CHAPTER 5
ENVIRONMENTAL IMPACTS OF STATION OPERATION

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ACRONYMS AND ABBREVIATIONS

°C	degrees Celsius
°F	degrees Fahrenheit
7Q10	7-day, 10-year low flow
AADT	average annual daily traffic
AC	alternating current
ac.	acre
ac-ft	acre-foot
AEA	Atomic Energy Act
ALARA	As Low As Reasonably Achievable
AP1000	Westinghouse Electric Company, LLC's AP1000 Reactor
BLS	Bureau of Labor Statistics
BMP	best management practice
BOD	biochemical oxygen demand
BTA	best technology available
BWR	boiling water reactor
CAA	Clean Air Act
CANDU	Atomic Energy of Canada, Limited's Advanced CANDU Reactor
CDC	Centers for Disease Control and Prevention
CDM	Camp Dresser & McKee, Inc.
CESQG	Conditionally Exempt Small-Quantity Generator

ACRONYMS AND ABBREVIATIONS (CONTINUED)

CFR	Code of Federal Regulations
CFRBHM	Cape Fear River Basin Hydrologic Model
cm	centimeter
COL	Combined License
COLA	Combined License Application
CP&L	Carolina Power & Light Company
Ci/yr	Curies per year
CWA	Clean Water Act
CWIS	cooling water intake structure
CWS	circulating water system
D&D	decontamination and dismantlement
dBA	decibel (A-weighted scale)
DCD	Westinghouse Electric Company, LLC, AP1000 Design Control Document
DSN	discharge serial number
EAB	exclusion area boundary
EHV	extra high voltage
EMF	electromagnetic field
EPRI	Electric Power Research Institute
EPZ	emergency planning zone
ER	Environmental Report
ESP	Early Site Permit

ACRONYMS AND ABBREVIATIONS (CONTINUED)

ESRP	Environmental Standard Review Plan
FDA	U.S. Food and Drug Administration
FEIS	Final Environmental Impact Statement
fps	feet per second
FSAR	Final Safety Analysis Report
ft^3/year	cubic feet per year
ft^3/s	cubic feet per second
GAE	granulomatous amoebic encephalitis
GEIS	Generic Environmental Impact Statement for License Renewal of Nuclear Plants
gpcd	gallon per capita per day
gpd	gallon per day
gpm	gallon per minute
GPS	global positioning system
G.S.	General Statute
ha	hectare
HAR	proposed Shearon Harris Nuclear Power Plant Units 2 and 3
HAR 2	proposed Shearon Harris Nuclear Power Plant Unit 2
HAR 3	proposed Shearon Harris Nuclear Power Plant Unit 3
HEEC	Harris Energy & Environmental Center
HLW	high-level waste
HNP	existing Shearon Harris Nuclear Power Plant Unit 1
hr/yr	hour per year

ACRONYMS AND ABBREVIATIONS (CONTINUED)

Hz	hertz
IAEA	International Atomic Energy Agency
ICRP	International Council on Radiation Protection
in.	inch
IEEE	Institute of Electrical and Electronics Engineers
IVM	Integrated Vegetation Management
kg	kilogram
kg/cm^2	kilogram per square centimeter
kg/ha/mo	kilogram per hectare per month
kg/ha/yr	kilogram per hectare per year
kg/yr	kilogram per year
km	kilometer
km^2	square kilometer
kV	kilovolt
l/min	liter per minute
l/yr	liter per year
lb.	pound
lb/ac/mo	pound per acre per month
lb/ac/yr	pound per acre per year
LLW	low-level waste
lpcd	liter per capita per day
lpd	liter per day
LPZ	low population zone

ACRONYMS AND ABBREVIATIONS (CONTINUED)

LWR	light-water-cooled reactor
m	meter
m^3	cubic meter
m^3/s	cubic meter per second
m^3/year	cubic meter per year
MDD	maximum day demand
MEI	Maximally Exposed Individual
mgd	million gallons per day
mg/L	milligram per liter
mi.	mile
$mi.^2$	square mile
mld	million liters per day
MOU	Memorandum of Understanding
mps	meter per second
mrad	millirad
mrem/yr	millirem per year
MSDS	material safety data sheet
msl	mean sea level
MT	millions of metric tons
MWd/MTU	megawatt days per metric ton of Uranium
MW	megawatt
MWe	megawatt electric
MWt	megawatt thermal

ACRONYMS AND ABBREVIATIONS (CONTINUED)

MW-yr	megawatt year
NANRC	National Academies’ National Research Council
NAS	National Academy of Sciences
NC	North Carolina
NCAC	North Carolina Administrative Code
NC CGIA	North Carolina Center for Geographic Information and Analysis
NCDC	National Climatic Data Center
NCDENR	North Carolina Department of Environment and Natural Resources
NCDOC	North Carolina Department of Commerce
NCDOT	North Carolina Department of Transportation
NCDWQ	North Carolina Division of Water Quality
NCDWR	North Carolina Division of Water Resources
NCNHP	North Carolina Natural Heritage Program
NCSHPO	North Carolina State Historic Preservation Office
NCWRC	North Carolina Wildlife Resources Commission
NDE	Non-Destructive Examination
NESC	National Electrical Safety Code
NHPA	National Historic Preservation Act
NMMA	National Marine Manufacturers Association
NOAA	National Oceanic and Atmospheric Administration
NO_x	nitrogen oxides
NPDES	National Pollutant Discharge Elimination System

