting from visitor and delivery vehicles (Dominion 2018b).

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 Title VI, "Stratospheric Ozone Protection." Dominion maintains a program to manage stationary refrigeration appliances at Surry to recycle, recapture, and reduce emissions of ozone-depleting substances. Therefore, Table 4-11 below does not account for any potential emissions from stationary refrigeration sources at Surry (Dominion 2018b).

Table 4-11 Annual Greenhouse Gas Emissions[(a)] from Operation at Surry, Units 1 and 2

Year	Onsite Combustion Sources[(b)] (tons/year)	Workforce Commuting[(b,c)] (tons/year)	Total CO_{2eq} (tons/year)
2011	1,370	4,730	6,100
2012	430	4,730	5,160
2013	420	4,730	5,150
2014	340	4,730	5,070
2015	4,630	4,730	9,360

Note: GHG emissions reported in metric tons and converted to short tons. All reported values are rounded. To convert tons per year to metric tons per year, multiply by 0.90718.

(a) Expressed in carbon dioxide equivalents (CO_{2eq}), 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) Includes stationary and portable diesel and gasoline engines described in Table 3-2.

(c) Emissions consider Surry full-time employees and does not include additional contractor workers during refueling outages. Refueling outages occur on a staggered, 18-month schedule and last approximately 30 days per unit.

Source: Dominion 2018b

In addition, Dominion asserts that no perfluorocarbons have been added to electrical equipment including in the switchyard/substation at Surry over the last 5 years. This is because Dominion uses mineral oil in electrical equipment (e.g., transformers) and does not purchase electrical equipment containing perfluorocarbon liquids (Dominion 2018b).

No-Action Alternative

Under the no-action alternative, the NRC would not issue subsequent renewed licenses, and Surry Units 1 and 2 would shut down on or before the expiration of the current renewed licenses. At some point, all nuclear plants will terminate operations and undergo decommissioning. The Decommissioning GEIS (NUREG-0586, NRC 2002a) considers the environmental impacts from decommissioning. Therefore, the scope of impacts considered under the no-action alternative includes the immediate impacts resulting from activities at Surry that would occur between plant shutdown and the beginning of decommissioning (i.e., activities and actions necessary to cease operation of Surry). Facility operations would terminate at or before the expiration of the current renewed licenses. When the facility stops operating, a reduction in GHG emissions from activities related to plant operation, such as the use of diesel 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 4-12, which shows the estimated direct GHG emissions from operation of Surry Units 1 and 2 and associated mobile emissions.

Since the no-action alternative would result in a loss of power-generating capacity due to shutdown, the sections below discuss GHG emissions associated with replacement baseload power generation for each replacement power alternative analyzed.

New Nuclear Alternative (Small Modular Reactor)

The GEIS (NUREG-1437) presents life-cycle GHG emissions associated with nuclear power generation. As presented in Tables 4.12-4 through 4.12-6 of the GEIS (NRC 2013a), life cycle GHG emissions from nuclear power generation can range from 1 to 288 grams carbon equivalent per kilowatt-hour (g C_{eq}/kWh). Nuclear power plants do not burn fossil fuels to generate electricity. Sources of GHG emissions from the new nuclear alternative would include stationary combustion sources such as emergency diesel generators, boilers, and pumps similar to existing sources at Surry (see Section 3.3.2, "Air Quality," of this SEIS). The NRC staff estimates that GHG emissions from a new nuclear alternative would be similar to those from Surry Units 1 and 2.

Natural Gas Combined-Cycle Alternative

The GEIS (NRC 2013a) presents life-cycle GHG emissions associated with natural gas power generation. As presented in Table 4.12 5 of the GEIS, life-cycle GHG emissions from natural gas can range from 120 to 930 g C_{eq}/kWh. The NRC staff estimates that direct emissions from the operation of three, 560-MWe natural gas combined-cycle units would total 6.4 million tons (5.8 million MT) of carbon dioxide equivalents (CO_{2eq}) per year.

Combination Alternative

For the combination alternative, GHGs would primarily be emitted from the natural gas component of this alternative. The NRC staff estimates that the operation of the three, 430-MWe natural gas-fired units would emit a total of 4.9 million tons (4.4 million MT) of CO_{2eq} per year.

Summary of Greenhouse Gas Emissions from the Proposed Action and Alternatives

Table 4-12 below presents the direct GHG emissions from facility operations under the proposed action of subsequent license renewal and alternatives to the proposed action. Greenhouse gas emissions from the proposed action (subsequent license renewal), the no-action alternative, and the new nuclear alternative would be the lowest. Greenhouse gas emissions from the natural gas and combination alternatives are several orders of magnitude greater than those from the continued operation of Surry. If Surry's generating capacity were to be replaced by either of these two alternatives, there would be an increase in GHG emissions. Therefore, the NRC staff concludes that continued operation of Surry (the proposed action) results in GHG emissions avoidance as compared to the natural gas and combination alternatives.

Table 4-12 Direct Greenhouse Gas Emissions from Facility Operations Under the Proposed Action and Alternatives

Technology/Alternative	CO_{2eq}[(a)] (tons/year)
Proposed Action (Surry subsequent license renewal)[(b)]	1,438
No-Action Alternative[(c)]	<1,438
New Nuclear[(d)]	1,438
Natural Gas Combined-Cycle[(e)]	6,400,000
Combination Alternative[(f)]	4,900,000

Note: All reported values are rounded. To convert tons per year to metric tons per year, multiply by 0.90718.

(a) Carbon dioxide equivalent (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) Greenhouse gas emissions include only direct emissions from combustion sources averaged over the 5-year period presented in Table 4-11 (Source: Dominion 2018b).

(c) Emissions resulting from activities at Surry that would occur between plant shutdown and the beginning of decommissioning and assumed not to be greater than greenhouse gas emissions from operation of Surry.

(d) Emissions assumed to be similar to Surry operation.

(e) Emissions from direct combustion of natural gas. Greenhouse gas emissions estimated using emission factors developed by the U.S. Department of Energy's (DOE's) National Energy Technology Laboratory (NETL 2012).

(f) Emissions from the natural gas combined-cycle component of the combination alternative. Greenhouse gas emissions estimated using emission factors developed by DOE's National Renewable Energy Laboratory (NETL 2012).

4.15.3.2 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; EPA 2016a; USGCRP 2014). Climate change can vary regionally, spatially, and seasonally, depending on local, regional, and global factors. Just as regional climate differs throughout the world, the impacts of climate change can vary among locations.

Observed Trends in Climate Change Indicators

On a global level, from 1901 to 2015, average surface temperatures rose at a rate of 0.15 ˚F (0.08 ˚C) per decade, and total annual precipitation increased at an average rate of 0.08 inches (0.2 cm) per decade (EPA 2016a). The years 2018 and 2017 were the fourth and second warmest, respectively, on record globally, with 2017 second only to 2016. This finding is based on average global temperature data dating back to 1880. Analyses performed by both the National Aeronautics and Space Administration (NASA) and the National Oceanic and Atmospheric Administration (NOAA) show that globally, the last 5 years have been the warmest in the modern record (NASA 2018, NASA 2019).

The observed global change in average surface temperature and precipitation has been accompanied by an increase in sea surface temperatures, a decrease in global glacier ice, an increase in sea level, and changes in extreme weather events. Such extreme events include an increase in the frequency of heat waves, very heavy precipitation (defined as the heaviest 1 percent of all daily events), and recorded maximum daily high temperatures (IPCC 2007; EPA 2016a; USGCRP 2009, USGCRP 2014).

The U.S. Global Change Research Program (USGCRP) compiles the best available information and maintains the current state of knowledge regarding climate change trends and effects at the regional and national level. The USGCRP reports that, from 1901 to 2016, average surface temperature has increased by 1.8 °F (1.0 °C) across the contiguous United States (USGCRP 2017, USGCRP 2018). Since 1901, average annual precipitation has increased by 4 percent across the United States, comprised of increases in the Northeast, Midwest, and Great Plains, and decreases across parts of the Southwest and Southeast (USGCRP 2017, 2018: Fig 2.5). On a seasonal basis, warming has been the greatest in winter. Since the 1980s, NOAA data show an increase in the length of the frost-free season, 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 than between 1901 and 1960 (USGCRP 2014). Over just the past two decades, the number of high temperature records observed in the United States far exceeds the number of low temperature records (USGCRP 2018).

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, increase in occurrence of heat waves, and a decrease in occurrence of cold waves. Since the 1980s, the intensity, frequency, and duration of North Atlantic hurricanes has increased; however, there is no trend in landfall frequency along the U.S. eastern and Gulf coasts (USGCRP 2014).

Warming has generally been uneven across the Southeast region of the United States, where Surry is located (USGCRP 2017, 2018). It is one of the few in the world where there has not been an overall increase in daily maximum temperatures since 1900 (NOAA 2013a; USGCRP 2018). Across the Southeast region, annual average temperatures have warmed by less than 0.5 °F (0.28 °C) (USGCRP 2014, 2017). The overall lack of warming in the Southeast has been termed “the warming hole” (NOAA 2013a, NOAA 2013b; USGCRP 2017). Since the 1970s, average annual temperatures have steadily increased across the Southeast and have been accompanied by an increase in the number of hot days with maximum temperatures above 95 °F (35 °C) in the daytime and above 75 °F (23.9 °C) in the nighttime (NOAA 2013a; USGCRP 2009, 2014, 2018: Fig 19.1). The average annual number of hot days observed since the 1960s remains lower than the average number during the first half of the 20th century. In contrast, the number of warm nights above 75 °F (23.9 °C) has doubled on average in the Southeast region compared to the first half of the 20th century and have increased at most observing stations (USGCRP 2018: Fig 19.1). The average length of the frost-free season has also slightly increased by up to 4 days across the Southeast between 1901 and 2015 (USGCRP 2017). However, the eastern and far southern portions of the region have experienced a more definitive warming trend (EPA 2016a, 2016b; USGCRP 2018: Fig 2.4). Most of Virginia has warmed by up to about 1.0 °F (0.56 C) over the last century (EPA 2016b; USGCRP 2018: Fig 2.4). Across tidewater Virginia, average temperatures have warmed by between 1.0 and 1.5 °F (0.56 and 0.83 °C) since 1901 (EPA 2016a, EPA 2016b; USGCRP 2017: Fig 6.1).

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 2013b). 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 2013b; USGCRP 2009). Across parts of the Southeast region, decreases in annual average precipitation of up to 10 percent have occurred over the period 1986–2015 (relative to 1901–1960 for the contiguous United States) (USGCRP 2018: Fig 2.5). Changes in the frequency and intensity of heavy precipitation events across the United States have been more definitive. Between 1958 and 2016, 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: Fig 2.6). Heavy precipitation events can lead to an increase in flooding because of greater runoff (USGCRP 2014, USGCRP 2018).

Specific to eastern Virginia, the NRC staff used the National Oceanic and Atmospheric Administration's (NOAA) Climate at a Glance tool to analyze temperature and precipitation trends for the period of 1895 to 2019 in the Tidewater region of Virginia. A trends analysis shows that average annual temperature has increased at a rate of 0.1 °F (0.06 °C) per decade while average annual precipitation has increased by 0.34 inches (0.86 cm) per decade (NOAA 2019b).

Based on an analysis of tidal gauge data, global mean sea level has risen by approximately 8 to 9 inches (20 to 23 cm) since 1880, with about 3 inches (7.6 cm) of the rise having occurred since 1993. Since the early 1990s, tidal gauge and satellite altimeter data indicate an acceleration in the rate of sea level rise, which is now on the order of 1.2 inches (3 cm) per decade. While the Northeast region of the United Stations has experienced a rise in sea level that exceeds the global average since the 1970s, sea level rise along the Southeast region has been slower. Regardless, due to sea level rise, the frequency of daily tidal flooding has been increasing in more than 25 cities along the Atlantic and Gulf Coasts (USGCRP 2017).

Observed changes in sea level and their effects vary regionally and locally. In the United States, the Mid-Atlantic and parts of the Gulf coasts have experienced the greatest sea level rise, with some stations having experienced increases of more than 8 inches (20 cm) between 1960 and 2015 (EPA 2016a). Currently, the relative sea level rise trend at Sewells Point, VA, near the mouth of the James River, is 0.18 inch per year (0.46 cm per year), or about 18 inches (46 cm) per century. This measurement is based on NOAA tidal gauge readings and includes local vertical land motion (e.g., regional subsidence and/or uplift) (NOAA 2019g).

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 over the next few decades, temperature increases will continue due to current GHG emission concentrations in the atmosphere (USGCRP 2014). Over the longer term, the magnitude of temperature increases and climate change effects will depend on both past and future global greenhouse gas emissions (IPCC 2007, IPCC 2013; USGCRP 2009, 2014, 2018). 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 Intergovernmental Panel on Climate Change (IPCC) has generated various representative concentration pathway (RCP) scenarios commonly used by climate modeling groups to project future climate conditions (IPCC 2000, IPCC 2013; USGCRP 2017, USGCRP 2018). 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 carbon dioxide equivalents (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 midcentury before falling to 30 GT of CO_{2eq} per year by 2100 (IPCC 2000; USGCRP 2014).

The RCP scenarios 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 RCPs are numbered in accordance with the change in radiative forcing measured in watts per square meter (i.e., +2.6 (very low), +4.5 (lower), +6.0 (mid-high), and +8.5 (higher)) (USGCRP 2014, 2017, 2018). For example, RCP 8.5 reflects a continued increase in global emissions resulting in increased warming by 2100, whereas RCP 2.6 assumes immediate and rapid reductions in emissions resulting in less warming by 2100 (USGCRP 2014). Most recently, the USGCRP and IPCC have used the RCPs and associated modelling results as the basis of their climate change assessments (IPCC 2013; USGCRP 2017, 2018).

The NRC staff considered the best available climate change studies performed by the USGCRP and partner agencies as part of the staff’s assessment of potential changes in climate indicators during the Surry subsequent license renewal terms (2032–2052 for Unit 1, and 2033–2053 for Unit 2). The results of these studies are summarized as follows.

As input to the Third National Climate Assessment report (USGCRP 2014), NOAA analyzed future regional climate change scenarios based on climate model simulations using the high (A2) and low (B1) emission scenarios (NOAA 2013a). NOAA’s climate model simulations (for the period between 2041 and 2070 (2055 midpoint) relative to the reference period, 1971–1999) indicate the following. 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, with Virginia in the higher end of the range. For the high-emissions scenario, projected temperature increases fall within the range of 2.5–4.5 °F (1.4–2.5 °C), again with Virginia in the 3.5 to 4.5 °F (1.9–2.5 °C) range. Increases in temperature during this timeframe are projected to occur for all seasons with the largest increase occurring in the summertime (June, July, and August) (NOAA 2013a: Fig 26, NOAA 2013b: Fig 27).

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: Tab 6.4). Specific to the northern portion of the Southeast region and encompassing Virginia, predicted annual temperature increases range from 2–4 °F (1.1–2.2 °C) under the RCP 4.5 scenario and 4–6 °F (2.2–3.3 °C) under the RCP 8.5 scenario (USGCRP 2017: 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. For the period 2041–2070 (2055 midpoint), a 0 to 3 percent increase in annual mean precipitation is projected for both a low- and high-emission modeled scenario across the northern reaches of the Southeast region, encompassing Virginia. Increases are projected to occur in the winter, spring, and fall, with decreases during the summer (NOAA 2013a: Fig 37).

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, 2017, 2018). 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: Fig 7.7).

With a warming climate, model simulations indicate that the total number of tropical storms will either remain steady or decrease worldwide. However, projections show that the frequency of the most intense storms will increase, and rainfall will be more intense with a given storm (USGCRP 2018). Climate models are not in agreement when projecting changes in Atlantic hurricane activity such as frequency; nonetheless, models agree that under a warmer climate, hurricane intensity and rainfall rates will increase (EPA 2016a; USGCRP 2014, 2018).

In 2017, the USGCRP issued its Fourth National Climate Assessment report (USGCRP 2017), which includes updated sea level rise projections. The 2017 report updates NOAA's global sea level rise scenarios and represents the best available projections for sea level rise. The USGCRP reports that, relative to the year 2000, global mean sea level is projected to rise by 0.3 to 0.6 ft (0.09 to 0.18 m) by 2030, and 0.5 to 1.2 ft (0.15 to 0.37 m) by 2050. The USGCRP assigns very high confidence to the lower bounds of these projections and medium confidence to the upper bounds. For the first half of this century, future GHG emissions will have little effect as sea levels continue to rise, but emissions significantly affect levels beyond mid-century. Relative sea level rise on the East and Gulf Coasts of the United States is likely to be higher than the global average (USGCRP 2017, 2018).

Beyond the 2050 timeframe (and beyond the subsequent license renewal term for Surry Units 1 and 2) and to the end of the century, sea levels are projected to continue to rise but the projections are subject to even greater uncertainty. The latest consensus estimates from the USGCRP similarly indicate potential global sea level rise of 1 to 4.3 ft (0.3 to 1.3 m) by 2100. The USGCRP assigns low confidence to the upper bounds estimates for the year 2100, in part because future GHG emissions drive sea level rise projections for the second half of the century (USGCRP 2017, 2018). The USGCRP also states that a sea level rise of 8 ft (2.4 m) or higher is physically possible, although the probability of that occurring has not been assessed by the USGCRP (USGCRP 2017, 2018). Nevertheless, it is apparent that future sea level rise is difficult to predict and is dependent on the amount of warming, ice melt from glaciers and ice sheets, and vertical land motion (e.g., local land subsidence or uplift) that may occur (USGCRP 2017).