ACRONYMS AND ABBREVIATIONS (CONTINUED)

NPSH	net positive suction head
NRC	U.S. Nuclear Regulatory Commission
NSSS	Nuclear Steam Supply System
O&M	operation and maintenance
ORNL	Oak Ridge National Laboratory
OSHA	Occupational Safety and Health Administration
PAM	primary amoebic meningoencephalitis
PEC	Progress Energy Carolinas, Inc.
ppm	parts per million
PPWMP	Pollution Prevention and Waste Minimization Program
psi	pounds per square inch
PWR	pressurized water reactor
RAT	Reserve Auxiliary Transformer
RCRA	Resource Conservation and Recovery Act
rem	Roentgen equivalent man
RFI	Request for Information
RI	radio interference
RO	reverse osmosis
ROW	right-of-way
RR	Reference Reactor
RRY	Reference Reactor Year
RTP	Research Triangle Park
S&L	Sargent & Lundy, LLC

ACRONYMS AND ABBREVIATIONS (CONTINUED)

SESCP	soil erosion and sediment control plan
SMZ	streamside management zone
SO_x	sulphur oxide
SPCC	Spill Prevention, Control, and Countermeasures
SQG	Small Quantity Generator
SSC	structure, system, and component
SU	standard unit
SWPPP	Stormwater Pollution Prevention Plan
SWS	service water cooling system
TEDE	total effective dose equivalent
TIA	transportation impact analysis
TMDL	total maximum daily load
TRC	total residual chlorine
TRU	transuranic
TSD	treatment, storage, and disposal
TSS	total suspended solids
TVI	television interference
UDO	Unified Development Ordinance
UFC	Uranium Fuel Cycle
USACE	U.S. Army Corps of Engineers
U.S.C.	United States Code
USDOE	U.S. Department of Energy
USDOL	U.S. Department of Labor

ACRONYMS AND ABBREVIATIONS (CONTINUED)

USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WCPSS	Wake County Public School System
Westinghouse	Westinghouse Electric Company, LLC
WP	Worley Parsons
WRF	water reclamation facility
WTP	water treatment plant
WWTP	wastewater treatment plant
yoy	young-of-the-year

5.0 ENVIRONMENTAL EFFECTS OF STATION OPERATION

This chapter evaluates the environmental impacts related to the operation of the proposed Shearon Harris Nuclear Power Plant Units 2 and 3 (HAR) and several appurtenant facilities (Figure 4.0-1). These appurtenant facilities include electric transmission lines, an electric switchyard, modifications to the dam at Harris Reservoir, the Harris Lake makeup water system intake structure and pumphouse, the Harris Lake makeup water system pipeline, a discharge structure on Harris Reservoir, and blowdown pipelines from HAR 2 and HAR 3 to be installed in the Harris Reservoir in parallel with the existing blowdown pipeline for Unit 1.

For the purposes of this discussion and consistent with the information presented in Environmental Report (ER) Chapters 2 and 4, the following terms are used:

- **Plant Site.** The plant site is the area within the fence line (Figure 4.0-2). This area includes the footprint of the HAR, including the reactor buildings and generating facilities.

- **HAR Site.** The HAR site is an irregularly shaped area comprised of the following site components: the plant site (area within the fence line), Harris Reservoir, Harris Reservoir perimeter, the dam at Harris Reservoir, the pipeline corridor, and the intake structure and pumphouse (Figure 2.0-2). The HAR site is located within Wake and Chatham counties.

- **Exclusion Zone.** The area within the exclusion area boundary (EAB). The exclusion zone is defined as two overlapping areas centered on the reactor building of each unit (Figure 4.0-3). The areas are defined by a circular distance of 1600 meters (m) (5249 feet [ft.]) in the seven southerly sectors beginning with ESE clockwise through WSW and with a radius of 1245 meters (m) (4085 feet [ft.]) in the nine remaining sectors.

- **Pipeline Corridor**. The pipeline corridor includes the Harris Lake makeup water system pipeline and corridor connecting the Harris Reservoir and the Cape Fear River. The pipeline components will transport makeup water from the Cape Fear River to the Harris Reservoir (Figure 4.0-4).

- **Intake Structure and Pumphouse**. The Harris Lake makeup water system intake structure and pumphouse will be constructed on the Cape Fear River (Figure 4.0-5).

- **Harris Lake**. Harris Lake includes both the Harris Reservoir and the Auxiliary Reservoir.