Based on the studies referenced above, it is apparent that rising sea levels will continue to have measurable hydrologic effects on coastal communities, but those effects may vary in severity on a local and regional basis. As sea levels rise, the incidence of tidal and coastal flooding due to all coastal storms will increase, as will the depth and extent of such flooding (USGRP 2017, 2018). Further, the USGCRP reports that there is medium confidence that the intensity of North Atlantic hurricanes will increase, thus increasing the chances of extreme flooding along the East and Gulf Coasts. However, as noted above, there is less confidence in the projected increase in frequency of intense storms including Atlantic hurricanes (USGCRP 2017, 2018). Modeling also suggests that predicted changes in the tracks of tropical cyclones may reduce hurricane landfalls along the Northeast and Mid-Atlantic coasts of the United States (USGCRP 2018).

Changes in climate have broader implications for public health, water resources, land use and development, and ecosystems. For instance, changes in precipitation patterns and increases in air temperature can affect water availability and quality, distribution of plant and animal species, land use patterns, and land cover, which can, in turn, affect terrestrial and aquatic habitats. In Section 4.16 of this SEIS, the NRC staff considers the potential cumulative, or overlapping, impacts from climate change on environmental resources that could also be impacted by the proposed action (subsequent license renewal).

The effects of climate change on Surry structures, systems, and components 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." NRC regulations require that plant structures, systems, and components 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 prior to allowing licensees to make operational changes due to changing environmental conditions. Additionally, the NRC evaluates nuclear power plant operating conditions and physical infrastructure to ensure ongoing safe operations under the 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 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. This is a separate and distinct process from the NRC staff's subsequent license renewal environmental review that it conducts in accordance with the National Environmental Policy Act (NEPA). Nonetheless, as discussed below in Section 4.16, the NRC staff considers the impacts of climate change in combination with the effects of subsequent license renewal in assessing cumulative impacts.

4.16 Cumulative Impacts

Cumulative impacts may result when the environmental effects associated with the proposed action (subsequent license renewal) are added to the environmental effects from other past, present, and reasonably foreseeable future actions. Cumulative impacts can result from individually minor, but collectively significant, actions taking place over a period of time. An effect that may be inconsequential by itself could result in a greater environmental impact when combined with the effects of other actions. As explained in NUREG-1437, “Generic Environmental Impact Statement for License Renewal of Nuclear Plants” (GEIS) (NRC 2013a), the effects of the license renewal action combined with the effects of other actions could generate cumulative impacts on a given resource.

For the purposes of this analysis, past actions are those that occurred since the commencement of Surry Units 1 and 2 reactor operations and prior to the submittal of the subsequent license renewal application. Older actions are considered as part of the affected environment in Chapter 3 of this SEIS. Present actions are those that are occurring during current power plant operations. Reasonably foreseeable future actions are those that would occur through the end of power plant operation, including the period of extended operation. Therefore, the cumulative impacts analysis considers potential effects through the end of the current license term, as well as through the end of the 20-year renewal term.

The cumulative impacts analysis accounts for both geographic (spatial) and time (temporal) considerations of past, present, and reasonably foreseeable future actions to determine whether other potential actions are likely to contribute to the total environmental impact. In addition, because cumulative impacts accrue to resources and focus on overlapping impacts with the proposed action, no cumulative impacts analysis was performed for resource areas where the proposed action is unlikely to have any incremental impacts on that resource. Consequently, no cumulative impacts analysis was performed for the following resource areas: land use, noise, geology and soils, terrestrial resources, and aquatic resources.

As noted in Section 4.15.3.2, “Climate Change,” of this SEIS, changes in climate could have broad implications for certain resource areas. Accordingly, a climate change impact discussion is provided for those resource areas that could be incrementally impacted by the proposed action (license renewal). It is also important to note that the potential effects of climate change could occur irrespective of the proposed action.

Information from Dominion’s environmental report; 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 Surry were used to identify past, present, and reasonably foreseeable future actions in the cumulative impacts analysis. To evaluate cumulative impacts resulting from the continued operation of Surry Units 1 and 2, the incremental impacts of the proposed action, as described in Sections 4.2 to 4.13 of this chapter, are combined with the impacts of other past, present, and reasonably foreseeable future actions regardless of which agency (Federal or non-Federal) or person undertakes such actions. In general, the effects of past actions have already been described in Chapter 3, “Affected Environment,” which serves as the environmental baseline for the cumulative impacts analysis.

Appendix E describes other actions including new and continuing activities and specific projects that the NRC staff identified during this environmental review and that were considered in the analysis of potential cumulative impacts.

4.16.1 Air Quality

The region of influence the NRC staff considered in the cumulative air quality analysis consists of Surry County, because air quality designations in Virginia are made at the county level. Dominion has not proposed any refurbishment-related activities during the subsequent license renewal term. As a result, the NRC staff expects that air emissions from the plant during the subsequent license renewal term would be similar to those presented in Section 3.3.2, "Air Quality." Appendix E identifies present and reasonably foreseeable projects that could contribute to the cumulative impacts to air quality in Surry County. Current air emission sources operating in Surry County have not resulted in long-term National Ambient Air Quality Standards (NAAQS) violations, given the designated unclassifiable/attainment or better than national standards status for all criteria pollutants in the county. Consequently, cumulative changes to air quality in Surry County would be the result of future projects and actions that change present-day emissions within the county.

Development and construction activities identified in Appendix E could increase air emissions during their respective construction periods, but those air emissions would be temporary and localized. However, future operation of new commercial and industrial facilities and increases in vehicular traffic could result in overall long-term air emissions that contribute to cumulative air quality impacts. Any entity establishing new stationary sources of emissions in the region of influence would be required to apply for an air permit from the Virginia Department of Environmental Quality and would also be required to operate in accordance with applicable Federal, State, and local regulatory requirements.

Climate Change

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). Ozone is particularly sensitive to climate change (IPCC 2007; EPA 2009a). 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; EPA 2009b). The emission of ozone precursors also depends on temperature, wind, and solar radiation (IPCC 2007). According to the EPA, both nitrogen oxide and biogenic volatile organic compound emissions are expected to be higher in a warmer climate (EPA 2009a). Although surface temperatures are expected to increase in the Southeast region of the United States (where Surry is located), 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. 2008), others (e.g., Tao et al. 2007, Nolte et al. 2018) found differences in future changes in ozone for the Southeast with decreases in ozone concentrations under a low-emission modelled scenario and increases under a high-emission modelled scenario. Among modelled studies of climate-related ozone changes, model simulations for the Southeast region have the least consensus. Therefore, the potential cumulative impact to air quality ozone levels in the vicinity of Surry due to climate change is unknown.

4.16.2 Water Resources

4.16.2.1 Surface Water Resources

The description of the affected environment in Section 3.5.1, "Surface Water Resources," of this SEIS serves as the baseline for the NRC staff's cumulative impacts assessment for surface water resources. Surry withdraws from and discharges effluents into the James River within the Lower James River subbasin. Surface water impacts from Surry operations primarily occur to those segments of the James River and areas downstream from the plant site along the James River. Therefore, the geographic area of interest for this cumulative impact assessment for surface water resources focuses on the segment of the James River within the

Lawnes Creek-James River watershed and Powhatan Creek−James River watershed of the Lower James subbasin. As such, this cumulative impact review focuses on those projects and activities that would withdraw water from, or discharge effluents to, the James River mainstem from approximately the Chickahominy/James River confluence to the Pagan/James River confluence (see Figure 3-12 and Figure 3-13). This stretch of the James River traverses the counties of Surry, Newport News, James City, and Isle of Wight.

Water Use Considerations

The U.S. Geological Survey publishes state water-use data by type, category use (e.g., public supply, power generation, industrial) and county every 5 years since 1985. Data from the U.S. Geological Survey distinguish between water type (groundwater, surface water, saline, or freshwater), but do not identify the water source (e.g., river, stream, reservoir) or basin. Table 4-13 presents surface water withdrawals from Surry, Newport News, James City, and Isle of Wight counties. As shown, major surface water usage is for thermoelectric power generation, with relatively minor volumes for other uses (USGS 2019g; HRPDC 2011). Furthermore, surface water withdrawals for public water supply, industrial use, irrigation, livestock, and aquaculture are primarily from a freshwater source. The Virginia Department of Environmental Quality publishes an annual report on Virginia's water resources management activities that focuses on water quantity and supply and top water withdrawal facilities (based on amount/rate reported withdrawals). In 2017, surface water withdrawals (including power generation withdrawals) from Surry, Newport News, James City, and Isle of Wight counties totaled 2,054 mgd (3,158 cfs) (VDEQ 2018b). However, within this area, Surry is the only facility identified in the report that withdraws surface water from the James River (VDEQ 2018b).

As discussed in Section 3.5.1.2, with the exception of a small fraction of water being lost to evaporation, surface water withdrawn by Surry is returned to the James River.

Table 4-13 Cumulative Surface Water Withdrawals by County (2015)

	Surface Water Withdrawals (mgd[a])				
	Surry County	James City County	Isle of Wight County	Newport News County	Total
Public Supply	0	2.8	0.35	21.28	24.4
Industrial	0	0	1.8	5.15[b]	7.0
Thermoelectric Power	2,022[b]	0	0	0	2,022
General Irrigation	0.18	0.03	0.35	0.1	0.7
Livestock	0.14	0.01	0.1	0	0.3
Aquaculture	0	0.02	0	0	0.02
Total					2,055

[a] To convert million gallons per day (mgd) to cubic feet per second (cfs), multiply by 1.547.
[b] Reported values are withdrawals from saline surface waters
Source: USGS 2019g

As population increases, water demand is expected to similarly increase. The Hampton Roads Planning District Commission projects that water supply is anticipated to be adequate to meet demand for the counties through 2040 (HRPDC 2011). As discussed in Section 3.5.2, groundwater supports agricultural, commercial, and industrial users in the region. Beyond 2040, water demand can potentially exceed water supply, which might require the use of desalination, water conservation, or development of other water resources. (HRPDC 2011).

Water Quality Considerations

As discussed in Section 3.5.1.3, the entire Lower James River, from Richmond, Virginia, to its mouth is designated as an impaired reservoir. Specifically, the James River segment for this cumulative analysis is impaired for aquatic life and/or fish consumption. Virginia's Pollutant Discharge Elimination System permits issued under Section 402 of the Clean Water Act set limits on wastewater, stormwater, and other point source discharges to surface waters, including runoff from construction sites. Surry is only one of several facilities that contribute effluents to the James River. For instance, water supply and treatment facilities (including the James City Service Authority Five Forks Water Treatment Facility, the Newport News City Lee Hall Water Treatment Plant, the James River Sewage Treatment Plant, and the Williamsburg Sewage Treatment Plant), Joint Base Langley Eustis, and BASF Corporation are VPDES-permitted facilities that discharge into the segment of the James River for this cumulative analysis.

Future development can result in water quality degradation if those projects increase sediment loading and the discharge of other pollutants to nearby surface water bodies. Table E-1 in Appendix E of this SEIS identifies a number of ongoing and reasonably foreseeable future actions that could impact ambient quality within the segment of the James River within the Lawnes Creek−James River watershed and Powhatan Creek−James River watershed of the Lower James River subbasin.

As part of the James River Federal Navigation Project, the U.S. Army Corps of Engineers maintains the depth and width of the James River Federal navigation channel from Hampton Roads, VA, to Richmond, VA. This project consists of periodic maintenance dredging and disposal of dredge material. Section 404 of the Clean Water Act governs the discharge of dredge and fill materials to navigable waters, including wetlands, primarily through permits by the U.S. Army Corps of Engineers. The U.S. Army Corps of Engineers also regulates construction affecting navigable waterways, such as for flood control, under Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. 403 et seq.).

Stormwater discharges to the James River can result from construction activities and projects. On an individual facility basis, State-administered VPDES permits issued under CWA Section 402 set limits on wastewater, stormwater, and other point source discharges. Section 303(d) of the Federal CWA requires states to identify all "impaired" waters for which effluent limitations and pollution control activities are not sufficient to attain water quality standards and to establish total maximum daily loads (TMDLs) to ensure future compliance with water quality standards. Consequently, a substantial regulatory framework exists to address current and potential future sources of water quality degradation within the mainstem of the Lower James River with respect to potential cumulative impacts on surface water quality.

Climate Change and Related Considerations

Climate change can impact surface water resources as a result of changes in temperature, precipitation, and sea level rise. As discussed in Section 4.15.3 of this SEIS, sea level along the East Coast of the United States is rising at a rate higher than the global mean rate (USGS 2011). Sea level rise can result in saline water migrating upstream in estuaries and rivers. Rice et al. (2014) modelled the salinity effects of sea level rise on the James River. Under three sea level rise scenarios, computer modeling results indicate that salinity increases along the entire James River as the rate of sea level rise increases, and the upstream location of salinity intrusion along the stem of the James River also increases (Rice et al. 2014). Additionally, the upstream location of salinity intrusion with sea level rise is greater as mean annual freshwater discharge decreases. An increase in upstream migration of salinity can cause a general deterioration of surface water quality.

Sea level rise and storm surge can also result in flooding in the tidally influenced James River (CCRM 2013). A study conducted by the Center for Coastal Resources Management found that a 1.5 ft (0.45 m) rise in sea level and a 3 ft (0.9 m) storm surge could potentially inundate 0.02 percent of total land area in Surry County (CCRM 2013). Furthermore, increased and heavier precipitation can result in an increased potential for river flooding and increased rate of runoff from the land surface. This could also transport more pollutants and contaminants to surface waters, such as the James River. Elevated surface water temperatures can decrease the cooling efficiency of thermoelectric power generating facilities and plant capacity. Therefore, as intake water temperatures warm, the volume of surface water needed for power plant cooling can increase (USGCRP 2014). Power plants would have to account for any changes in water temperature in operational practices and procedures.

In summary, surface water withdrawals from the James River segment within the Lawnes Creek–James River watershed and Powhatan Creek–James River watershed would be unlikely to result in any water use conflicts during the Surry license renewal term. Climate change could result in incremental changes in the hydrology and ambient water quality of the Lower James River as a result of upstream migration of salinity and salinity increases associated with sea level rise and increased transportation of pollutants and contaminants.

4.16.2.2 Groundwater Resources

Regional groundwater water systems are described in Section 3.5.2 ("Groundwater Resources").

In the Surry region, over the period of license renewal, the groundwater within the Potomac aquifer should continue to be impacted by human activities and natural processes. Potomac aquifer resources may continue to be subject to depletion and water quality degradation.

Groundwater quality may be degraded by saltwater intrusion. Over-pumping of groundwater and rising sea levels contribute to the landward movement of saltwater within the aquifer. The location of the Surry site with respect to the Chesapeake Bay Impact Crater places it closer to the saltwater/freshwater interface within the Potomac aquifer. Therefore, if the saltwater/freshwater interface continues to move westward, locations like Surry that are near the Chesapeake Bay Impact Crater may experience groundwater quality degradation as a result of saltwater intrusion sooner than areas that are not near the crater.

Over-pumping of groundwater can cause a decrease in well water levels and the heads within an aquifer. As well water levels fall, the cost of pumping water from wells can increase and may also require wells to be drilled to deeper depths.

As heads in the aquifer drop, there is less volume of water available in the aquifer. Unfortunately, even if at a future date the heads in the aquifer recover, this subsidence is unlikely to be reversed. This means subsidence can cause a permanent loss in the volume of water that can be stored within the aquifer. Regionally, much of the subsidence caused by over-pumping of groundwater is impacting the Potomac aquifer.

Land subsidence at Surry and within the region is expected to continue to occur. The relatively flat topography in the area means small decreases in land elevations can result in a measurable increase in the potential for flooding and ecologic changes. Land subsidence in combination with rising sea levels have resulted in the highest rates of sea level rise on the Atlantic Coast of the United States. More than half of this subsidence rate has been caused by extensive groundwater pumping.

In the region including and around Surry, over-pumping of the Potomac aquifer and its attendant effects on declines in well water levels, reduced availability of groundwater, increased subsidence, and the degradation of groundwater quality by saltwater intrusion is a concern. This is likely to continue to be a concern in the future. Continued pumping of groundwater from the Potomac aquifer at Surry is projected to make a minor contribution to these impacts.

4.16.3 Historic and Cultural Resources

As described in Section 4.9 of this SEIS, historic properties (36 CFR 800.5(b), "Finding No Adverse Effect") at Surry are not likely to be adversely affected by license renewal-related activities because no ground-disturbing activities or physical changes would occur beyond ongoing maintenance and operations activities during the license renewal term. As discussed in Section 4.9, Dominion has site procedures and work instructions to ensure that plant personnel consider cultural resources during planned maintenance activities.

The geographic area considered in this analysis is the area of potential effect associated with the proposed undertaking, as described in Section 3.9. The archaeological record for the region indicates prehistoric and historic occupation of the Surry site and its immediate vicinity. The construction of Units 1 and 2 may have resulted in the loss of cultural resources within the developed portions of the Surry site. However, historic or cultural resources can still be found within other portions of the Surry site. Present and reasonably foreseeable projects at Surry could affect these resources, in addition to the effects of ongoing maintenance and operational activities during the license renewal term.

The archaeological sensitivity analysis discussed in Section 3.9.2 explains that Dominion's Surry property has been divided into three zones based on the potential to yield cultural resources and recommendations for ground disturbance within those areas. In addition, as discussed in Section 3.9.3, cultural resources on the Surry site are managed and protected by Dominion's historic resources consultation guidance and cultural resources description process. The guidance document and the cultural resources description process ensure that cultural resources are protected from unauthorized disturbance and removal.

Therefore, the contributory effects of continued reactor operations and maintenance at Surry Units 1 and 2, when combined with other past, present, and reasonably foreseeable future activities, would have no new or increased impact on historic properties within the area of potential effect beyond what already has been experienced.

4.16.4 Socioeconomics

This section addresses socioeconomic factors that have the potential to be directly or indirectly affected by changes in operations at Surry Units 1 and 2, in addition to the aggregate effects of other past, present, and reasonably foreseeable future actions. As discussed in Section 4.10, continued operation of Surry during the license renewal term would have no impact on socioeconomic conditions in the region beyond what is already being experienced.

Because Dominion has no plans to hire additional workers during the license renewal term, overall expenditures and employment levels at Surry would remain relatively unchanged with no new or increased demand for housing and public services. Based on this and other information presented in Chapter 4, there would be no contributory effect on socioeconomic conditions in the region during the license renewal term from the continued operation of Surry beyond what is currently being experienced. Therefore, the only contributory effects would come from reasonably foreseeable future planned activities at Surry unrelated to the proposed action (license renewal), and other reasonably foreseeable planned offsite activities.

Dominion has no reasonably foreseeable future planned activities at Surry beyond continued reactor operations and maintenance. When combined with other past, present, and reasonably foreseeable future activities, the contributory effects of continuing reactor operations and maintenance at Surry would have no new or increased socioeconomic impact in the region beyond what is currently being experienced.

4.16.5 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 in 10 CFR Part 20, “Standards for Protection Against Radiation,” and 40 CFR Part 190, “Environmental Radiation Protection Standards for Nuclear Power Operations.” As discussed in Section 4.11, “Human Health,” of this SEIS, the impacts to human health from continued plant operations during the subsequent license renewal term are SMALL. For the purposes of this cumulative impacts analysis, the geographical area considered is the area within a 50-mi (80-km) radius of Surry. There are no other nuclear power plants within this 50-mi (80-km) radius. However, that radius does overlap with the 50-mi (80-km) radius around North Anna Power Station, Units 1 and 2, which is located approximately 86 mi (138.4 km) from Surry. Like Surry, North Anna complies with all NRC and EPA regulations regarding radiation and radioactive materials exposure. As discussed in Section 3.1.4.4, “Radioactive Waste Storage,” of this SEIS, Dominion stores spent nuclear fuel from Units 1 and 2 in a storage pool and in an onsite independent spent fuel storage installation (ISFSI). Currently, the ISFSI consists of three separate spent fuel storage pads. Dominion stated in the ER that it is in the process of adding a fourth pad to the site to accommodate additional storage. Installation of the fourth pad within the current ISFSI area is scheduled to be completed by the end of 2020. Also, the addition of a fifth spent fuel storage pad to the current ISFSI area is under consideration, but plans are in the conceptual stage and no installation schedule has been established (Dominion 2018b).

The EPA regulations at 40 CFR Part 190 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 3.1.4.5 in this SEIS, Dominion has a radiological environmental monitoring program (REMP) that measures radiation and radioactive materials in the environment from Surry, its ISFSI, and all other sources. The NRC staff reviewed the radiological environmental monitoring results for the 5-year period from 2013 through 2017 as part of this cumulative impacts assessment. The review of Dominion’s data showed no indication of an adverse trend in radioactivity levels in the environment from either Surry or the ISFSI. The data showed that there was no measurable impact to the environment from operations at Surry.

In summary, the NRC staff concludes that there is no significant cumulative effect on human health resulting from the proposed action of subsequent license renewal, in combination with cumulative impacts from other sources. The NRC staff bases this conclusion on its review of radiological environmental monitoring program data, radioactive effluent release data, and worker dose data; the expectation that Surry 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 the Surry site by the NRC and the State of Virginia.

4.16.6 Environmental Justice

The environmental justice cumulative impact analysis evaluates the potential for disproportionately high 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 Surry Units 1 and 2 during the renewal term. As discussed in Section 4.12 of this SEIS, there would be no disproportionately high and adverse impacts on minority and low-income populations from the continued operation of Surry Units 1 and 2 during the license renewal term.

Everyone living near Surry Units 1 and 2, including minority and low-income populations, currently experiences its operational effects. The NRC addresses environmental justice matters for license renewal by identifying the location of minority and low-income populations, determining whether there would be any potential human health or environmental effects to these populations, and 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 in 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. Some of these potential effects have been identified in resource areas presented in preceding sections of this chapter of the SEIS. As previously discussed in this chapter, the impact from license renewal for all resource areas (e.g., land, air, water, and human health) would be SMALL.

As discussed in Section 4.12 of this SEIS, there would be no disproportionately high and adverse impacts on minority and low-income populations from the continued operation of Surry Units 1 and 2 during the license renewal term. Because Dominion has no plans to hire additional workers during the license renewal term, employment levels at Surry would remain relatively constant, 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 impacts presented in the preceding sections, it is not likely that there would be any disproportionately high and adverse contributory effect on minority and low-income populations from the continued operation of Surry Units 1 and 2 during the license renewal term. Therefore, the only contributory effects would come from the other reasonably foreseeable future planned activities at Surry, unrelated to the proposed action (license renewal), and other reasonably foreseeable planned offsite activities.

Dominion has no reasonably foreseeable future planned activities at Surry Units 1 and 2 beyond continued reactor operations and maintenance. When combined with other past, present, and reasonably foreseeable future activities, the contributory effects of continuing reactor operations and maintenance at Surry would not likely cause disproportionately high and adverse human health and environmental effects on minority and low-income populations residing near Surry beyond what those populations have already experienced.

4.16.7 Waste Management and Pollution Prevention

This section describes waste management impacts during the license renewal term when added to the aggregate effects of other past, present, and reasonably foreseeable future actions. For the purpose of this cumulative impact analysis, the NRC staff considered the area within a 50-mi (80-km) radius of Surry. In Section 4.11, the NRC staff concluded that the potential human health impacts from Surry's waste during the license renewal term would be SMALL.

As discussed in Sections 3.1.4 and 3.1.5, Dominion maintains waste management programs for radioactive and nonradioactive waste generated at Surry and is required to comply with Federal and State permits and other regulatory waste management requirements. The nuclear power plants and other facilities within a 50-mi (80-km) radius of Surry 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 Surry would likely remain unchanged during the license renewal term, and continued compliance with Federal and State requirements for radioactive and nonradioactive waste is expected.

In summary, the NRC staff concludes that there is no significant cumulative effect from the proposed action of license renewal from radioactive and nonradioactive waste. This is based on Surry's expected continued compliance with Federal and State of Virginia requirements for radioactive and nonradioactive waste management and the expected regulatory compliance of other waste producers in the area.

4.17 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.

4.17.1 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 SEIS, including the proposed action, would result in some unavoidable adverse environmental impacts.

Minor unavoidable adverse impacts on air quality would occur due to emission and release of various chemical and radiological constituents from power plant operations. Nonradiological emissions resulting from power plant operations are expected to comply with EPA emissions standards, although the alternative of operating a fossil-fueled power plant in some areas may worsen existing attainment issues. Chemical and radiological emissions would not exceed the national emission standards for hazardous air pollutants.

During nuclear power plant operations, workers and members of the public would face unavoidable exposure to minor levels of radiation as well as hazardous and toxic chemicals. Workers would be exposed to radiation and chemicals associated with routine 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 non-nuclear 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 non-nuclear power generating facilities. Wastes generated during plant operations would be collected, stored, and shipped for suitable treatment, recycling, or disposal in accordance with applicable Federal and State regulations. Due to the costs of handling these materials, the NRC staff expects that power plant operators would optimize all waste management activities and operations in a way that generates the smallest possible amount of waste.

4.17.2 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 Chapter 4. Short term is the period of time that continued power generating activities take place.

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 entail similar relationships 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 plant site. Over time, these emissions would result in increased concentrations and exposure, but the NRC staff 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 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 requires an increase in energy and consumes 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.

Power plant facilities are committed to electricity production over the short term. After decommissioning these facilities and restoring the area, the land could be available for other future productive uses.

4.17.3 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 man-made resources required for 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 SEIS would entail the irreversible and irretrievable commitments of energy, water, chemicals, and—in some cases—fossil fuels. These resources would be committed during the license renewal term and over the entire life cycle of the power plant, and they would be unrecoverable.

Energy expended would be in the form of fuel for equipment, vehicles, and 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. These resources are readily available, and the NRC staff does not expect that the amounts required would deplete available supplies or exceed available system capacities.

5 CONCLUSION

This supplemental environmental impact statement (SEIS) contains the NRC staff's environmental review of the Dominion Energy Virginia (Dominion) application for a renewed operating license for Surry Power Station, Units 1 and 2 (Surry, or Surry Units 1 and 2), as required by Title 10 of the *Code of Federal Regulations* (10 CFR) Part 51, "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.). This chapter briefly summarizes the environmental impacts of license renewal, lists and compares the environmental impacts of alternatives to license renewal, and presents the NRC staff's conclusions and recommendation.

5.1 Environmental Impacts of License Renewal

After reviewing the site-specific (Category 2) environmental issues in this SEIS, the NRC staff concluded that issuing a renewed license for Surry would have SMALL impacts for the applicable Category 2 issues applicable to subsequent license renewal at Surry. The NRC staff considered mitigation measures for each Category 2 issue, as applicable. The NRC staff concluded that no additional mitigation measure is warranted.

5.2 Comparison of Alternatives

In Chapter 4 of this SEIS, the NRC staff considered the following alternatives to issuing a renewed operating license to Surry:

- no-action alternative
- new nuclear (small modular reactor) alternative
- natural gas combined-cycle alternative
- combination alternative (natural gas combined-cycle, solar, and demand-side management)

Based on the review presented in this SEIS, the NRC staff concludes that the environmentally preferred alternative is the proposed action, recommending that a renewed Surry operating license be issued. As shown in Table 2-2, all other power-generation alternatives have impacts in at least two resource areas that are greater than license renewal, in addition to the environmental impacts inherent with new construction projects. To make up the lost power generation if the NRC does not issue a renewed license for Surry (i.e., the no-action alternative), energy decisionmakers would likely implement one of the replacement power alternatives discussed in this chapter, or a comparable alternative capable of replacing the power generated by Surry.

5.3 Preliminary Recommendation

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

- the analysis and findings in NUREG-1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants"
- the environmental report submitted by Dominion
- the NRC staff's consultation with Federal, State, Tribal, and local agencies
- the NRC staff's independent environmental review
- the NRC staff's consideration of public comments

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Members of the U.S. Nuclear Regulatory Commission's (NRC's) Office of Nuclear Reactor Regulation (NRR) prepared this supplemental environmental impact statement with assistance from other NRC organizations and support from Pacific Northwest National Laboratory. Table 7-1 identifies each contributor's name, affiliation, and function or expertise.

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8 LIST OF AGENCIES, ORGANIZATIONS, AND PERSONS TO WHOM COPIES OF THIS SEIS ARE SENT

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APPENDIX A
COMMENTS RECEIVED ON THE SURRY POWER STATION, UNITS 1 AND 2 ENVIRONMENTAL REVIEW

A.1 COMMENTS RECEIVED DURING THE SCOPING PERIOD

The scoping process for the environmental review of the Surry Power Station, Units 1 and 2 (Surry) license renewal began in December 2018, in accordance with the National Environmental Policy Act of 1969 (42 U.S.C. 4321 et seq.) (NEPA). On December 20, 2018, the U.S. Nuclear Regulatory Commission (NRC) issued a notice of intent to conduct an environmental scoping process for license renewal of Surry; that notice was published in the *Federal Register* on December 20, 2018 (83 FR 65367).

The scoping process included a public meeting held in Surry County, on January 8, 2019. The NRC issued press releases and purchased newspaper advertisements to advertise that meeting. In addition to participation from Dominion and local officials, several members of the public attended the meeting. After the NRC staff presented prepared statements on the license renewal process, the staff opened the meeting for public comments. Attendees were provided the opportunity to make oral statements that would be recorded and transcribed by a certified court reporter.

A summary and transcript of the scoping meeting are available in NRC's Agencywide Documents Access and Management System (ADAMS). The ADAMS Public Electronic Reading Room is accessible at http://www.nrc.gov/reading-rm/adams.html. The scoping meeting summary and the transcript of the meeting are available at ADAMS Accession Nos. ML19024A386 and ML19024A199. At the conclusion of the scoping, the staff issued the Surry Scoping Summary Report, dated June 4, 2019 (ADAMS Accession No. ML19135A197). The report contains comments from the public meeting, e-mails, and the Regulations.Gov website, as well as NRC staff responses to these comments.

APPENDIX B
APPLICABLE LAWS, REGULATIONS, AND OTHER REQUIREMENTS

There are a number of Federal laws and regulations that affect environmental protection, health, safety, compliance, and consultation at every NRC-licensed nuclear power plant. Some of these laws and regulations require permits by or consultation 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 have also enacted laws to protect public health and safety and the environment. It is the NRC's 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.), 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). Virginia is an NRC Agreement State. The Division of Radiological Health, Virginia Department of Health (VDH) has regulatory responsibility over certain byproduct, source, and quantities of special nuclear materials not sufficient to form a critical mass. The Virginia Department of Emergency Management (VDEM) maintains a Radiological Emergency Planning and Response Program to provide response capabilities to radiological accidents or emergencies at the commercial nuclear power plants in and near the State of Virginia.

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 (33 U.S.C. 1251 et seq., herein referred to as CWA). 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 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.

EPA has delegated the authority to issue NPDES permits to the Commonwealth of Virginia, which uses the terminology Virginia Pollutant Discharge Elimination System (VPDES) permits. The Virginia Department of Environmental Quality 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 Federal and State Requirements

Surry Power Station, Units 1 and 2 (Surry) 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 Surry.

Table B-1 Federal and State Requirements

Law/regulation	Requirements
Current operating license and license renewal	
Atomic Energy Act, 42 U.S.C. 2011 et seq.	The Atomic Energy Act (AEA) of 1954, as amended, and the Energy Reorganization Act of 1974 (42 U.S.C. 5801 et seq.) 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).
National Environmental Policy Act of 1969, 42 U.S.C. 4321 et seq.	The National Environmental Policy Act (NEPA), as amended, requires Federal agencies to integrate environmental values into their decisionmaking process by considering the environmental impacts of proposed Federal actions and reasonable alternatives to those actions. NEPA establishes policy, sets goals (in Section 101), and provides means (in Section 102) for carrying out the policy. NEPA Section 102(2) contains action-forcing provisions to ensure that 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 NEPA requires Federal agencies to prepare a detailed statement that includes the environmental impacts of the proposed action and other specified information.
10 CFR Part 20	Regulations in 10 CFR Part 20, "Standards for Protection Against Radiation," establish standards for protection against ionizing radiation resulting from activities conducted under licenses issued by the NRC. These regulations are issued under the AEA of 1954, as amended, and the Energy Reorganization Act of 1974, 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 51	Regulations in 10 CFR Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions," contain the NRC's regulations that implement NEPA.
10 CFR Part 50	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 Energy Reorganization Act of 1974, to provide for the licensing of production and utilization facilities, including power reactors.
10 CFR Part 54	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 Energy Reorganization Act of 1974 (88 Stat. 1242). The regulations focus on managing adverse effects of aging. The rule is intended to ensure that important systems, structures, and components will continue to perform their intended functions during the period of extended operation.

Law/regulation	Requirements
Air quality protection	
Clean Air Act, 42 U.S.C. 7401 et seq.	The Clean Air Act (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 with regard to the control and abatement of air pollution. Section 109 of the CAA directs the U.S. Environmental Protection Agency (EPA) to set National Ambient Air Quality Standards (NAAQS) for criteria pollutants. The EPA has identified and set NAAQS 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 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. EPA regulates the emissions of air pollutants using 40 CFR Parts 50 to 99.
Water resources protection	
Clean Water Act, 33 U.S.C. 1251 et seq., and the NPDES (40 CFR 122)	The Clean Water Act (CWA) 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 National Pollutant Discharge Elimination System (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 an NPDES permit. 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. EPA is authorized under the CWA to directly implement the NPDES program; however, EPA has authorized many States to implement all or parts of the national 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 schedules of compliance. The U.S. Army Corps of Engineers (USACE) is the lead agency for enforcement of CWA wetland requirements (33 CFR Part 320, "General Regulatory Policies"). Under Section 401 of the CWA, 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.

Law/regulation	Requirements
Coastal Zone Management Act of 1972, as amended, (16 U.S.C. 1451 et seq.)	Congress enacted the Coastal Zone Management Act (CZMA) in 1972 to address the increasing pressures of over-development upon 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 encourage States to participate, the CZMA makes Federal financial assistance available to any coastal State or territory, including those on the Great Lakes, as long as the State or territory is willing to develop and implement a comprehensive coastal management program.
Wild and Scenic Rivers Act, 16 U.S.C. 1271 et seq.	The Wild and Scenic Rivers Act created the National Wild and Scenic Rivers System, which was established to protect the environmental values of free-flowing streams from degradation by impacting activities, including water resources projects.
Virginia Administrative Code (VAC), Title 9, "Environment": Agency 15 "Department of Environmental Quality" and Agency 25 "State Water Control Board"	Establishes the State of Virginia's rules and regulations related to water quality and supply (Code of Virginia, Title 62.1 "Waters of the State, Ports and Harbors," Chapter 3.1 "State Water Control Law.")
Waste management and pollution prevention	
Resource Conservation and Recovery Act, 42 U.S.C. 6901 et seq.	The Resource Conservation and Recovery Act (RCRA) requires 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, "Authorized State Hazardous Waste Programs" (42 U.S.C. 6926), allows States to establish and administer these permit programs with EPA approval. EPA regulations implementing RCRA are found in 40 CFR Parts 260 through 283. 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 impacts the extent and complexity of the requirements.
Pollution Prevention Act, 42 U.S.C. 13101 et seq.	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.
VAC 33: Title 9, Agency 15, Chapter 3.1. State Water Control Law	DEQ is authorized to implement a variety of laws and regulations pertaining to water quality and supply.
Protected species	
Endangered Species Act, 16 U.S.C. 1531 et seq.	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 U.S. Fish and Wildlife Service (FWS) or the National Marine Fisheries Service (NMFS) on Federal actions that may affect listed species or designated critical habitats.
Magnuson–Stevens Fishery Conservation and	The Magnuson–Stevens Fishery Conservation and Management Act, as amended, governs marine fisheries management in U.S. Federal waters.