- **Harris Reservoir**. The Harris Reservoir is also known as the Main Reservoir. It does not include the affiliated Auxiliary Reservoir.

- **Harris Reservoir Perimeter**. The Harris Reservoir perimeter describes the area impacted by the 6-m (20-ft.) change in the reservoir's water level.

- **Transmission Corridors and Off-Site Areas**. Transmission corridors and off-site areas describe areas outside the site boundary that may fall within the footprint of new or existing transmission line corridors.

- **Vicinity**. The vicinity is a band or belt 9.7 kilometers (km) (6 miles [mi.]) wide surrounding the HAR site (Figure 2.0-6). The vicinity includes a much larger tract of land than the HAR site. The vicinity is located within four counties: Wake, Chatham, Harnett, and Lee.

- **Region**. The region applies to the area within an 80-km (50-mi.) radius from the center point of the HAR power block footprint, excluding the site and vicinity (Figure 4.0-6). The following counties are located entirely within the region: Chatham, Durham, Harnett, Lee, Orange, and Wake. The following counties are located partially within the region: Alamance, Caswell, Cumberland, Franklin, Granville, Guilford, Hoke, Johnston, Montgomery, Moore, Nash, Person, Randolph, Richmond, Robeson, Sampson, Scotland, Vance, Wayne, and Wilson. The region includes the economic centers of Raleigh, Durham, Fayetteville, Cary, and Chapel Hill.

The environmental effects of the operation of HAR will co-exist with the operation of HNP. Cumulative impacts of the operation of the three units are addressed in this chapter, as appropriate.

HAR site preparation and construction for the HAR as described in Chapter 4 are assumed to be complete for the following discussion. The 6-m (20-ft.) increase in the water level in Harris Reservoir to an elevation of 73.2 m (240 ft.) NGVD29 required for operation is also assumed to be complete for the following discussion. The installation of the intake structure and pumphouse on the Cape Fear River and shoreline, the makeup water pipeline, and the discharge structure on Harris Reservoir are also assumed as complete and operational for the purposes of this evaluation.

The evaluation of the Environmental Effects of Operation includes the following key components:

- Operation of the HAR (Figure 4.0-2).

- Operation of the blowdown pipeline from the HAR into Harris Reservoir (Figure 4.0-10).

- Operation of the Cape Fear River water intake structure.

- Operation of the Cape Fear River pumphouse.

- Operation of the makeup water pipeline.

- Operation of the discharge structure on Harris Reservoir.

- Operation of the modified Main Dam at Harris Reservoir with a modified concrete service spillway with an ogee-shaped crest increased to an elevation of 73.2 m (240 ft.) NGVD29. The spillway will also have an uncontrolled, ogee-shaped crest with a net length of 15.2 m (50.0 ft.) and a pier at mid-length.

- Operation of three new transmission lines, potential new corridors, and the associated electric switchyard.

- Maintenance of the water level in Harris Reservoir at a full pool elevation of 73.2 m (240 ft.) NGVD29.

Pumping water from the Cape Fear River to maintain the new water level will be an ongoing process during plant operations. For the purposes of this ER, the evaluation of impacts associated with the withdrawal of water from the Cape Fear River and the maintenance of the water level in Harris Reservoir are discussed in this chapter. This discussion includes the inundation of land, evaluation of water intake impacts on aquatic ecosystems, and operational impacts on infrastructure. Preparation of the perimeter of the lake in anticipation of increasing the water level within Harris Reservoir will occur during the construction phase of the project. These construction activities and the associated impacts resulting from the physical relocation of infrastructure, including those associated with recreation, are addressed in ER Chapter 4.

Throughout this chapter, environmental impacts of the alternatives will be assessed using the U.S. Nuclear Regulatory Commission's (NRC's) three-level standard of significance—SMALL, MODERATE, or LARGE. This standard of significance was developed using Council on Environmental Quality guidelines set forth in the footnotes to Table B-1 of Title 10 of the Code of Federal Regulations (CFR) Part 51, Subpart A, Appendix B:

- **SMALL**. Environmental effects are not detectable or are so minor 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.

The impact categories evaluated in this chapter are the same as those used in the Generic Environmental Impact Statement for License Renewal of Nuclear Plants (GEIS), NUREG-1437, Volumes 1 and 2.

This chapter is organized into the following sections:

- Section 5.1 — Land Use Impacts
- Section 5.2 — Water-Related Impacts
- Section 5.3 — Cooling System Impacts
- Section 5.4 — Radiological Impacts of Normal Operation
- Section 5.5 — Environmental Impacts of Waste
- Section 5.6 — Transmission System Impacts
- Section 5.7 — Uranium Fuel Cycle Impacts
- Section 5.8 — Socioeconomic Impacts
- Section 5.9 — Decommissioning
- Section 5.10 — Measures and Controls to Limit Adverse Impacts during Operation

5.1 LAND USE IMPACTS

Land use impacts to the HAR site and the vicinity will result from operation of the proposed facility, associated structures (transmission lines, cooling and heat dissipation system, Harris Lake makeup water system), and new water level at Harris Reservoir. Many operational impacts are only an extension in time of the construction impact and, therefore, are not evaluated in this section. Land use changes due to the physical presence of the plant are discussed as construction impacts in ER Section 4.1.