Law/regulation	Requirements
Management Act, 16 U.S.C. 1801 et seq.	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 National Marine Fisheries Service for any Federal actions that may adversely affect essential fish habitat.
Historic preservation and cultural resources	
National Historic Preservation Act, 54 U.S.C. 100101 et seq. (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 (ACHP). Section 106 of the Act requires Federal agencies to take into account the effects of their undertakings on historic properties. The Advisory Council on Historic Preservation regulations implementing Section 106 of the Act are found in 36 CFR Part 800, "Protection of Historic Properties." 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.

B.2 Operating Permits and Other Requirements

Table B-2 lists the permits and licenses issued by Federal, State, and local authorities for activities at Surry, as identified in Chapter 9 of the Environmental Report (ER).

Table B-2 Operating Permits and Other Requirements

Permit	Responsible Agency	Number	Expiration Date	Authorized Activity
Authorization to export waste	Central Interstate Low-Level Radioactive Waste Commission (CILLRWC)	None	Updated annually	Export of low-level radioactive waste outside the region
Virginia Pollutant Discharge Elimination System permit (VPDES)	Virginia Department of Environmental Quality (VDEQ)	VA0004090	02/28/2021	Discharge of wastewaters to waters of the State
Air permit (Title V permit)	VDEQ	Registration number: PRO50336	12/31/2022	Operation of air emission sources (oil-fired boilers, backup diesel generators, and backup electric generators)
Hazardous waste transportation/ shipment registration	U.S. Department of Transportation (USDOT)	531000020241	None	Hazardous materials shipments
Authorization to operate a wastewater treatment plant	VDEQ	23074	None	Wastewater treatment plant operating permit

Permit	Responsible Agency	Number	Expiration Date	Authorized Activity
Waterworks operation permits	Virginia Department of Health (VDH)	31810800, 3181802	N/A	Authorization to operate a non-transient non-community (potable) waterworks
Operating license	NRC	DPR-32 DPR-37	05/25/2032 01/29/2033	Operation of Surry
Permit	VDEQ	GW0003901	11/1/2023	Groundwater withdrawal for use as potable, process, and cooling water
ISFSI Authorization	NRC	SNM-2501	07/31/2046	Operation of a dry storage ISFSI
Permit	Virginia Marine Resources Commission (VMRC)	VMRC16-0710	07/26/2021	Dredging activities at the intake structure
Authorization to use regional permit	U.S. Army Corp of Engineer (USACE)	2013-RP-02 NAO-2008-1451/ VMRC#16-0710	08/14/2018 Reissuance application is in progress	Dredging of the intake channel in the James River
Authorization to use nationwide permit	USACE	2012-NWP #3 NAO-2018-00103 /VMRC#18-0069	Reissued 04/17/2018 to 03/18/2022	Maintenance of low-level intake structure debris removal
Authorization to use construction storm water general permit	VDEQ	VAR106343	06/30/2019	Land disturbance activity, spoils yard
Depredation permit	U.S. Fish and Wildlife Service (USFWS)	MB705136-0	03/31/2018	Taking of migratory birds

Source: Dominion 2018b

APPENDIX C
CONSULTATION CORRESPONDENCE REVIEW

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, as amended (16 *United States Code* (U.S.C.) 1531 et seq.) (ESA), 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 licenses for the continued operation of Surry Power Station, Units 1 and 2 (Surry), which would authorize operation for an additional 20 years beyond the current renewed 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 agency 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 Section 7 of the Act (Title 50 of the *Code of Federal Regulations* (50 CFR) Part 402, "Interagency Cooperation—Endangered Species Act of 1973, as Amended") 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 habitat are likely to be adversely affected by the action (50 CFR 402.12(a); 16 U.S.C. 1536(c)). Biological assessments are required for any agency action that is a "major construction activity" (50 CFR 402.12(b)), which is defined as 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). 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)). In such cases, the Federal agency should include the results of the ESA Section 7 consultation in the NEPA document (50 CFR 402.06(b)).

C.1.2 Biological Evaluation

Subsequent license renewal does not require the preparation of a biological assessment because it is not a major construction activity. Nonetheless, the NRC must consider the impacts of its actions on federally listed species and designated critical habitats and consult with the Services under ESA Section 7 in the case of "may affect" findings. To support such consultations, the NRC staff has incorporated its analysis of the potential impacts of the proposed subsequent license renewal on federally listed species and critical habitats into this supplemental environmental impact statement (SEIS). 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). Section 3.8 of this report describes the action area as well as the federally listed and proposed species and designated and proposed critical habitats potentially present in the action area. This section includes information pursuant to 50 CFR 402.12(f)(1), (2), and (3). Section 4.8 of this SEIS provides an assessment of the potential effects of the proposed Surry subsequent license renewal on the species and critical habitats present. Section 4.8 also contains the NRC's effect determinations for each of the listed species and critical habitats potentially present in the action area. Finally, Section 4.8 of this SEIS addresses cumulative effects and alternatives to the proposed action pursuant to 50 CFR 402.12(f)(4) and (5).

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

As part of its environmental review, the NRC staff considered whether any federally listed, proposed, or candidate species or proposed or designated critical habitats may be present in the action area (as defined at 50 CFR 402.02 and described in Section 3.8.1.1) for the proposed action of Surry license renewal. With respect to species under the FWS's jurisdiction, the NRC staff submitted project information to the Service's Environmental Conservation Online System (ECOS) Information for Planning and Conservation (IPaC) system to obtain a list of species in accordance with 50 CFR 402.12(c). The Service provided the NRC with a list of threatened and endangered species that may occur in the proposed action area. The list identified only one species: the northern long-eared bat (*Myotis septentrionalis*). The list also stated that no critical habitats are within the project area under review. During its review, the NRC staff identified no other listed species, proposed or candidate species, or proposed or designated critical habitats that may occur in the action area and that would be relevant to the staff's review.

The NRC staff evaluated the potential impacts of the proposed action on the northern long-eared bat in SEIS Sections 3.8 and 4.8. The staff concludes that the proposed license renewal may affect, but is not likely to adversely affect, the northern long-eared bat. In a letter dated April 9, 2019, the FWS concurred with this determination, based on the premise that activities associated with the proposed license renewal with the potential to affect the northern long-eared bat are consistent with the activities analyzed in a 2016 programmatic biological opinion. The FWS's April 9, 2019, letter documents that the NRC staff has fulfilled its ESA Section 7(a)(2) obligations with respect to the proposed Surry license renewal.

Table C-1 lists the correspondence relevant to the NRC's ESA Section 7 consultation with the FWS. The NRC staff will update this table in the final SEIS to include any correspondence transpiring between the issuance of this draft SEIS and the final SEIS.

Table C-1 Endangered Species Act Section 7 Consultation Correspondence with the U.S. Fish and Wildlife Service

Date	Description	ADAMS Accession No.[a]
April 9, 2019	Virginia Ecological Services Field Office (FWS) to B. Grange (NRC), Verification letter for the proposed Surry subsequent license renewal under the January 5, 2016, programmatic biological opinion on final 4(d) rule for northern long-eared bat and activities excepted from take prohibition	ML19157A112
June 6, 2019	Virginia Ecological Services Field Office (FWS) to B. Grange (NRC), List of threatened and endangered species for the proposed Surry subsequent license renewal	ML19157A113

[a] Access these documents through the NRC's Agencywide Documents Access and Management System (ADAMS) at http://adams.nrc.gov/wba/.

Endangered Species Act Section 7 Consultation with the National Marine Fisheries Service

With respect to species under NMFS's jurisdiction, the NRC staff determined the species that may occur in the action area through teleconferences with the NMFS Greater Atlantic Regional Fisheries Office. Through these discussions, the NRC staff determined that shortnose sturgeon (*Acipenser brevirostrum*) and Atlantic sturgeon (*A. oxyrinchus oxyrinchus*) occur in the action area. Additionally, NMFS has designated the entirety of the James River within the action area as critical habitat for the Chesapeake Bay distinct population segment of Atlantic sturgeon.

The NRC staff evaluated the potential impacts of the proposed action on the listed sturgeon and designated critical habitat in SEIS Sections 3.8 and 4.8. The staff concludes that the proposed subsequent license renewal may affect, but is not likely to adversely affect, these species. The staff concludes that the proposed subsequent license renewal may affect, but is not likely to destroy or adversely modify, critical habitat of the Atlantic sturgeon. The NRC staff will submit a copy of this draft SEIS, upon its issuance, to NMFS for review accompanied by a request for NMFS to concur with the NRC staff's ESA effect determinations in accordance with 50 CFR 402.12(j).

Table C-2 lists the correspondence relevant to the NRC's Endangered Species Act Section 7 consultation with NMFS. The NRC staff will update this table in the final SEIS to include any correspondence transpiring between the issuance of this draft SEIS and the final SEIS.

Table C-2 Endangered Species Act Section 7 Consultation Correspondence with the National Marine Fisheries Service

Date	Description	ADAMS Accession No.[(a)]
November 2, 2018	Summary of November 2, 2019, teleconference between the NRC and NMFS	ML19107A371
April 5, 2019	Summary of April 5, 2019, teleconference between the NRC and NMFS	ML19107A350

[(a)] Access these documents through the NRC's Agencywide Documents Access and Management System (ADAMS) at http://adams.nrc.gov/wba/.

C.2 Magnuson–Stevens Act Essential Fish Habitat Consultation

The NRC must comply with the Magnuson–Stevens Fishery Conservation and Management Act of 1996, as amended (16 U.S.C. Section 1801 et seq.), 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 Magnuson–Stevens Act. In SEIS Section 3.8.1.4, "Magnuson–Stevens Act: Essential Fish Habitat," the NRC staff finds that the following species and life stages have EFH in the James River near the Surry site.

- Summer flounder (*Paralichthys dentatus*) – larvae, juveniles, adults
- Atlantic butterfish (*Peprilus triacanthus*) – juveniles, adults
- Bluefish (*Pomatomus saltatrix*) – juveniles
- Windowpane flounder (*Scopthalmus aquosus*) – juveniles, adults

Additionally, little skate (*Leucoraja erinacea*) and winter skate (*L. ocellate*) adults consume anadromous prey that may occur in the James River near the Surry site.

In SEIS Section 4.8.1.4, "Magnuson–Stevens Act: Essential Fish Habitat," the NRC staff evaluates the potential effects of the proposed license renewal on the EFH of these species and life stages. The NRC staff concludes in its analysis that the subsequent license renewal would result in minimal adverse effects on the EFH of each of the species and life stages identified above. Upon issuance of this draft SEIS, the NRC will initiate EFH consultation with NMFS. The staff will report the results of this consultation in the final SEIS.

C.3 National Historic Preservation Act Section 106 Consultation

The National Historic Preservation Act of 1966, as amended (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 (ACHP) in 36 CFR Part 800, "Protection of Historic Properties." 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 National Historic Preservation Act.

Table C-3 lists the chronology of consultation and consultation documents related to the NRC's National Historic Preservation Act Section 106 review of the Surry license renewal. The NRC staff is required to consult with the noted agencies and organizations in accordance with the statutes listed above. The NRC staff will update this table in the final SEIS to include any correspondence transpiring between the issuance of this draft SEIS and the final SEIS, as appropriate.

Table C-3 National Historic Preservation Act Correspondence

Date	Sender and Recipient	Description	ADAMS Accession No.[(a)]
01/24/2019	B. Beasley (NRC) to R. Nelson, Director, Office of Federal Agency Programs Advisory Council on Historic Preservation	Request for Scoping Comments Concerning the Environmental Review of Surry Power Station, Units Nos. 1 and 2 Subsequent License Renewal Application	ML19016A124
01/24/2019	B. Beasley (NRC) to J. Langan, State Historic Preservation Officer, Virginia Department of Historic Resources	Request for Scoping Comments Concerning the Environmental Review of Surry Power Station, Unit Nos. 1 and 2 Subsequent License Renewal Application	ML19016A125
01/24/2019	B. Beasley (NRC) to E. Butler-Wolfe, Governor Absentee-Shawnee Tribe	Request for Scoping Comments Concerning the Environmental Review of Surry Power Station, Unit Nos. 1 and 2 Subsequent License Renewal Application	ML19016A126
01/24/2019	B. Beasley (NRC) to W. Harris, Chief Catawba Indian Nation	Request for Scoping Comments Concerning the Environmental Review of Surry Power Station, Unit Nos. 1 and 2 Subsequent License Renewal Application	ML19016A126
01/24/2019	B. Beasley (NRC) to B. John Baker, Principal Chief Cherokee Nation of Oklahoma	Request for Scoping Comments Concerning the Environmental Review of Surry Power Station, Unit Nos. 1 and 2 Subsequent License Renewal Application	ML19016A126

Date	Sender and Recipient	Description	ADAMS Accession No.[(a)]
01/24/2019	B. Beasley (NRC) to S. Adkins, Chief Chickahominy Indian Tribe	Request for Scoping Comments Concerning the Environmental Review of Surry Power Station, Unit Nos. 1 and 2 Subsequent License Renewal Application	ML19016A126
01/24/2019	B. Beasley (NRC) to G. W. Adkins, Chief Chickahominy Indians – Eastern Division	Request for Scoping Comments Concerning the Environmental Review of Surry Power Station, Unit Nos. 1 and 2 Subsequent License Renewal Application	ML19016A126
01/24/2019	B. Beasley (NRC) to D. Dotson, President Delaware Nation	Request for Scoping Comments Concerning the Environmental Review of Surry Power Station, Unit Nos. 1 and 2 Subsequent License Renewal Application	ML19016A126
01/24/2019	B. Beasley (NRC) to C. Brooks, Chief Delaware Tribe of Indians	Request for Scoping Comments Concerning the Environmental Review of Surry Power Station, Unit Nos. 1 and 2 Subsequent License Renewal Application	ML19016A126
01/24/2019	B. Beasley (NRC) to R. Sneed, Principal Chief Eastern Band of Cherokee Indians	Request for Scoping Comments Concerning the Environmental Review of Surry Power Station, Unit Nos. 1 and 2 Subsequent License Renewal Application	ML19016A126
01/24/2019	B. Beasley (NRC) to G.J. Wallace, Chief Eastern Shawnee Tribe of Oklahoma	Request for Scoping Comments Concerning the Environmental Review of Surry Power Station, Unit Nos. 1 and 2 Subsequent License Renewal Application	ML19016A126
01/24/2019	B. Beasley (NRC) to D. Branham, Chief Monacan Indian Nation	Request for Scoping Comments Concerning the Environmental Review of Surry Power Station, Unit Nos. 1 and 2 Subsequent License Renewal Application	ML19016A126

Date	Sender and Recipient	Description	ADAMS Accession No.[(a)]
01/24/2019	B. Beasley (NRC) to S. Bass, Chief Nansemond Indian Tribe	Request for Scoping Comments Concerning the Environmental Review of Surry Power Station, Unit Nos. 1 and 2 Subsequent License Renewal Application	ML19016A126
01/24/2019	B. Beasley (NRC) to R. Gray, Chief Pamunkey Indian Tribe	Request for Scoping Comments Concerning the Environmental Review of Surry Power Station, Unit Nos. 1 and 2 Subsequent License Renewal Application	ML19016A126
01/24/2019	B. Beasley (NRC) to G. Anne Richardson, Chief Rappahannock Tribe	Request for Scoping Comments Concerning the Environmental Review of Surry Power Station, Unit Nos. 1 and 2 Subsequent License Renewal Application	ML19016A126
01/24/2019	B. Beasley (NRC) to R. Sparkman, Chief Shawnee Tribe Oklahoma	Request for Scoping Comments Concerning the Environmental Review of Surry Power Station, Unit Nos. 1 and 2 Subsequent License Renewal Application	ML19016A126
01/24/2019	B. Beasley (NRC) to L. Henry, Chief Tuscarora Nation	Request for Scoping Comments Concerning the Environmental Review of Surry Power Station, Unit Nos. 1 and 2 Subsequent License Renewal Application	ML19016A126
01/24/2019	B. Beasley (NRC) to J. Bunch, Chief United Keetoowah Band of Cherokee Indians in Oklahoma	Request for Scoping Comments Concerning the Environmental Review of Surry Power Station, Unit Nos. 1 and 2 Subsequent License Renewal Application	ML19016A126
01/24/2019	B. Beasley (NRC) to W. Frank Adams, Chief Upper Mattaponi Indian Tribe	Request for Scoping Comments Concerning the Environmental Review of Surry Power Station, Unit Nos. 1 and 2 Subsequent License Renewal Application	ML19016A126

Date	Sender and Recipient	Description	ADAMS Accession No.[a]
01/24/2019	B. Beasley (NRC) to W.D. "Red Hawk" Brown, III, Chief Cheroenhaka (Nottoway) Tribe	Request for Scoping Comments Concerning the Environmental Review of Surry Power Station, Unit Nos. 1 and 2 Subsequent License Renewal Application	ML19016A126
01/24/2019	B. Beasley (NRC) to M. Custalow, Chief Mattaponi Tribe	Request for Scoping Comments Concerning the Environmental Review of Surry Power Station, Unit Nos. 1 and 2 Subsequent License Renewal Application	ML19016A126
01/24/2019	B. Beasley (NRC) to L. Allston, Chief Nottoway Tribe	Request for Scoping Comments Concerning the Environmental Review of Surry Power Station, Unit Nos. 1 and 2 Subsequent License Renewal Application	ML19016A126
01/24/2019	B. Beasley (NRC) to W. Brown, Principal Chief Meherrin Nation	Request for Scoping Comments Concerning the Environmental Review of Surry Power Station, Unit Nos. 1 and 2 Subsequent License Renewal Application	ML19016A126

[a] Access these documents through the NRC's Agencywide Documents Access and Management System (ADAMS) at https://adams.nrc.gov/wba/

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 Surry Power Station, Units 1 and 2 (Surry) subsequent license renewal application (SLRA). 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 supplemental environmental impact statement (SEIS). For scoping comments, see Appendix A of this SEIS and the NRC's, "Scoping Summary Report" (Agencywide Documents Access and Management System (ADAMS) Accession No. ML19135A197). 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 Dominion Energy Virginia (Dominion) to renew the operating license for Surry.

Table D-1 Environmental Review Correspondence

Date	Correspondence Description	ADAMS Accession No.
10/15/2018	Transmittal of Surry license renewal application from Dominion to NRC	ML18291A842
10/26/2018	Letter from NRC to Dominion regarding receipt and availability of Surry license renewal application	ML18297A093
11/16/2018	Surry Power Station Subsequent License Renewal Application Online Reference Portal	ML18319A252
12/03/2018	Surry – Determination of Acceptability and Sufficiency for Docketing, Review Schedule, and Opportunity for a Hearing Regarding the Virginia Electric and Power Company's Application for Subsequent License Renewal (EPID Nos. L-2018-RNW-0023 and L-2018-RNW-0024)	ML18320A188
12/21/2018	Notice of Intent to Prepare an Environmental Impact Statement and Conduct Scoping Process for Surry Power Station, Unit Nos. 1 and 2 (EPID: L-2018-RNW-0024)	ML18340A265
01/08/2019	Subsequent License Renewal Scoping Meeting Surry Power Station Units 1 and 2 – Transcript	ML19024A199
01/29/2019	Surry Power Station, Units 1 and 2 – Submittal of Supplement to Subsequent License Renewal Operating Licenses Application for Sufficiency Review Change Notice 1	ML19042A137

Date	Correspondence Description	ADAMS Accession No.
01/30/2019	EIS Scoping Meeting Summary	ML19024A386
03/4/2019	License Renewal Environmental Site Audit Plan Regarding the Surry Power Station, Units 1 and 2, Subsequent License Renewal Application (EPID No. L-2018-RNW-0024)	ML19044A556
03/4/2019	License Renewal Severe Accident Mitigation Alternatives Audit Plan Regarding the Surry Power Station, Unit Nos. 1 and 2, Subsequent License Renewal Application (EPID No. L-2018-RNW-0024)	ML19044A659
04/5/2019	Draft Environmental RAIs [requests for additional information] for Surry Power Station Subsequent License Renewal Application	ML19106A333
04/11/2019	RAI Set 1 – Surry SLRA Environmental Review (EPID No. L-2018-RNW-0024)	ML19114A423
04/25/2019	Surry Power Station, Units 1 and 2 – Summary of the Subsequent License Renewal Severe Accident Mitigation Alternatives Audit (EPID NO. L-2018-RNW-0024)	ML19106A416
04/29/2019	Surry Power Station Summary of the Subsequent License Renewal Environmental Audit (EPID No. L-2018-RNW-0024)	ML19107A020, ML19107A021
05/28/2019	Surry Power Station Units 1 and 2, Response to Requests for Additional Information Set 1 – Regarding Environmental Review.	ML19148A441
06/04/2019	Issuance of Environmental Scoping Summary Report Associated with the Staff's Review of the Surry Power Station, Units Nos. 1 and 2, Subsequent License Renewal Application (EPID NO. L-2018-RNW-0024)	ML19135A197

APPENDIX E
PROJECTS AND ACTIONS CONSIDERED IN THE CUMULATIVE IMPACTS ANALYSIS

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 Surry Power Station, Units 1 and 2 (Surry) for an additional 20 years. The staff's analysis of potential cumulative impacts associated with the proposed action (subsequent license renewal) is presented in Section 4.16 of this SEIS. However, because of the uniqueness of each environmental resource area evaluated and its associated geographic area of analysis, Section 4.16 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 Cumulative Impacts Analysis

Project Name	Summary of Project	Location (Relative to Surry Power Station)	Status
Onsite and Adjacent Facilities/Projects			
Surry Independent Spent Fuel Storage Installation Expansion	Planned expansion to add a fourth pad (measuring 302 ft by 26 ft (92 by 7.9 m), designed to hold 30 horizontal storage modules	Onsite, adjacent to existing pads	Scheduled for completion by end of 2020 (Dominion 2018b, 2019b)
Surry Independent Spent Fuel Storage Installation Future Expansion	Potential future expansion to add a fifth pad	Onsite, no site identified	Conceptual and dependent on future needs; no schedule has been identified (Dominion 2018b, 2019b)
Dredge Materials Management Area	New 58-ac (23-ha) disposal facility within a 400-ac (162-ha) site for disposal of materials dredged from the Surry intake channel; facility is a replacement for the onsite dredge material management pond	Offsite, approximately 4 mi (6.4 km) south of Surry	Construction scheduled for completion and operational by December 2019; Expected to be operational by January 2020 (Dominion 2018b, 2019b)
Fossil Fuel Energy Facilities			
Gravel Neck Combustion Turbines Station	Natural gas- and oil-fueled plant with 368-MW generating capacity from four oil units (28 MW) and two natural gas units (340 MW)	Onsite, adjacent to Surry	Operational (EIA 2019d; Dominion 2019h; EPA 2019j)

Project Name	Summary of Project	Location (Relative to Surry Power Station)	Status
Yorktown Power Station	Coal- and oil-fueled plant with 1,113-MW generating capacity from two coal units (323 MW) and one oil-fired peaking unit (790 MW)	Yorktown, VA, approximately 14 mi (23 km) east-northeast	Operational; coal units scheduled for decommissioning by end of 2019; oil unit scheduled for decommissioning in 2022 (EIA 2019d; EPA 2019j; Dominion 2019h, 2019d)
Renewable Energy Facilities			
Colonial Trail West	Solar photovoltaic facility with 142 MW generating capacity on 1,800 ac (730 ha)	Surry County, VA, approximately 11 mi (18 km) west-southwest	Scheduled to be in service by December 2019 (Dominion 2019c, 2019a)
Spring Grove 1	Solar photovoltaic facility with 98 MW generating capacity on 1,150 ac (465 ha)	Surry County, VA, approximately 11 mi (18 km) west-southwest	Scheduled to be in service by October 2020 (Dominion 2019c, 2019a)
Waste Management Bethel Landfill Gas to Energy Plant	Landfill-gas (biomass) fueled plant with 4.8 MW generating capacity	Hampton City, VA, approximately 15 mi (24 km) southeast	Operational (EIA 2019d; EPA 2019j)
Woodland Solar Farm	Solar photovoltaic facility with 19 MW (7.6 MW net) generating capacity	Smithfield, VA, approximately 18 mi (29 km) south-southeast	Operational (EIA 2019d; Dominion 2019e)
Correctional Solar LLC	Solar photovoltaic facility on 260 ac (105 ha) with 20 MW generating capacity	Barhamsville, VA, approximately 23 mi (37 km) northwest	Operational (EIA 2019d; Richmond Magazine 2018; Virginia Solar 2016)
INGENCO Charles City Plant	Landfill-gas (biomass) fueled plant (at Charles County Landfill) with 14.4 MW generating capacity	Providence Forge, VA, approximately 30 mi (48 km) northwest	Operational (EIA 2019d; EPA 2019j; INGENCO 2019)
Manufacturing Facilities			
Anheuser-Busch Inc.	Brewery; 114-ac (58-ha) site with 1.2 million f^2 (111,500 m^2) of production space	Williamsburg, VA, approximately 6 mi (10 km) north-northeast	Operational (Dominion 2018b; EPA 2019j; Anheuser-Busch 2019)
Ball Metal Beverage Container Corporation	Beverage (metal can) packaging manufacturing facility	Williamsburg, VA, approximately 5.5 mi (9 km) northeast	Operational (EPA 2019j)
Kinyo Virginia, Inc.	Fabricated rubber products (printing blankets)	Newport News, VA, approximately 7 mi (11 km) northeast	Operational (EPA 2019j; Kinyo 2019)

Project Name	Summary of Project	Location (Relative to Surry Power Station)	Status
Smithfield Packing Co. (Smithfield Foods), North Facility	Meat processing and packing facilities	Smithfield, VA, approximately 12 mi (19 km) south-southeast	Operational (EPA 2019j; Smithfield 2019)
Newport News Shipbuilding	550-ac (220-ha) shipyard including manufacturing facilities, dry docks, and piers; it is the sole builder, refueler, and overhaul provider for U.S. Navy aircraft carriers and one of two providers of U.S. Navy submarines; largest industrial employer in Virginia	Newport News, VA, approximately 18 mi (29 km) southeast	Operational (EPA 2019j; HIH 2019)
Military and Other Federal Facilities			
Naval Weapons Station Yorktown	13,200 ac (5,300 km) U.S. Navy installation primarily charged with providing ordnance logistics and supply support	Yorktown, VA, approximately 6 mi (10 km) northeast	Operational (EPA 2019j; USN 2019)
Joint Base Langley Eustis	11,000-ac (4,450-ha) joint U.S. military installation comprised of the U.S. Army's Fort Eustis, including various training, aviation support, Felker Army Air Field, and logistics units), and the U.S. Air Force's Langley Air Force Base (including units of the Air Combat Command)	Fort Eustis located 5 mi (8 km) east (Newport News, VA) and Langley Air Force Base located approximately 19 mi (31 km) east-southeast (Hampton, VA)	Operational (EPA 2019j; USAF 2019)
U.S. Department of Energy Thomas Jefferson National Accelerator Facility	206-ac (83-ha) research campus that includes the Continuous Electron Beam Accelerator Facility (CEBAF)	Newport News, VA, approximately 12.5 mi (20 km) southeast	Operational (EPA 2019j; DOE 2019b, 2019c)
Craney Island Dredged Material Management Area	2,500-ac (1,010-ha) confined dredged material disposal site used for disposal of maintenance, private, and permit dredged material from projects in the Hampton Roads area	Near Portsmouth, VA, approximately 24 mi (39 km) southeast	Operational (EPA 2019j; USACE 2018a)

Project Name	Summary of Project	Location (Relative to Surry Power Station)	Status
Landfills			
Bethel Landfill	Municipal (non-hazardous) solid-waste landfill	Hampton, VA, approximately 15 mi (24 km) southeast	Operational (WM 2019)
Recovery Operations Center and Former Newport News Landfill	Residential waste drop-off and composting facility at closed landfill	Newport News, VA, approximately 8.5 mi (14 km) east	Landfill closed (1996); Operational drop-off facility (EPA 2019j; Newport News 2019b, 2019c)
Water Supply and Treatment Facilities			
James City Service Authority Five Forks Water Treatment Facility	Municipal water supply with groundwater source for James City County and portions of York County and City of Williamsburg	Williamsburg, VA, approximately 7 mi (11 km) north-northwest	Operational (EPA 2019j, James City County 2019, Water Technology, undated)
Newport News City Lee Hall Water Treatment Plant	Municipal water supply with groundwater source (wellfield) and surface water reservoir	Newport News, VA, approximately 8 mi (13 km) east-northeast	Operational (EPA 2019j; Newport News 2019a)
Harwoods Mill Water Treatment Plant	Municipal water supply with surface water reservoir	Yorktown, VA, approximately 13 mi (21 km) east-southeast	Operational (EPA 2019j; Newport News 2019a)
Williamsburg Sewage Treatment Plant	Wastewater treatment plant	Williamsburg, VA, approximately 5 mi (8 km) north-northeast	Operational (EPA 2019j; HRSD 2019a)
Surry Wastewater Treatment Facility	Wastewater treatment plant	Surry, VA, approximately 8 mi (13 km) southwest	Operational (EPA 2019j; HRSD 2019a)
Lawnes Point Wastewater Treatment Plant	Wastewater treatment plant	Smithfield, VA, approximately 5 mi (8 km) south-southeast	Operational (EPA 2019j; HRSD 2019)
City of Williamsburg Water Filter Plant	Municipal water supply with surface water reservoir	Williamsburg, VA, approximately 9 mi (14 km) southeast	Operational (EPA 2019j)
James River Sewage Treatment Plant	Wastewater treatment plant	Newport News, VA, approximately 11 mi (18 km) southeast	Operational (EPA 2019j; HRSD 2019a)
Boat Harbor Sewage Treatment Plant	Wastewater treatment plant	Newport News, VA, approximately 21 mi (34 km) southeast	Operational (EPA 2019j; HRSD 2019a)

Project Name	Summary of Project	Location (Relative to Surry Power Station)	Status
Hampton Roads Sanitation District (HRSD) Sustainable Water Initiative for Tomorrow (SWIFT) program	Wastewater reuse and aquifer replenishment program that includes treating effluent from up to seven HRSD wastewater treatment facilities and injecting the treatment product into the Potomac aquifer	Various locations within 5-25 mi (8-40 km)	Ongoing; proposed completion in 2030 (HRSD 2017, 2018a, 2018b)
Parks and Recreation Sites			
Hog Island Wildlife Management Area	3,908-ac (40-ha) historic site offering hunting, fishing, and waterfowl watching	Hog Island Tract located adjacent to the northern Surry site boundary, with the Carlisle and Stewart tracts located approximately 0.5 mi (0.8 km) south	Operational; Managed by Virginia Department of Game and Inland Fisheries (VDGIF 2019g)
Chippokes Plantation State Park	1,947-ac (790-ha) State park and agricultural museum offering tours, hiking, camping, picnicking, and water activities	Approximately 1.5 mi (2.4 km) south-southwest	Operational; Managed by Virginia Department of Conservation and Recreation (EPA 2019j; VDCR 2019a)
Busch Gardens Williamsburg	383-ac (155-ha) European-themed amusement park with rides and attractions	5.5 mi (9 km) north-northeast	Operational; Privately owned and managed by SeaWorld Entertainment (Busch Gardens 2019; EPA 2019j)
Fort Huger	22-ac (35-ha) historic archaeological site consisting of a well-preserved Civil War fort	Approximately 5 mi (8 km) southeast	Operational; Managed Isle of Wight County Parks & Recreation (Isle of Wight 2019; VDCR 2019b)
Colonial National Historical Park	9,349-ac (15,000-ha) area comprising the Colonial Era communities of Jamestown, Williamsburg, and Yorktown and linked by the 23-mi (37-km) long Colonial Parkway	Approximately 5 mi (8 km) northwest (Jamestown) on the north side of the James River and approximately 10 mi (16 km) northeast (Yorktown)	Operational; Managed by National Park Service, Preservation Virginia, and Colonial Williamsburg Foundation (EPA 2019j; NPS 2019

Project Name	Summary of Project	Location (Relative to Surry Power Station)	Status
Plum Tree Island National Wildlife Refuge	3,500-ac (1,400-ha) refuge providing protected breeding habitat for Federal and State-listed threatened and endangered species as well as many migrating bird species	Near Poquoson, VA, approximately 19 mi (31 km) east	Operational; Managed by U.S. Fish and Wildlife Service (FWS 2017)
Other Recreational Areas	Several golf courses, smaller parks, and other recreational attractions	Within 10 mi (16 km)	Operational
Transportation Facilities/Projects			
James River Federal Navigation Project	Maintenance dredging of the James River; navigation channel is maintained at 18-25 ft (5.5–7.6 m) deep and 200–300 ft (61–91 m) wide for a distance of 90.8 mi (146 km) from Hampton Roads to Richmond, VA	Adjacent to Surry site	Ongoing; USACE 2019
Newport News/Williamsburg International Airport	Full-service commercial airport	Newport News, VA, approximately 11 mi (18 km) east-southeast	Operational; (EPA 2019j; PHF 2019)
Other Aviation Facilities	Three private airfields, one public general aviation airport, one U.S. Navy helipad, and one Army aviation airfield	Located within 12 mi (19 km) of Surry	Operational (AirNav 2019)
Other Facilities/Projects			
Surry-Skiffes Creek 500-kilovolt transmission line	New 7.7 mi (12 km) transmission line from the Surry switchyard and crossing the James River to the new Skiffes Creek switching station in James City County	Partially onsite and extending approximately 5 mi (8 km) northeast	Operational (February 2019) (Dominion 2019g)
Various minor air pollutant emissions, National Pollutant Discharge Elimination System permitted wastewater discharges, and hazardous waste small quantity generators	Various businesses with smaller effluent discharges and waste streams	Within 10 mi (16 km)	Operational (EPA 2019j)

Project Name	Summary of Project	Location (Relative to Surry Power Station)	Status
Future Development	Newport News and Hampton Roads metropolitan areas; construction and redevelopment of housing units and associated commercial buildings; military installations; roads, bridges, rail, and ports; water and/or wastewater treatment and distribution facilities; and associated pipelines	Throughout region	Construction would occur in the future, as described in State and local land-use planning documents

APPENDIX F
ENVIRONMENTAL IMPACTS OF POSTULATED ACCIDENTS

This appendix describes the environmental impacts from postulated accidents that may occur at Surry Power Station Units 1 and 2 (Surry, or Surry Units 1 and 2) during the subsequent license renewal period. The term “accident” refers to any unintentional event outside the normal plant operational envelope that could result in either (a) an unplanned release of radioactive materials into the environment or (b) the potential for an unplanned release of radioactive materials into the environment. NUREG-1437, “Generic Environmental Impact Statement for License Renewal of Nuclear Plants” (GEIS) (NRC 1996, 2013), evaluates in detail 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, with or without serious offsite consequences.

This appendix first describes the evaluation of new and significant information related to design-basis accidents. This is followed by an evaluation of new and significant information for postulated severe accidents at Surry.