As described in ER Subsection 2.2.1 and shown on Figure 2.2-1, the U.S. Geological Survey (USGS) land use classification for the HAR site is primarily water body, southern yellow pine, bottomland forest/hardwood swamp, high intensity developed, mixed upland hardwoods, managed herbaceous cover, and mixed hardwoods/conifers. As shown on Figure 2.2-2, the primary USGS land use classifications for the vicinity are southern yellow pine, mixed hardwoods/conifers, bottomland forest/hardwood swamps, and water bodies. The tabulation of areas within the site and vicinity by each land use category is presented in Table 2.2-1. The principal terrestrial features of the site are described in ER Subsection 2.4.1 and a geologic description is provided in ER Section 2.6.

The HAR site is located within Wake and Chatham counties, and the vicinity is located within Wake, Chatham, Harnett, and Lee counties. There are no federal, state, or regional land use plans for this area; however, there are county land use plans. ER Subsections 2.2.1 and 4.1.1.3 discuss the county plans in detail.

Subsections 5.1.1, 5.1.2, and 5.1.3 contain information regarding land use impacts associated with HAR operation. Subsection 5.1.1 contains a discussion of land use impacts at the site and in the vicinity of the site. Subsection 5.1.2 contains a discussion of land use impacts in transmission line rights-of-way (ROWs) and off-site areas. Subsection 5.1.3 contains a discussion of land use impacts on historic properties.

A summary of unavoidable adverse environmental impacts on land use that are predicted to occur as a result of plant operation is provided in Subsection 10.1.2. A summary of irreversible and irretrievable commitments of land use resources that are predicted to occur as a result of plant operation is provided in ER Section 10.2. Land use information at the HAR site and vicinity related to short-term uses and long-term productivity of the environment is provided in ER Section 10.3. A list of potential adverse environmental impacts from operation and potential measures and controls to limit these impacts is provided in Section 5.10.

5.1.1 THE SITE AND VICINITY

There are two main types of land use changes that will occur from operation of the proposed plants and appurtenant facilities:

- Long-term restrictions and physical changes.
- Short-term changes that can be mitigated.

An assessment of long-term and short-term land use changes are described in Subsections 5.1.1.1 and 5.1.1.2, respectively.

Long-term changes in land use from operation of the HAR will be primarily associated with the increase in the water level of Harris Reservoir, an increase in the workforce, the operation of the cooling and heat dissipation system, and the operation of the Harris Lake makeup water system. Long-term land use at the site will change due to the larger lake size; however, impacts will neither be noticeable nor destabilize important attributes of land resources in the vicinity and will be SMALL.

Short-term changes in land use arising from the increase in the water level of Harris Reservoir to support start of operations of the HAR are expected to be SMALL and will be mitigated, as necessary, by Progress Energy Carolinas, Inc. (PEC). These changes will primarily result in short-term impacts to water quality, recreational areas, roads, HAR facilities, and municipal facilities.

5.1.1.1 Long-Term Restrictions and Physical Changes to Land Use of the Site and Vicinity Resulting from Operation

The discussion of long-term land-use changes resulting from HAR operation has been organized into the following subsections: increase in pool level of Harris Reservoir, impacts on transportation system from an increased workforce, cooling and heat dissipation system, and Harris Lake makeup water system. Long-term land use impacts from operation will be SMALL at the site and in the vicinity.

During the operation of the HAR, two EABs will be maintained surrounding each of the two new reactors, as shown on Figure 2.1-2. Public use of the land within these boundaries will be restricted and the boundaries will be patrolled by PEC. No changes in land use restrictions are expected, because the HAR EABs will be located entirely within the existing Shearon Harris Nuclear Power Plant Unit 1 (HNP) EAB (refer to FSAR Figure 2.1.1-203).

5.1.1.1.1 Increase in Pool Level of Harris Reservoir

The HAR will require additional makeup water from Harris Reservoir. Clearing around the Harris Reservoir perimeter will occur during the construction phase. Construction-related impacts on land use are discussed in Section 4.1. Natural drainage into Harris Reservoir will be used to fill the lake naturally, but supplemental flow from the Cape Fear River may be used to increase the water level of Harris Reservoir by approximately 6 m (20 ft.) to provide adequate cooling tower makeup water for the HAR. Also, flow from the Cape Fear will be required to maintain and manage the lake level during operation. Operational impacts on land use are related to maintaining and managing the lake level elevation.

Long-term physical land use changes will result from inundating the land located between the existing normal pool elevation and the proposed pool elevation of 73.2 m (240 ft.) NGVD29. The USGS land use designation for the approximate 1440 hectares (ha) (3570 acres [ac.] or 5.6 square miles [mi.^{2}]) of land located between 67.1 and 73.2 m (220 and 240 ft.) NGVD29 will change from the current designations to that of water bodies. ER Figure 2.2-1 illustrates land use within the site. The current use of much of the land proposed to be inundated is designated as forest. Impacts, including expected benefits, to water quality and fisheries from the rise in the water level of Harris Reservoir are discussed in Sections 5.2 and 5.3.

PEC owns all land at and below the 73.2-m (240-ft.) NGVD29 contour; therefore, there are no private property issues related to the reservoir level rise. The socioeconomic effects from changes in land use are addressed in ER Section 4.4 for construction and Section 5.8 for operation.

The increased water level will inundate certain infrastructure along the shores of Harris Reservoir, including roads, transmission lines, boat ramps, Harris Lake

County Park, the Town of Cary Police firing range, and PEC facilities. Affected structures or facilities will be relocated to higher ground during the construction phase and prior to the rise in water level of Harris Reservoir. Use of these structures will not be adversely affected in the long term. Short-term impacts are discussed in Subsection 5.1.1.2.1.

Land located between 73.2 m (240.0 ft.) NGVD29 and 74.1 m (243.0 ft.) NGVD29 will be within the 100-year flood zone. Land use changes to this zone would result from the creation of wetlands, as discussed in Subsection 5.2.1.4. The land in this flood zone is owned by PEC; therefore, private property will not be physically affected (Reference 5.1-001). Indirect effects on these private properties may include an increase in property value, due to closer proximity to the expanded lake.

5.1.1.1.1.1 Ecology

Long-term changes in land use resulting from operation of the HAR will have an effect on ecology in the site and vicinity. The increase of water elevation from 67.1 m to 73.2 m (220 ft. to 240 ft.) NGVD29 in Harris Reservoir would inundate approximately 1440 ha (3570 ac. or 5.6 mi.^{2}). It can be determined from ER Figure 4.0-7 that the current shoreline of Harris Reservoir is 139,379 m (457,281 ft.) long. Elevation of the water level to 240 ft. will add 99,684 m (327,046 ft.) to the shoreline, for a new perimeter of 239,063 m (784,327 ft.), as can be determined from Figure 4.0-7. Currently, the majority of this area is in a natural state. Wetland and upland habitat, permanent, ephemeral, and intermittent streams, and the shoreline riparian habitat of Harris Reservoir would all be affected by the increased water level. A detailed description of the terrestrial and aquatic ecology of the site and vicinity is presented in ER Section 2.4.

Ecological impacts resulting from clearing the land to increase the reservoir elevation are discussed in ER Subsections 4.3.1.2 and 4.3.2.2. Inundating the area surrounding Harris Reservoir will decrease vegetation and wildlife terrestrial habitat by 1440 ha (3570 ac. or 5.6 mi.^{2}), resulting in long-term direct and indirect effects.

Because relatively large areas of undeveloped land adjoin PEC property, wildlife will relocate naturally and populations will adapt to the altered habitat area over time. Terrestrial ecological effects along Harris Reservoir will be MODERATE, primarily resulting from long-term loss of terrestrial habitat, including forest ecosystems and wetlands. The clearing of 1440 ha (3570 ac. or 5.6 mi.^{2}) will result in disturbance and loss of approximately 31 percent of the forested habitat within the 5353 ha (13,227 ac. or 20.67 mi.^{2}) enrolled in the North Carolina Game Lands Program, as discussed in ER Chapter 4. In addition, there will be permanent inundation of 1440 ha (3570 ac. or 5.6 mi.^{2}) of terrestrial habitat that will be cleared during construction that is currently available for plants and wildlife, including approximately 47 ha (117 ac. or 0.18 mi.^{2}) of wetlands around the perimeter of the lake. Although the terrestrial ecological effects will have

MODERATE localized impact, specifically due to the loss of forest ecosystem currently used by plants and wildlife, the impact on the vicinity will be SMALL.

There will be a localized effect to the habitat of the stream-dwelling benthic invertebrates and fish in those streams that will be flooded by the larger lake. Habitat for these organisms will remain in streams unaffected by the lake rise; therefore, the environmental impact will be SMALL. The long-term aquatic effect of raising the water level in Harris Reservoir will be positive, because of increased aquatic habitat and resulting increases in aquatic populations of fish, amphibians, reptiles, and invertebrates, and increased areas for waterfowl and other wading birds feeding and resting. The overall ecological impacts on land and water resources will be SMALL in the vicinity.