F.1 <u>Background</u>

Although this supplemental environmental impact statement (SEIS) documents the NRC staff’s review of a subsequent license renewal application, 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 new 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 design-basis accidents and the safety features designed to prevent or mitigate their impacts. The NRC staff reviews the operating license application to determine if the plant’s design—including designs for preventing or mitigating accidents—meets the NRC’s regulations and requirements.

F.1.1 Design-Basis Accidents

Design-basis accidents are 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. Planning for design-basis accidents ensures that the proposed plant can withstand normal transients (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 design-basis accidents may occur but are unlikely to occur even once during the life of the plant; nevertheless, carefully evaluating each design-basis accident is crucial to establishing the design basis for the preventive and mitigative safety systems of the proposed nuclear power plant. Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, “Domestic Licensing of Production and Utilization Facilities,” and 10 CFR Part 100, “Reactor Site Criteria,” describe the NRC’s acceptance criteria for design-basis accidents.

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 design-basis accidents. The applicant and the NRC staff evaluate the environmental impacts of design-basis accidents for the hypothetical maximum-exposed individual. The results of these evaluations of design-basis accidents 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 final environmental statement. 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 design-basis accidents) throughout the operating life of the nuclear power plant, including any license renewal periods of extended operation. The consequences for design-basis accidents are evaluated for the hypothetical maximum exposed individual; as such, changes in the plant environment will not affect these evaluations.

The NRC regulation at 10 CFR 54.29(a) requires license renewal applicants to demonstrate that identified actions have been or will be taken 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) (10 CFR 54.3(a)). Furthermore, the applicant must show that any changes made to the plant’s CLB to comply with paragraph (a) of 10 CFR 54.29, “Standards for issuance of a renewed license,” are in accordance with the Atomic Energy Act and the NRC’s regulations. In other words, because of the requirements that the existing design basis and aging management programs be in effect for license renewal, the environmental impacts of design-basis accidents as calculated for the original operating license application should not differ significantly from the environmental impacts of design-basis accidents at any other time during plant operations, including during the initial license renewal and subsequent renewal periods. Accordingly, the design of the nuclear power plant, relative to design-basis accidents during the period of extended operation, is considered to remain acceptable.

F.1.2 Design-Basis Accidents and License Renewal

Consistent with RIS-14-6, “Consideration of Current Operating Issues and Licensing Actions in License Renewal,” the early and adequate identification of the design-basis accidents mitigation (prior to subsequent license renewal) makes them a part of the CLB of the plant as defined at 10 CFR 54.3(a), “Current licensing basis (CLB).” The NRC requires licensees to maintain the CLB of the 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,” design-basis accidents are not subject to review under license renewal.

As stated in Section 5.3.2 of the 1996 GEIS, the NRC staff assessed the environmental impacts from design-basis accidents in individual plant-specific environmental impact statements (EISs) at the time of the initial license application review. Because consistent with the NRC ROP, the licensee is required to maintain the plant within acceptable design and performance criteria, including during any license renewal term, the NRC staff would not expect environmental impacts to change significantly. Therefore, additional assessment of the environmental impacts from design-basis accidents is not necessary (10 CFR 51).

The GEIS concludes that the environmental impacts of design-basis accidents are of SMALL significance for all nuclear power plants, because the plants were designed to withstand these accidents. For the purposes of initial or subsequent license renewal, the NRC designates design-basis accidents as a Category 1 generic issue—applicable to all nuclear power plants (see 10 CFR Part 51, Subpart A, Appendix B, Table B-1, "Summary of Findings on NEPA Issues for License Renewal of Nuclear Power Plants"). During the license renewal review process, the NRC staff adopts the applicable Category 1 issue conclusions from the GEIS (unless there exists new and significant information about the issue). Hence, the NRC staff need not address Category 1 issues (like design-basis accidents) in the site-specific SEIS for license renewal, unless new and significant information exists for those issues.

In its environmental report for the Surry subsequent license renewal application, Dominion did not identify any new and significant information related to design-basis accidents at Surry (Dominion 2018b). The NRC staff also did not identify any new and significant information related to design-basis accidents during its independent review of Dominion's environmental report, through the scoping process, or in its evaluation of other available information. Therefore, the NRC staff concludes that there are no environmental impacts related to design-basis accidents at Surry during the subsequent license renewal period beyond those already discussed generically for all nuclear power plants in the GEIS.

F.1.3 Severe Accidents

Severe accidents are postulated accidents that are more severe than design-basis accidents 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. The likelihood of a severe accident occurring is generally even lower than the likelihood of a design-basis accident occurring.

F.1.4 Severe Accidents and License Renewal

Chapter 5 of the 1996 GEIS (NRC 1996) conservatively predicts the environmental impacts of postulated severe accidents that may occur during the period of extended operations at nuclear power plants. In the 2013 GEIS, the staff updated the NRC's 1996 plant-by-plant severe accident environmental impact assessments (NRC 2013a, Appendix E). In the 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 environmental statements that the NRC staff had prepared for each of the plants in support of their original reactor operating licenses. When the NRC staff prepared the 1996 GEIS, 28 nuclear power plant sites (44 units) had EISs or final environmental statements that contained a severe accident analysis. Not all original operating reactor licenses contain a severe accident analysis because the NRC has not always required such analyses. The 1996 GEIS assessed the environmental impacts of severe accidents during the license renewal period for all plants by using the results of existing analyses and site-specific information to make conservative predictions. With few exceptions, the severe accident analyses evaluated in the 1996 GEIS were limited to consideration of reactor accidents caused by internal events. The 1996 GEIS addressed the impacts from external events qualitatively.

For its severe accident environmental impact analysis for each plant, the 1996 GEIS used very conservative 95th percentile upper confidence bound estimates for environmental impact whenever available. This approach provides conservatism to cover uncertainties, as described in Section 5.3.3.2.2 of the 1996 GEIS. The 1996 GEIS concluded that the probability-weighted consequences of severe accidents as related to license renewal are SMALL compared to other risks to which the populations surrounding nuclear power plants are routinely exposed. Since issuing the 1996 GEIS, the NRC's understanding of severe accident risk has continued to evolve. The updated 2013 GEIS assesses more recent information and developments in severe accident analyses and how they might affect the conclusions in Chapter 5 of the 1996 GEIS. The 2013 GEIS also provides comparative data where appropriate. Based on information in the 2013 GEIS, the NRC staff determined that for all nuclear power plants, the probability-weighted consequences of severe accidents are SMALL. However, the GEIS determined that alternatives to mitigate severe accidents must be considered for all plants that have not considered such alternatives as a Category 2 issue. See Table B-1, "Summary of Findings on NEPA Issues for License Renewal of Nuclear Power Plants," of Appendix B to Subpart A of 10 CFR Part 51, which states:

> 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.

An analysis of severe accident mitigation alternatives was performed for Surry at the time of initial license renewal (Dominion 2001b). The staff documented its review in NUREG-1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 6, Regarding Surry Nuclear Plant, Units 1 & 2" (NRC 2002b). For the Surry subsequent license renewal severe accident mitigation alternatives analysis, the NRC staff considered any new and significant information that might alter the conclusions of that analysis, as discussed below.

F.2 Severe Accident Mitigation Alternatives

In a severe accident mitigation alternatives (SAMA) analysis, the NRC requires license renewal applicants to consider the environmental impacts of severe accidents, their probability of occurrence, and potential means to mitigate those accidents. As quoted above, 10 CFR Part 51, Table B-1 states, "alternatives to mitigate severe accidents must be considered for all plants that have not considered such alternatives." This NRC requirement to consider alternatives to mitigate severe accidents can be fulfilled by a SAMA analysis. The purpose of the SAMA analysis is to identify design alternatives, procedural modifications, or training activities that may further reduce the risks of severe accidents at nuclear power plants and that are also potentially cost-beneficial to implement. The SAMA analysis includes the identification and evaluation of SAMAs that may reduce the radiological risk from a severe accident by preventing substantial core damage (i.e., preventing a severe accident) or by limiting releases from containment if substantial core damage occurs (i.e., mitigating the impacts of a severe accident) (NRC 2013a). The regulation, 10 CFR 51.53(c)(3)(ii)(L), states that each license renewal applicant must submit an environmental report that considers alternatives to mitigate severe accidents, "[i]f the staff has not previously considered severe accident mitigation alternatives for the applicant's plant in an environmental impact statement or related supplement or in an environmental assessment."

F.2.1 Surry Initial License Renewal Application and SAMA Analysis in 2001

As part of its initial license renewal application submitted in 2001, Dominion's environmental report included an analysis of SAMAs for Surry Units 1 and 2 (Dominion 2001b). Dominion based this SAMA analysis on (1) the Surry probabilistic risk assessment (PRA) for total accident frequency, core damage frequency (CDF), and containment large early release frequency (LERF); and (2) a supplemental analysis of offsite consequences and economic impacts for risk determination. The Surry 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 the MELCOR Accident Consequence Code System 2 (MACCS2) code, Version 1.12, to determine the offsite risk impacts on the surrounding environment and the public. Inputs for the latter analysis included plant- or site-specific values for core radionuclide inventory, source term and release fractions, meteorological data, projected population distribution (based on 1990 census data, projected out to 2030), emergency response evacuation modeling, and economic data. To help identify and evaluate potential SAMAs, Dominion considered insights and recommendations from SAMA analyses for other plants, potential plant improvements discussed in NRC and industry documents, and documented insights that the Surry staff provided.

In its 2001 environmental report, Dominion considered 160 SAMA candidates. Dominion then performed a qualitative screening of those SAMAs, eliminating SAMAs that were not applicable to Surry or had already been implemented at Surry. Based on this qualitative screening, 107 SAMAs were eliminated, leaving 53 SAMAs subject to the final screening and evaluation process. The 53 remaining SAMAs are listed in Table G.2-2 of Appendix G of the 2001 environmental report (ER) (Dominion 2001b). The final screening process involved identifying and eliminating those SAMAs whose cost exceeded twice their benefit (Dominion 2001b). Ultimately, Dominion concluded that there were no potentially cost-beneficial SAMAs associated with the initial Surry license renewal.

As part of its review of the initial Surry license renewal application, the NRC staff reviewed Dominion's 2001 analysis of SAMAs for Surry, as documented in Supplement 6 to NUREG-1437 (NRC 2002b). Chapter 5 of Supplement 6 to NUREG-1437 contains the NRC staff's evaluation of the potential environmental impacts of 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.

In Section 5.2 of NUREG-1437, Supplement 6, the NRC staff found that Dominion used a systematic and comprehensive process for identifying potential plant improvements for Surry Units 1 and 2, and that its bases for calculating the risk reductions afforded by these plant improvements were reasonable and generally conservative. Further, the NRC staff found that Dominion's estimates of the costs of implementing each SAMA were reasonable and consistent with estimates developed for other operating reactors. In addition, the NRC staff concluded that Dominion's cost-benefit comparisons were performed appropriately. The NRC staff concluded that Dominion's SAMA methods and implementation of those methods were sound, and it agreed with Dominion's conclusion that none of the candidate SAMAs were potentially cost-beneficial based on conservative treatment of costs and benefits. The staff found that Dominion's conclusion was consistent with the low residual level of risk indicated in the Surry PRA, and was also consistent with the fact that Surry had already implemented many plant improvements identified during two risk analysis processes: (1) the individual plant examination

(IPE), a risk analysis that considers the unique aspects of a particular nuclear power plant, identifying the specific vulnerabilities to severe accidents of that plant; and (2) the individual plant examination of external events (IPEEE), a risk analysis that considers external events such as earthquakes, internal fires, and high winds (NRC 2002b).

F.2.2 Subsequent License Renewal Application and New and Significant Information as It Relates to the Probability-Weighted Consequences of Severe Accidents

As mentioned above, a license renewal application must include an environmental report that describes SAMAs if the NRC staff has not previously evaluated SAMAs for that plant in an EIS, in a related supplement to an EIS, or in an environmental assessment. Also discussed above, the NRC staff performed a site-specific analysis of Surry SAMAs in NUREG-1437, Supplement 6 to NUREG-1437 (NRC 2002b). Therefore, in accordance with 10 CFR 51.53(c)(3)(ii)(L) and Table B-1 of Appendix B to Subpart A of 10 CFR Part 51, Dominion is not required to provide another SAMA analysis in its environmental report for the Surry subsequent license renewal application.

The NRC's regulations in 10 CFR Part 51, which implement Section 102(2) of the National Environmental Policy Act (NEPA), require that all applicants for license renewal submit an environmental report to the NRC, in which they 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)). This includes new and significant information that could affect the environmental impacts related to postulated severe accidents or that could affect the results of a previous SAMA analysis. Accordingly, in its subsequent license renewal application environmental report, Dominion evaluates areas of new and significant information that could affect the environmental impact of postulated severe accidents during the subsequent license renewal period of extended operation, and possible new and significant information as it relates to SAMAs.

In Dominion's assessment of new and significant information related to SAMAs in its subsequent license renewal application, Dominion used the recently issued Nuclear Energy Institute (NEI) guidance, which the NRC staff has endorsed (NRC 2018d). As discussed in Section F.5 below, 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. This effort led to the publication of NEI 17-04, Revision 0, "Model SLR New and Significant Assessment Approach for SAMA," on June 29, 2017 (NEI 2017). NEI 17-04 provides a tiered approach that entails a three-stage screening process for the evaluation of new information.

In this screening process, new information is deemed to be "potentially significant" to the extent that it results in the identification in Stage 1 (involving the use of PRA risk insights and/or risk model quantifications) of an unimplemented SAMA that reduces the maximum benefit (MB) by 50 percent or more. Maximum benefit is defined in Section 4.5 of NEI 05-01, Revision A, "Severe Accident Mitigation Alternatives (SAMA) Analysis Guidance Document" (NEI 2005b), 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. If a SAMA is found to result in a 50 percent reduction in maximum benefit in Stage 1, a Stage 2 assessment would then be performed (involving an updated averted cost-risk estimate for implementing that SAMA). A Stage 3 assessment (involving a cost-benefit analysis) would be required only for "potentially significant" SAMAs (i.e., those that are shown by the Stage 2 assessment to reduce the maximum benefit by 50 percent or more). Finally, if the Stage 3 assessment shows that a “potentially significant” SAMA is “potentially cost-beneficial,” thus indicating the existence of “new and significant” information, then the applicant must supplement the previous SAMA analysis. The NRC staff endorsed NEI 17-04 for use by license renewal applicants on January 31, 2018 (NRC 2018d). Dominion’s assessment of new and significant information related to its SAMA cost-benefit analysis is discussed in Section F.5 of this appendix.

Below, the NRC staff summarizes possible areas of new and significant information and assesses Dominion’s conclusions.

F.3 Evaluation of New Information Concerning Severe Accident Consequences for Surry as It Relates to the GEIS

The 2013 GEIS considers developments in plant operation and accident analysis that could have changed the assumptions made in the 1996 GEIS concerning severe accident consequences. The 2013 GEIS confirmed the determination in the 1996 GEIS that the probability-weighted consequences of severe accidents are SMALL for all plants. In the 2013 GEIS, Appendix E provides the NRC staff’s evaluation of the environmental impacts of postulated accidents. Table E-19, “Summary of Conclusions,” of the 2013 GEIS shows the developments that the NRC staff considered, as well as the staff’s conclusions. Consideration of the listed items was the basis for the NRC staff's overall determination in the 2013 GEIS that the probability-weighted consequences of severe accidents remain SMALL for all plants.

For subsequent license renewal for Surry, the staff confirmed that there is no new and significant information that would change the 2013 GEIS conclusions on the probability-weighted consequences of severe accidents. The NRC staff evaluated Dominion’s information related to the 2013 GEIS, Table E-19, “Summary of Conclusions,” during the Surry audit and by reviewing docketed information (NRC 2019e). The results of that review follow.

F.3.1 New Internal Events Information (Section E.3.1 of the 2013 GEIS)

After Dominion submitted the Surry initial license renewal application environmental report in 2001, and the NRC staff issued its corresponding SAMA review in its 2002 SEIS, there have been many improvements to Surry’s risk profile. The Surry internal events CDF in the initial license renewal SAMA was approximately 3.8×10^{-5}/year (Dominion 2001b). The current Surry internal events PRA model of record has a CDF of approximately 3.2×10^{-6}/year (Dominion 2018b). This change represents a 93-percent reduction or a factor-of-14 reduction in CDF for each unit. This substantial improvement in CDF makes any proposed new SAMA or previously evaluated SAMA less likely to be cost-beneficial.

In the 2013 GEIS, the NRC staff reviewed the updated boiling-water reactor (BWR) and pressurized-water reactor (PWR) internal event CDFs. The CDF is an expression of the likelihood that, given the way a reactor is designed and operated, an accident could cause the fuel in the reactor to be damaged. The 2013 GEIS addresses new information on the risk and environmental impacts of severe accidents caused by internal events that had emerged following issuance of the 1996 GEIS and includes consideration of Surry’s plant-specific PRA analysis. The new information addressed in the 2013 GEIS indicates that PWR and BWR CDFs evaluated for the 2013 GEIS are generally comparable to or less than the CDFs that formed the basis of the 1996 GEIS (NRC 2013a).

Therefore, the NRC staff concludes that the offsite consequences of severe accidents initiated by internal events during the subsequent license renewal term would not exceed the impacts predicted in the 2013 GEIS. For these issues, the GEIS predicted that the impacts would be small for all nuclear plants. The NRC staff identified no new and significant information regarding internal events during its review of Dominion's environmental report, during the SAMA audit, through the scoping process, or through the evaluation of other available information. Thus, the NRC staff finds Dominion's conclusion acceptable that no new and significant information exists for Surry concerning offsite consequences of severe accidents initiated by internal events that would alter the conclusions reached in the 2013 GEIS.