5.1.1.1.2 Impacts on Transportation System from an Increased Workforce

The increase in the number of workers required for the operation of HAR will have SMALL long-term impacts on transportation facilities within the site and vicinity. An estimated additional 773 operating personnel (515 for the proposed Shearon Harris Nuclear Power Plant Unit 2 [HAR 2] and 258 for the proposed Shearon Harris Nuclear Power Plant Unit 3 [HAR 3]) will be employed during operation of the HAR (Reference 5.1-002). Approximately 773 additional work trips during peak hours will occur on the roads and highways in the vicinity. However, the roads and highways will not be unduly congested except for brief periods (varying between 10 to 45 minutes) during the beginning and ending of shifts. Subsection 5.8.2.8 discusses this analysis in more detail. To determine the impact of additional workers on traffic, average daily traffic counts for nearby routes were obtained from the North Carolina Department of Transportation (NCDOT) (Reference 5.1-003). Based on the addition of the average daily traffic counts and the expected number of additional trips resulting from operation, the additional operation-related activity would not put an excessive burden on the roadways near the HAR site. Modifications and improvements to existing roads and highways may result in an increase in the impervious surfaces in the site and vicinity. Subsections 5.8.1.1 and 5.8.2.8 discuss in detail the highways and roads to the HAR site and potential access improvements. The improvements of summarized below.

Several new asphalt-paved roads will be constructed prior to HAR construction, as shown on ER Figure 4.0-11. These new roads include a plant access road that will be approximately 10 m (32 ft.) wide and 4724 m (15,500 ft.) long, new plant roads totaling 3048 m (10,000 ft.) in length, and 10 m (32 ft.) wide, and miscellaneous plant roads totaling 2652 m (8700 ft.) in length and 7 m (24 ft.) wide (Reference 5.1-004 and Reference 5.1-005). Impacts from construction of new roads or improvements to existing roads are discussed in ER Subsection 4.1.1.2.2. Operational impacts are primarily an extension in time of the construction impacts. Very little maintenance will be required, because the roads will be paved. When maintenance or improvements are required, appropriate measures will be taken to minimize any disturbances. Operational impacts from these new plant roads are expected to be SMALL.

5.1.1.1.3 Cooling and Heat Dissipation System

Each of the two new cooling towers will be a counter-flow induced draft tower and divided into two cells. Each cell will use one fan, located in the top portion of the cell, to draw air upward counter to the flow of water. Under normal operation, only one cell would be operational at a time. Raw water would automatically be supplied to the basin to make up for water losses due to evaporation, drift, and blowdown. A more detailed description of the cooling and heat dissipation system is described in ER Chapter 3.

Potential impacts to land use from cooling towers are primarily related to salt drift, but also include icing and fogging. Freshwater from Harris Reservoir will be used to supply water for the new cooling towers. It is assumed that new cooling towers would produce salt concentrations similar to cooling towers at existing nuclear power plants that also use freshwater supply sources. The impact of salt drift, icing, and fogging on agricultural crops, ornamental vegetation, and native plants was evaluated for existing nuclear power plants in the GEIS, and was found to be of small significance. The GEIS found no instances where cooling tower operations (salt drift, icing, or fogging) resulted in measurable damage to ornamental vegetation or measurable productivity losses in agricultural crops. Cooling tower operation has resulted in minor and localized or undetectable degradation of the health of natural plant communities. Because the findings of the GEIS were based on sample nuclear plants, literature reviews, and information provided by natural resource agencies and agricultural agencies in all states with nuclear power plants, resident species are expected to be no more sensitive than species evaluated in the GEIS. The GEIS found impacts from salt drift, fogging, and icing to be undetectable or minor; therefore, land use changes at the HAR site and vicinity are expected to be SMALL. In addition, the cooling towers for the HAR will use freshwater from Harris Reservoir; therefore, salt drift will be similar to that of the HNP cooling tower, which has not resulted in any salt drift-related problems. Operational impacts of the cooling system, including information about the plumes and drift, are further detailed in Section 5.2 (Water-Related Impacts) and Section 5.3 (Cooling System Impacts). ER Subsection 6.5.1.3 presents a discussion of planned pre-operational monitoring of drift and vapor plume effects on vegetation growth and habitat modification.

An evaluation of land use impacts from alternative heat dissipation systems is presented in ER Subsection 9.4.1 and from alternative circulating systems is presented in Subsection 9.4.2.

5.1.1.1.4 Harris Lake Makeup Water System

Operations at the HAR will require additional water for plant cooling. A proposed Harris Lake makeup water system will be used to raise and maintain the water level of Harris Reservoir at approximately 73.2 m (240 ft.). The Harris Lake makeup water system will include an intake structure and pumphouse on the Cape Fear River, a makeup water pipeline connecting with Harris Lake, and a makeup water discharge structure on Harris Reservoir. Details about these proposed structures are discussed in ER Subsections 2.4.1.4, 2.4.2.4, 4.3.1.3, and 4.3.1.4. Potential ecological impacts from construction are discussed in Subsections 4.3.1.3 and 4.3.1.4. Construction impacts on land use are discussed in Subsections 4.1.1.1.1, 4.1.2.4, and 4.1.2.5.

Operational impacts on land use are generally expected to be an extension in time of impacts from construction. No additional land area is anticipated to be changed beyond that land area committed because of the Harris Lake makeup water system construction.

Operational impacts not associated with construction would be SMALL and temporary and may include the following:

- Routine maintenance of structures, ROWs, and access roads.
- Vegetation maintenance.
- Waste generation and transport.

As visible from ER Figure 4.0-1, Harris Lake makeup water system facilities would be co-located along existing infrastructure. Operation and maintenance activities would be implemented from these pre-existing road and transmission line ROWs, in consultation with affected landowners, when applicable. Appropriate measures will be taken to minimize any disturbances. The impacts due to the operation of electrical power lines and corridors providing power to the pumphouse are also expected to be SMALL.

Impacts to the water supply, water quality, aquatic life, and fisheries in the Cape Fear River and Harris Reservoir, potential impacts due to transfer and introduction of species, and impacts to the Cape Fear River due to water withdrawal and reintroduction several miles downstream are further discussed in Sections 5.2 and 5.3.

5.1.1.2 Short-Term Physical Changes in Land Use of the Site and Vicinity and Plans for Mitigation of Adverse Impacts

Short-term changes in land use from operation of the HAR will be primarily associated with impacts resulting from the increase in the water level of Harris Reservoir. Short-term changes in land use of the site and vicinity will be SMALL. The discussion of short-term land use impacts has been organized into the following subsections.

5.1.1.2.1 Water Quality

The inundation of land will result in short-term impacts on water quality. These short-term physical impacts may include an increase in turbidity in Harris Reservoir and the potential for sedimentation along Buckhorn Creek below the dam. The heavy band of hydrilla around the shoreline will buffer the sediment inputs and act to retain some sediment, especially during the active growing season of June through December. Proper mitigation and best management practices (BMPs) implemented during construction will limit the potential water quantity and quality effects to the surface water (e.g., Harris Reservoir, stream crossings, and intermittent drainage ways) and groundwater. Further details on the effects on water quality from the increase in the water level of Harris Reservoir are discussed in Section 5.2.

5.1.1.2.2 Recreational Areas

The increase in the pool level of Harris Reservoir due to operation will result in changes in land use of areas currently used for recreation. Recreational areas that will be affected include Harris Lake County Park, two public boat launch facilities, and the Shearon Harris Game Lands. The impact on recreation from the water level rise will be short-term because PEC is committed to mitigating these losses by re-creating or designating recreational areas at higher elevations. In addition, the increase in the lake level of Harris Reservoir will result in an increase in the area available for water-based recreation.

5.1.1.2.2.1 Harris Lake County Park

During the construction phase of the HAR site, as described ER Chapter 4, the affected infrastructure of the Harris Lake County Park will be relocated. Located in Wake County approximately 32 km (20 mi.) southwest of Raleigh, Harris Lake County Park opened to the public in 1999. The 275 ha (680 ac. or 1.06 mi.^{2}) park is owned by PEC and leased to Wake County Parks, Recreation, and Open Space who manages the park (Reference 5.1-006). During fiscal year 2005 to 2006, the park received 107,000 visitors, with a peak of approximately 1000 visitors per day (Reference 5.1-007). Recreation is the primary reason people visit the park. Recreational activities at the park include playing disc golf, mountain biking, using the playground, and fishing (Reference 5.1-008).

There will be no impact on recreational use of the Harris Lake County Park during operation because infrastructure in the park located 73.2 m (240 ft.) NGVD29 will have been relocated during construction of the HAR site (Reference 5.1-009). The recreational impacts during operation will be SMALL.

5.1.1.2.2.2 Boat Launch Facilities

During the construction phase of the HAR site, as described in ER Chapter 4, boat launch facilities on Harris Reservoir that are impacted by the increased water level will be relocated. One boat launch is located in Harris Lake County

Park (car-top boat launch) and will be mitigated along with the park, as discussed above. PEC will mitigate the impact to Holleman's Crossing and Highway NC-42 boat launch facilities during construction (Reference 5.1-009). PEC will modify the Highway NC-42 boat launch, the two ramps, and one-half of the 66-space parking lot during construction (Reference 5.1-001, Reference 5.1-010, and Reference 5.1-011). The boat ramps will be available for use during operation in a location uphill from their current locations (Reference 5.1-009). Relocated boat launch facilities will be available for use during operation and will be designed to accommodate fluctuating lake levels (Reference 5.1-009). The impact associated with the use of the boat launch facilities during operation will be SMALL.

5.1.1.2.2.3 Shearon Harris Game Lands

PEC has enrolled 5353 ha (13,227 ac. or 20.67 mi.^{2}) of the area surrounding Harris Lake in the North Carolina Game Lands Program through the North Carolina Wildlife Resources Commission (NCWRC) (ER Figure 4.3-1) (Reference 5.1-012). As noted in Subsection 4.3.1.2.1, PEC originally committed approximately 1619 ha (4,000 ac. or 6.25 mi.^{2}) to the North Carolina Game Lands Program and has voluntarily committed the remaining acreage over the years. This area is known as the Shearon Harris Game Lands. It can be determined from Figure 4.3-1 that approximately 818 ha (2022 ac. or 3.16 mi.^{2}) or 14 percent, of the game lands will be inundated. The USGS land use classification will change from forested to water body (ER Figure 2.2-1). PEC initiated communication with the NCWRC in early 2007 regarding potential impacts to the Shearon Harris Game Lands.