F.3.2 External Events (Section E.3.2 of the 2013 GEIS)

Section E.3.2.3 of the 2013 GEIS concludes 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 1990b), and other sources documented in the GEIS, are comparable to CDFs from accidents initiated by internal events but lower than the CDFs that formed the basis for the 1996 GEIS. In the 2013 GEIS, the environmental impacts from externally initiated events are generally significantly lower—one or more orders of magnitude lower—than the environmental impacts from external events determined in the 1996 GEIS.

The 1996 GEIS concluded that severe accidents initiated by external events (such as earthquakes) could have potentially high consequences but also found that the risks from these external events are adequately addressed through a consideration of severe accidents initiated by internal events (such as a loss of cooling water). Therefore, the 1996 GEIS concluded that an applicant for license renewal need only analyze the environmental impacts from an internal event to characterize the environmental impacts from either internal or external events. Dominion indicated that the quantitative evaluations performed for this analysis use the Surry internal events model only. Dominion also noted that the Surry external events PRA analyses are not available for quantification using the current PRA models, and they do not reflect some of the plant safety improvements, such as the upgrade of the reactor cooling pump seals to the Flowserve N9000 seal design, which would significantly benefit the station blackout (SBO) CDF, which tends to dominate the external events risk at Surry.

The staff confirmed that in 2014, Dominion performed a bounding seismic evaluation for Surry using appropriate seismic hazard curves and a plant-level fragility curve (VEP 2014). By letter dated November 17, 2016 (NRC 2016b), the NRC staff documented its review of the reevaluated seismic hazard, also referred to as the mitigating strategies seismic hazard information. The NRC staff concluded that no further seismic evaluations are necessary for Surry because: (1) the reevaluated seismic hazard for the site is essentially bounded by the safe shutdown earthquake (SSE) spectrum at frequencies of 1 Hz and greater, and (2) the FLEX strategies can be implemented as designed.

In conclusion, there was a greater-than-a-factor-of-14 decrease in the Surry internal events CDF and the updated seismic risk for Surry was determined to be within the design basis SSE spectrum. Therefore, the offsite consequences of severe accidents initiated by external events during the subsequent license renewal term would not exceed the impacts predicted in the 2013 GEIS. For these issues, the GEIS predicts that the impacts would be small for all nuclear plants. The NRC staff identified no new and significant information regarding external events during its review of Dominion's environmental report, 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 Surry concerning offsite consequences of severe accidents initiated by external events that would alter the conclusions reached in the 2013 GEIS.

F.3.3 New Source Term Information (Section E.3.3 of the 2013 GEIS)

The source term 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 GEIS concludes that, in most cases, more recent estimates give significantly lower release frequencies and release fractions than was assumed in the 1996 GEIS. Thus, the environmental impacts of radioactive materials released during severe accidents, used as the basis for the 1996 GEIS (i.e., the frequency-weighted release consequences), are higher than the environmental impacts that would be estimated today using more recent source term information. The NRC staff also notes that results from the NRC's State-of-the-Art Reactor Consequence Analysis (SOARCA) project (which represents a significant ongoing effort to re-quantify realistic severe accident source terms) confirm that source term timing and magnitude values calculated in the SOARCA reports are significantly lower than those quantified in previous studies. The NRC staff expects to incorporate the information gleaned from the SOARCA project in future revisions of the GEIS (NRC 2013a).

For the reasons described above, current source term timing and magnitude at Surry is likely to be significantly lower than had been quantified in previous studies and the initial license renewal Surry SAMA analysis in 2001. Therefore, the offsite consequences of severe accidents initiated by the new source term during the subsequent license renewal term would not exceed the impacts predicted in the GEIS. For these issues, the GEIS predicts that the impacts would be small for all nuclear plants. The NRC staff identified no new and significant information regarding internal events during its review of Dominion's environmental report, 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 Surry concerning offsite consequences of severe accidents initiated by internal events that would alter the conclusions reached in the 2013 GEIS.

F.3.4 Power Uprate Information (Section E.3.4 of the 2013 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, this larger source term could result in higher doses to offsite populations.

Large early release frequency (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 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 GEIS, Section E.3.4.3, "Conclusion," determines that power uprates 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 GEIS, the increases would be bounded by the 95 percent upper confidence bound values in Table 5.10 and Table 5.11 of the 1996 GEIS.

In 2010, the NRC approved a 1.6 percent measurement uncertainty recapture (MUR), from 2,546 megawatts thermal (MWt) to 2,587 MWt (NRC 2010). The change in plant risk due to the MUR power uprate is insignificant. This determination is supported by NRC Regulatory Issue Summary (RIS) 2002-03, "Guidance on the Content of Measurement Uncertainty Recapture Power Uprate Applications" (NRC 2002c). The NRC staff's safety evaluation report for the MUR power uprate concluded that the CLB dose consequence analyses for design-basis accidents will remain bounding at the proposed MUR uprated power level with a margin that is within the assumed uncertainty associated with the leading-edge flow meter system (NRC 2010). Therefore, the offsite consequences from the power uprate would not exceed the impacts predicted in the 2013 GEIS. For these issues, the GEIS predicted that the impacts would be small to moderate for all nuclear plants. The NRC staff has identified no new and significant information regarding power uprates during its review of Dominion's environmental report, 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 Surry concerning offsite consequences due to power uprates that would alter the conclusions reached in the 2013 GEIS.

F.3.5 Higher Fuel Burnup Information (Section E.3.5 of the 2013 GEIS)

According to the 2013 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 BWRs, results in small to moderate increases (up to 38 percent) in environmental impacts in the event of a severe accident. However, taken in combination with the other information presented in the 2013 GEIS, the increases would be bounded by the 95 percent upper confidence bound values in Table 5.10 and Table 5.11 of the 1996 GEIS.

Dominion operates the reactors at an equilibrium core maximum fuel discharge burnup rate of 62 GWd/MTU (Dominion 2018c). Therefore, the offsite consequences from higher fuel burnup would not exceed the impacts predicted in the 2013 GEIS. For these issues, the GEIS predicted that the impacts would be small for all nuclear plants. The NRC staff identified no new and significant information regarding higher fuel burnup during its review of Dominion's environmental report, 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 Surry concerning offsite consequences due to higher fuel burnup that would alter the conclusions reached in the 2013 GEIS.

F.3.6 Low Power and Reactor Shutdown Event Information (Section E.3.6 of the 2013 GEIS)

The 2013 GEIS concludes that the environmental impacts from accidents at low-power and shutdown conditions are generally comparable to those from accidents at full power, based on a comparison of the values in NUREG/CR-6143, "Evaluation of Potential Severe Accidents During Low Power and Shutdown Operations at Grand Gulf, Unit 1" (NRC 1995a), and NUREG/CR-6144, "Evaluation of Potential Severe Accidents During Low Power and Shutdown Operations at Surry, Unit 1" (NRC 1995b), with the values in NUREG-1150, "Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants" (NRC 1990b). The 1996 GEIS estimates of the environmental impact of severe accidents bound the potential impacts from accidents at low power and shut down, with margin. Surry was evaluated in NUREG-1150 and NUREG/CR-6144; thus, there are no plant configurations in low power and shutdown conditions that would distinguish Surry from the evaluated plants such that the assumptions in the 2013 and 1996 GEISs would not apply.

Finally, as discussed in SECY-97-168, "Issuance for Public Comment of Proposed Rulemaking Package for Shutdown and Fuel Storage Pool Operation" (NRC 1997), industry initiatives taken during the early 1990s have also contributed to the improved safety of low-power and shutdown operations for all plants. Therefore, the offsite consequences of severe accidents, considering low-power and reactor shutdown events, would not exceed the impacts predicted in either the 1996 or 2013 GEIS. For these issues, the GEIS predicts that the impacts would be small for all nuclear plants. The NRC staff identified no new and significant information regarding low-power and reactor shutdown events during its review of Dominion's environmental report, 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 Surry concerning low-power and reactor shutdown events that would alter the conclusions reached in the 2013 GEIS.

F.3.7 Spent Fuel Pool Accident Information (Section E.3.7 of the 2013 GEIS)

The 2013 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)), can be comparable to those from reactor accidents at full power (as estimated in NUREG-1150 (NRC 1990b)). Subsequent analyses performed, and mitigative measures employed since 2001, have further lowered the risk of accidents involving spent fuel pools. In addition, 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 GEIS. Therefore, the environmental impacts stated in the 1996 GEIS bound the impact from spent fuel pool accidents for all plants. For these issues, the GEIS predicts that the impacts would be small for all nuclear plants. There are no spent fuel configurations that would distinguish Surry from the evaluated plants such that the assumptions in the 2013 and 1996 GEISs would not apply. The NRC staff identified no new and significant information regarding spent fuel pool accidents during its review of Dominion's environmental report, 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 Surry concerning spent fuel pool accidents that would alter the conclusions reached in the 2013 GEIS.

F.3.8 Use of Biological Effects of Ionizing Radiation (BEIR) VII Risk Coefficients (Section E.3.8 of the 2013 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: Biological Effects of Ionizing Radiation (BEIR) VII, Phase 2" (NRC 2005). The 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). 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 Surry's subsequent license renewal term. This general topic is discussed further in the NRC's 2007 denial of Petition for Rulemaking (PRM)-51-11 (NRC 2007), in which the NRC states that it finds no need to modify the 1996 GEIS considering the BEIR VII report. For these issues, the GEIS predicts that the impacts of using the BEIR VII risk coefficients would be small for all nuclear plants.

The NRC staff identified no new and significant information regarding the risk coefficient used in the BEIR VII report during its review of Dominion's environmental report, 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 Surry concerning the biological effects of ionizing radiation that would alter the conclusions reached in the 2013 GEIS.

F.3.9 Uncertainties (Section E.3.9 of the 2013 GEIS)

Section 5.3.3 in the 1996 GEIS provides a discussion of the uncertainties associated with the analysis in the GEIS and in the individual plant EISs used to estimate the environmental impacts of severe accidents. The 1996 GEIS used 95th percentile upper confidence bound estimates whenever 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 GEIS. Many of these same uncertainties also apply to the analysis used in the 2013 GEIS update. As discussed in Sections E.3.1 through E.3.8 of the 2013 GEIS, the GEIS update used more recent information to supplement the estimate of environmental impacts contained in the 1996 GEIS. In effect, the assessments contained in Sections E.3.1 through E.3.8 of the 2013 GEIS provided additional information and insights into certain areas of uncertainty associated with the 1996 GEIS. However, as provided in the 2013 GEIS, the impact and magnitude of uncertainties, as estimated in the 1996 GEIS, bound the uncertainties introduced by the new information and considerations addressed in the 2013 GEIS. Accordingly, in the 2013 GEIS, the NRC staff concluded that the reduction in environmental impacts resulting from the use of new information (since the 1996 GEIS analysis) outweighs any increases in impact resulting from the new information. As a result, the findings in the 1996 GEIS remain valid. The NRC staff identified no new and significant information regarding uncertainties during its review of Dominion's environmental report, 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 Surry concerning uncertainties that would alter the conclusions reached in the 2013 GEIS.

Section E.3.9.2 of Appendix E to the 2013 GEIS discusses the impact of population increases on offsite dose and economic consequences. The 2013 GEIS, in Section E.3.9.2, 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 EIs 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.

The population used in the Surry initial license renewal ER (Dominion 2001b, Section 4.20) was extrapolated to the year 2030 and found to be 3,365,040. Dominion extrapolated this population to the year 2053 (Dominion 2018b). The total population projected for the year 2053 is 4,425,681. This updated data show that the population is estimated to increase by 32 percent during this period (2030–2053). Dominion's estimated population increase is slightly above the 30 percent range determined by the NRC in the 2013 GEIS to be not significant. However, as discussed in Section E.3.3 of the 2013 GEIS and in this SEIS, more recent estimates give significantly lower release frequencies and release fractions for the source term than was assumed in the 1996 GEIS. Specifically, the 2013 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 GEIS values." Thus, the effect of this reduction in total dose impacts far exceeds the effect of a population increase. The staff concludes that the effect of increased population around the plant does not result in significant increases in impacts. Thus, the staff concludes that no new and significant information exists for Surry concerning population increase that would alter the conclusions reached in the 2013 GEIS.

F.3.10 Summary and Conclusion (Section E.5 of the 2013 GEIS)

The 2013 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.

Areas of new and significant information that can result in the first effect (decrease the environmental impacts associated with severe accidents) at Surry include:

- new internal events information (significant decrease)
- new source term information (significant decrease)
- population (population dose decreases when using more recent studies)

Areas of new and significant information that can result in the second effect (no effect on the environmental impact associated with severe accidents) or the third effect (increase the environmental impact associated with severe accidents) include:

- Use of BEIR VII risk coefficients
- Consideration of external events (comparable to internal event impacts)
- Spent fuel pool accidents (could be comparable to full-power event impacts)
- Higher fuel burnup (small to moderate increases)
- Low power and reactor shutdown events (could be comparable to full-power event impacts)

The 2013 GEIS states, "[g]iven the difficulty in conducting a rigorous aggregation of these results with the differences in the information sources utilized, a fairly simple approach is taken." The GEIS estimated the net increase from the five areas listed above would be (in a simplistic sense) approximately an increase by a factor of 4.7. At the same time, however, for Surry, the reduction in risk due to newer internal event information alone is a decrease in risk by a factor of 14. The net effect of an increase by a factor of 4.7 and a decrease by a factor of 14 would be an overall lower estimated impact (as compared to the 1996 GEIS assessment) by a factor of 9.3. Thus, the NRC staff finds that there is no new and significant information related to severe accidents at Surry that would alter the conclusions reached in the 2013 GEIS.

Other areas of new information relating to Surry 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 GEIS and Dominion's ER, because they result in further reductions in the impact of a severe accident.

F.4 Other New Information Related to NRC Efforts to Reduce Severe Accident Risk Following Publication of the 1996 GEIS

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. 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 in Appendix B to Subpart A of 10 CFR Part 51, the Commission explained in a *Federal Register* notice:

> The Commission has considered containment improvements for all plants pursuant to its Containment Performance Improvement (CPI) 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 (June 5, 1996)).

These "additional ongoing regulatory programs" that the Commission mentioned include the IPE and the IPEEE program, which consider "potential improvements to reduce the frequency or consequences of severe accidents on a 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). 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" (61 FR 28481). 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 plants for which it had not done so previously, pending further rulemaking on this issue (61 FR 28481).

The Commission reaffirmed its SAMA-related conclusions in Table B-1 of Appendix B to Subpart A of 10 CFR Part 51 and 10 CFR 51.53(c)(3)(ii)(L), in *Exelon Generation Co., LLC* (Limerick Generating Station, Units 1 and 2), CLI-13-07, (October 31, 2013) (ADAMS Accession No. ML13304B417). 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 2013b).

The NRC has continued to address severe accident-related issues since the agency published the GEIS in 1996. Combined NRC and licensee efforts have reduced risks from accidents beyond those accidents that were considered in the 1996 GEIS. The 2013 GEIS describes many of those efforts (NRC 2013a). In some cases, such as the NRC's response to the accident at Fukushima, these activities are still ongoing. In the remainder of Section F.4 of this SEIS, the NRC staff describes efforts to reduce severe accident risk (CDF and LERF) following publication of the 1996 GEIS. Each of these initiatives applies to all reactors, including Surry. Section F.4.1 describes requirements adopted following the terrorist attacks in September 2001, to address the loss of large areas of a plant caused by fire or explosions. Section F.4.2 describes the SOARCA project, which indicates that source term timing and magnitude values may be significantly lower than source term values quantified in previous studies using other analysis methods. Section F.4.3 describes measures adopted following the Fukushima earthquake and tsunami events of 2013. Section F.4.4 discusses efforts that have been made to use plant operating experience to improve plant performance and design features. These are areas of new information that reinforce the conclusion that the probability-weighted consequences of a severe accident are SMALL for all plants, as stated in the 2013 GEIS, and further reduce the likelihood of finding a cost-beneficial SAMA that would substantially reduce the severe accident risk at Surry.

F.4.1 10 CFR 50.54(hh)(2) Requirements Regarding Loss of Large Areas of the Plant Caused by Fire or Explosions

As discussed on page E-7 of the 2013 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 plant due to explosions or fires, including those that an aircraft impact might create. For example, the Commission issued Order EA-02-026, "Interim Compensatory Measures (ICM) Order." The ICM Order provided interim safeguards and security compensatory measures, and ultimately led to the promulgation of a new regulation in 10 CFR 50.54(hh). 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. In accordance with 10 CFR 50.54(hh)(2), 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 plant due to explosion or fire (NRC 2013 GEIS).

NRC requirements pertaining to plant security are subject to NRC oversight on an ongoing basis under a plant's current operating license and are beyond the scope of license renewal. As discussed in Section 5.3.3.1 of the 1996 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. However, the implementation of measures that reduce the risk of severe accidents, including measures adopted to comply with 10 CFR 50.54(hh), also have a beneficial impact on the level of risk evaluated in a SAMA analysis, the purpose of which is to identify potentially cost-beneficial design alternatives, procedural modifications, or training activities that may further reduce the risks of severe accidents. Dominion has updated Surry's guidelines, strategies, and procedures to meet the requirements of 10 CFR 50.54(hh); therefore, those efforts have contributed to mitigation of the risk of a beyond-design-basis event. Accordingly, actions taken by Dominion to comply with those regulatory requirements have further contributed to the reduction of risk at Surry.

In sum, the new information regarding actions that Dominion has taken to prepare for potential loss of large areas of the plant due to fire or explosions has further contributed to the reduction of severe accident risk at Surry. Thus, this information does not alter the conclusions reached in the 2013 GEIS regarding the consequences of a severe accident.

F.4.2 State-of-the-Art Reactor Consequence Analysis

The 2013 GEIS notes that a significant NRC effort is ongoing to re-quantify realistic severe accident source terms under the State-of-the-Art Reactor Consequence Analysis (SOARCA) project. Preliminary results indicate that source term timing and magnitude values quantified using SOARCA may be significantly lower than source term values quantified in previous studies using other analysis methods (NRC 2008). The NRC staff plans to incorporate this new information regarding source term timing and magnitude using SOARCA in future revisions of the GEIS.

The NRC has completed a SOARCA study for Surry (NRC 2013f). The Surry SOARCA summary concludes that with SOARCA, the NRC has achieved its objective of developing a body of knowledge regarding detailed, integrated, state-of-the-art modeling of the more important severe accident scenarios for 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”). As a result, the calculated risks of public health consequences of severe accidents modeled in SOARCA are very small.

This new information regarding the SOARCA project’s findings has further contributed to the reduction of the calculated severe accident risk at Surry, as compared to the 1996 GEIS and the Surry SAMA evaluation for the initial license renewal application in 2001. Thus, the NRC staff finds there is no new and significant information related to Surry SAMAs that would alter the conclusions reached in the 2013 GEIS.

F.4.3 Fukushima-Related Activities

As discussed in Section E.2.1 of the 2013 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. This event damaged the six-unit Fukushima Dai-ichi 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 2013a).

As further discussed in Section E.2.1 of the 2013 GEIS, in response to the earthquake, tsunami, and resulting reactor accidents at Fukushima Dai-ichi (hereafter referred to as the Fukushima events), the Commission directed the NRC staff to convene an agency task force of senior leaders and experts to conduct a methodical and systematic review of NRC regulatory requirements, programs, and processes (and their implementation) relevant to the Fukushima event. After thorough evaluation, the NRC required significant enhancements to U.S. commercial nuclear power plants. The enhancements included: adding capabilities to maintain key plant safety functions following a large-scale natural disaster, updating evaluations on the potential impact from seismic and flooding events, adding new equipment to better handle potential reactor core damage events, and strengthening emergency preparedness capabilities. Further information regarding this matter is presented in the 2013 GEIS and on the NRC's Web page for Fukushima-related actions at https://www.nrc.gov/reactors/operating/ops-experience/post-fukushima-safety-enhancements.html.

In sum, the Commission has imposed additional safety requirements on operating reactors, including Surry, following the Fukushima accident (as described in the preceding paragraphs). The new regulatory requirements have further contributed to the reduction of severe accident risk at Surry. Therefore, the NRC staff concludes that there is no new and significant information related to the Fukushima events that would alter the conclusions reached in the 2013 GEIS or Surry's previous SAMA analysis.

F.4.4 Operating Experience

Section E.2 of the 2013 GEIS mentions the considerable operating experience that supports the safety of U.S. nuclear power plants. As with the use of any technology, greater user experience generally leads to improved performance and improved safety. Additional experience at nuclear power plants has contributed to improved plant performance (e.g., as measured by trends in plant-specific performance indicators), a reduction in adverse operating events, and new lessons learned that improve the safety of all the operating nuclear power plants.

In sum, the new information related to NRC efforts to reduce severe accident risk described above contribute to improved safety, as do safety improvements not related to license renewal, including the NRC and industry response to generic safety issues (e.g., Generic Safety Issue 191, "Assessment of Debris Accumulation on PWR Sump Pump Performance"). Thus, the performance and safety record of nuclear power plants operating in the United States, including Surry, continue to improve. This improvement is also confirmed by analysis which indicates that, in many cases, improved plant performance and design features have resulted in reductions in initiating event frequency, CDF, and containment failure frequency (NRC 2013a).

Conclusion

As discussed above, the NRC and the nuclear industry have addressed and continue to address numerous severe accident-related issues since the publication of the 1996 GEIS and the 2001 Surry SAMA analysis. These actions reinforce the conclusion that the probability-weighted consequences of a severe accident are SMALL for all plants, as stated in the 2013 GEIS, and further reduce the likelihood of finding a cost-beneficial SAMA that would substantially reduce the severe accident risk at Surry.

F.5 Evaluation of New and Significant Information Pertaining to SAMAs Using NEI 17-04, "Model SLR New and Significant Assessment Approach for SAMA"

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 consequences (risk) of a severe accident occurring (NRC 2013a).

As discussed earlier in Section F.2.2, Dominion stated in its environmental report submitted as part of its subsequent license renewal application that it used the methodology in NEI 17-04, “Model SLR New and Significant Assessment Approach for SAMA,” dated June 29, 2017 (NEI 2017), to evaluate new and significant information as it relates to the Surry subsequent license renewal SAMAs. By letter dated January 31, 2018, the staff reviewed NEI 17-04 and found it acceptable for interim use, pending formal NRC endorsement of NEI 17-04 by incorporation in RG 4.2, Supplement 1, “Preparation of Environmental Reports for Nuclear Power Plant License Renewal Applications” (NRC 2018d). In general, as discussed earlier, the NEI 17-04 methodology (NEI 2017) 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 RG 4.2, Supplement 1 (NRC 2013a).

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 subsequent license renewal 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 plant and (2) those SAMAs identified as potentially cost beneficial for other U.S. nuclear power plants and which are applicable to the analyzed plant. If one or more of those SAMAs are shown to reduce the maximum benefit by 50 percent or more, then 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 subsequent license renewal 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 subsequent license renewal applicant performs a cost-benefit analysis for the “potentially significant” SAMAs identified in Stage 2.

The following sections describe Dominion’s application of the NEI 17-04 methodology to Surry SAMAs. After completing Stage 1 of the “new and significant information” assessment process, some previously unimplemented, potentially cost-beneficial SAMAS were carried to Stage 2. An update (including population projections) to the Surry Level 3 PRA was performed, yielding new consequence results for each source term category. Following the methodology from NUREG/BR-0184 and utilizing updated guidance for the cost per person-rem from the draft NUREG-1530, an updated maximum benefit was calculated for Surry. The percentage reduction in maximum benefit was then calculated for each SAMA in Stage 2. Utilizing bounding PRA evaluations to evaluate these cases, none of the proposed SAMAs resulted in a reduction in MB of at least 50 percent. As a result, Dominion concluded it is not required to perform the Stage 3 evaluations for any SAMAs (Dominion 2018b).

F.5.1 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 Surry subsequent license renewal, the NRC staff reviewed the onsite information during an audit at NRC headquarters and determined that Dominion had considered the appropriate information (NRC 2019e).

F.5.2 Stage 1 and 2 Assessment

Section E4.15.3, “Methodology for Evaluation of New and Significant SAMAs,” of Dominion’s environmental report describes the process it used to identify any potentially new and significant SAMAs from the 2001 SAMA analysis (Dominion 2018b). In Stage 1 of the process, Dominion 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 Surry

(2) those SAMAs identified as potentially cost beneficial for other U.S. nuclear power plants and that are applicable to Surry (Dominion 2018b)

F.5.3 Dominion’s Evaluation of Unimplemented Surry “Phase 2” SAMAs

In 2001, Dominion submitted an application for initial operating license renewal (Dominion 2001a), which the NRC approved in 2002 as described above in Section F.2.1. As part of the subsequent license renewal application, Dominion examined its initial license renewal SAMA analysis and the Surry probabilistic risk assessment again, for insights. The purpose was to determine if there was any new and significant information regarding the initial Surry SAMA analyses that were performed to support issuance of the initial renewed operating licenses for Surry. Dominion re-evaluated the 53 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 Surry, or already exist at Surry. In addition, two other screening criteria were applied to eliminate SAMAs that have excessive cost. First, SAMAs were screened if they were found to reduce the Surry MB by greater than 50 percent in the first Surry license renewal but also found not to be cost-effective due to high cost in the first license renewal. Second, one SAMA (filtered containment vent) was screened due to excessive cost because this plant modification has been evaluated industry-wide and explicitly found to not be cost-effective in Westinghouse large/dry containments like the containments at Surry.

The remaining SAMAs were then grouped (if similar) based on similarities in mitigation equipment or risk-reduction benefits, and all were evaluated for the impact they have on the Surry CDF and source term category frequencies if implemented. If any of the SAMAs were found to reduce the total CDF or at least one source term category frequency by at least 50 percent, then the SAMA was retained for a Stage 2 assessment (full Level 3 PRA evaluation of the reduction in maximum benefit).

F.5.4 Dominion Evaluation of SAMAs Identified as Potentially Cost Beneficial at Other U.S. Nuclear Power Plants and Which Are Applicable to Surry

The 2013 GEIS (NRC 2013a) considered the plant-specific supplemental EISs that document potential environmental impacts and mitigation measures for severe accidents relevant to license renewal for each plant. Some of these plant-specific supplements had identified potentially cost-beneficial SAMAs. Dominion reviewed the SEISs of plants with a similar design to Surry (PWR Large/Dry Containments), to identify 269 potentially cost-beneficial SAMAs from other plants. The industry SAMAs included 240 relating to internal events and 29 relating to external events. This large list of industry SAMAs was qualitatively screened using the criteria that a potential SAMA is either not applicable to the Surry design or the SAMA has already been implemented at Surry. Dominion grouped the remaining SAMAs based on similarities in mitigation equipment or risk reduction benefits. Thus, Dominion evaluated 53 Surry-specific SAMAs and 269 potentially cost-beneficial SAMAs identified at similarly designed nuclear power plants (industry SAMAs) for a total of 322 SAMAs.

Section E4.15.4 of Dominion's subsequent license renewal environmental report provides the Surry Stage 1 and 2 evaluations, 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 Surry-specific SAMAs collected from initial license renewal, with similar SAMAs grouped together 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. Qualitative and quantitative screening of the plant-specific and industry SAMAs, along with binning of similar SAMAs, reduced the total number of SAMAs requiring further evaluation in Stage 2 to 19 SAMAs. Table E4.15-1 of Dominion's environmental report presents the SAMAs that were neither qualitatively nor quantitatively screened. Specifically, Dominion quantitatively screened SAMAs if the bounding Surry-specific case yielded a reduction of less than 50 percent in the frequency of each source term category group or the CDF.

A Stage 2 assessment was then performed in Surry ER Section E.15.4.3, in which the Level 3 PRA was conservatively updated and calculations of reduction in MB were performed. The analyses of each SAMA are presented in the Surry ER Sections E4.15.4.4 and E4.15.5, respectively. In the Stage 2 assessment, the screened-in SAMAs are evaluated further to calculate the reduction in MB resulting from implementation of each SAMA. The calculations of conditional dose and cost for each source term category are derived from the Level 3 PRA results calculated in ER Section E4.15.4.4.

The baseline risk result from the Level 3 PRA analysis is the maximum risk reduction that can be attained from any modification that can be devised; this risk value is the MB. It represents the benefit if the entire frequency of all source term categories were reduced to zero (i.e., the risk is assumed to be completely eliminated by SAMA implementation). The methodology used for this evaluation was based upon the NRC's guidance for the performance of cost-benefit analyses in NUREG/BR-0184.

Dominion determined the maximum benefit to be $1,135,942. Table E4.15-2 summarizes the estimated bounding reductions in the MB (expressed as percentage) for the screened-in Stage 2 SAMAs and indicates that they ranged from 0 percent to 41 percent. Because implementation of none of the unscreened SAMAs results in a reduction in MB of at least 50 percent, complete Stage 3 cost-benefit analyses are not required for the Surry SLR in accordance with the methodology in NEI 17-04.

A conservative, bounding update to the Surry Level 3 PRA was performed, yielding new consequence results for each source term category. Following the methodology from NUREG/BR-0184 and utilizing updated guidance for the cost per person-rem from draft NUREG-1530, Revision 1, an updated MB was calculated for Surry. The percentage reduction in MB was then calculated for each SAMA in Stage 2. Utilizing conservative, bounding PRA evaluations to evaluate these cases, none of the proposed SAMAs resulted in a reduction in MB of at least 50 percent. Therefore, Dominion concluded that a Stage 3 assessment is not needed and there is no new and significant information that would alter the conclusions of the original SAMA analysis for Surry (Dominion 2018b).

The NRC staff reviewed Surry's onsite information and its SAMA Stage 1 and Stage 2 process, during an in-office audit at NRC headquarters (NRC 2019e). The staff found that Dominion 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 Dominion properly concluded, in accordance with the NEI 17-04 guidance, that it did not need to conduct a Stage 3 assessment.

F.5.5 Other New Information

As discussed in Dominion's subsequent license renewal application environmental report and in NEI 17-04, there are some inputs to the SAMA analysis that are expected to change or to potentially change for all plants. Examples of these inputs include the following:

- 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-mile (80-km) radius of the 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 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 plant risk model (e.g., a fire probabilistic risk assessment that replaces the individual plant examination of external events (IPEEE) analysis).
- Impacts of plant changes that are included in the plant risk models will be reflected in the model results and do not need to be assessed separately.

- Nonmodeled modifications to the plant.
  - Modifications determined to have no risk impact need not be included (e.g., replacement of the condenser vacuum pumps), unless they impact a specific input to SAMA (e.g., new low-pressure turbine in the power conversion system that results in a greater net electrical output).

Offsite consequence codes used for the Level 3 PRA in SAMA analyses consider plant-specific inputs as provided above. As described in Section D.5.4, a Stage 2 assessment was performed in which the Level 3 PRA was updated and calculations of reduction in MB were performed. For SAMAs that are screened-in in Section E4.15.4, the Level 3 PRA developed for the initial Surry license renewal SAMA is updated (Section E4.15.4.4), and the MB calculated in detail using the current Surry PRA model of record which was described in Surry ER Section E4.15.5. Section E4.15.4.3 of the Surry ER describes the assumptions and inputs of the Level 3 modeling in the Stage 2 assessment, including population, meteorological, and economic inputs. Section E4.15.4.3 also provides a description of the data associated with the source term category frequency and source term release fraction data. Again, the criterion for a SAMA being potentially significant was whether it reduces the total MB by at least a factor of two (i.e., by at least 50 percent). For Surry, all SAMAs were found to not meet the criteria for "new and significant information" in Stage 2. If such a SAMA had been identified, the final determination of significance for the new information causing this result would have been made in a Stage 3 assessment. The Stage 3 assessment would have determined whether implementing the SAMA would be potentially cost beneficial.

The NEI methodology described in NEI 17-04 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 2005b), 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 NEI 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 NRC staff finds the criterion of exceeding a 50-percent reduction in the maximum benefit a reasonable significance value because its correlates with significance determinations in the American Society of Mechanical Engineers and American Nuclear Society PRA standard (cited in Regulatory Guide (RG) 1.200) (ASME/ANS 2009; NRC 2009), NUMARC 93-01, "Industry Guideline for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants" (NRC endorsed in RG 1.160) (NEI 2018; NRC 2018e) and NEI 00-04, "10 CFR 50.69 SSC Categorization Guideline" (endorsed in RG 1.201) (NEI 2005a; NRC 2006), 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). Furthermore, it is consistent with the criteria that the NRC staff accepted in the Limerick Generating Station license renewal final supplemental environmental impact statement (NRC 2014b). The NRC staff finds the approach in NEI 17-04 to be reasonable because, with respect to SAMAs, new information may be significant if it indicates 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.5.6 Conclusion

As described above, Dominion evaluated a total of 322 SAMAs for Surry subsequent license renewal and did not find any SAMAs that would reduce the maximum benefit by 50 percent or more. Dominion concluded that further SAMA analysis was not required based on the guidance in NEI 17-04. The NRC staff reviewed Dominion's evaluation and concludes that Dominion's methods and results were reasonable. Based on Surry's Phase 1 qualitative and quantitative screening results, and Phase 2 analysis, Dominion demonstrated that none of the plant-specific and industry SAMAs that it considered constitute new and significant information in that none changed the conclusion of Surry'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 Surry. Therefore, the NRC staff concludes that there is no new and significant information that would alter the conclusions of the SAMA analysis performed for Surry's initial license renewal.

The NRC staff reviewed Dominion's new and significant information analysis for severe accidents and SAMAs at Surry during the subsequent license renewal period and finds Dominion's analysis and methods to be reasonable. Given the low residual risk at Surry, the substantial decrease in CDF at Surry from the previous SAMA analysis, and the fact that no potentially cost-beneficial SAMAs were identified during Surry's initial license renewal review, the staff considers it unlikely that Dominion would have found any potentially cost-beneficial SAMAs for subsequent license renewal. Further, Dominion's implementation of actions to satisfy the NRC's orders and regulatory requirements regarding beyond-design-basis events after the September 11, 2001, terrorist attacks and Fukushima events, as well as the conservative assumptions used in earlier severe accident studies and SAMA analyses, also made it unlikely that Dominion would have found any potentially significant cost-beneficial SAMAs during its subsequent license renewal review. For all the reasons stated above, the NRC staff concludes that Dominion reached reasonable SAMA conclusions in its subsequent license renewal environmental report 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 Surry.

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T. Tran

11. ABSTRACT (200 words or less)

The U.S. Nuclear Regulatory Commission staff prepared this draft supplemental environmental impact statement (SEIS) as part of its environmental review of Dominion Energy Virginia's application to renew the operating licenses for Surry Power Station, Units 1 and 2 (Surry) for an additional 20 years. This draft SEIS includes the NRC staff's preliminary evaluation of the environmental impacts of the license renewal and alternatives to license renewal. Alternatives considered include: (1) a new nuclear (Small Modular Reactor) generation alternative, (2) a natural gas combined cycle power plant, and (3) a combination of natural gas combined cycle power plant, solar, and demand-side management. The NRC staff's preliminary recommendation is that the adverse environmental impacts of license renewal for Surry are not so great that preserving the option of license renewal for energy planning decisionmakers would be unreasonable.

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