5.1.1.2.2.4 Roads

During the construction phase of the HAR site, as described ER Chapter 4, the highways, county roads, and unimproved or unmaintained roads within the 67.1-m to 73.2-m (220-ft. to 240-ft.) NGVD29 contour that will be affected by the Harris Reservoir level rise to 73 m (240 ft.) NGVD29, will be modified to accommodate for the increased lake level (Reference 5.1-001).

The rise in reservoir elevation will require enhancements to the existing roads. In-use roadways, along with associated infrastructure (bridges and culverts), will be reconstructed in their current locations to accommodate the rise in the reservoir's elevation. Road enhancements may impact adjacent land; therefore the purchase of adjacent lands may be required. Assuming that the top surface of the reconstructed roads will be at an elevation of 75.9 m (249 ft.) (100-year flood level of 74.1 m [243 ft.] plus 1.8 m [5.9 ft.] for wind/wave action) and that 30.5 m (100 ft.) of road on each side of the affected section will need to be resurfaced, an estimated 4873 m (15,988 ft.) of paved roads will be affected (Reference 5.1-004 and Reference 5.1-005).

PEC initially contacted the NCDOT in April 2007 and held a meeting in August 2007 to discuss the HAR 2 and HAR 3 and potential effects on local roadways.

The names and lengths of road segments projected to be affected by the rise in the water level of Harris Reservoir and potential mitigation alternatives are described below:

- North Carolina Highway 42 (Highway NC-42) will drop to an elevation of 73.5 m (241.0 ft.) NGVD29 (Reference 5.1-001). An estimated 236 m (777 ft.) of Highway NC-42 will need to be resurfaced to avoid impacts from wind and wave action and a 100-year flood event (Reference 5.1-004 and Reference 5.1-009).

- Local roads include Rex Road, New Hill-Holleman Road Shearon Harris Road, Holly Springs/New Hill Road, Cass Holt Road, and Sweet Springs Road (Reference 5.1-001, Reference 5.1-004, and Reference 5.1-009).

- Approximately 587-m (1927-ft.) of Rex Road (section from rd-105 to rd-106) will need to be improved to avoid inundation (Reference 5.1-004). A bridge or causeway will need to be constructed. Construction of this future crossing may affect adjacent landowners on both sides of Rex Road.

- The three depressions on Shearon Harris Road and the causeway to the plant site are located above 73.2 m (240 ft.) NGVD29 (Reference 5.1-009).

- Two sections of the Town of Cary Police Department firing range access road are located below 73.2 m (240 ft.) NGVD29 and will need to be mitigated. More details on this are provided in Subsection 5.1.1.2.3.

- In addition, several unimproved or unmaintained roads will be relocated or modified when the water level is increased (Reference 5.1-001 and Reference 5.1-004).

Because affected roadways will have been relocated during the construction phase, fluctuations in lake level during the operation of the HAR will not impact local roadways.

5.1.1.2.2.5 PEC Facilities

During the construction phase of the HAR site, as described in ER Chapter 4, PEC will relocate or modify PEC facilities affected by the increase in the level of Harris Reservoir to approximately 73.2 m (240 ft.) NGVD29. These facilities will be relocated or modified prior to operation of the HAR (Reference 5.1-001). Long-term land-use impacts are expected to be SMALL during the operation phase.

5.1.1.2.2.6 Transmission Line Impacts

During the construction phase of the HAR site, as described in Chapter 4, PEC will have relocated the transmission towers affected by the new elevation of Harris Reservoir. This will include an estimated 89 structures that will have been relocated by the start of operation (Reference 5.1-005). Long-term land-use impacts are expected to be SMALL.

5.1.1.2.2.7 Unused Transmission Foundations

Five sets of unused transmission tower foundations were identified during the Harris Reservoir survey. Their locations are shown on Figure 4.0-8. These concrete foundations were installed during the construction of the HNP; however, the transmission towers were never completed. These foundations have a potential to pose a boating hazard during the water level rise. PEC will implement a warning system for boats. (Reference 5.1-001).There will be no long-term or short-term land use impacts associated with these transmission foundations during operation.

5.1.1.2.3 Municipal Facilities

There is an earthen dam (fac-16) located downstream of the Town of Holly Springs wastewater discharge (Figure 4.0-9). The increase in the surface elevation of Harris Reservoir may affect this dam and the pond behind it, although this is unlikely due to the dam being above 73.2 m (240 ft.) NGVD29. (Reference 5.1-001) PEC will work with the Town of Holly Springs to mitigate any negative impacts. No short-term or long-term changes in land use are expected to result.

5.1.2 TRANSMISSION CORRIDORS AND OFF-SITE AREAS

Seven 230-kilovolt (kV) transmission lines currently connect the HNP to the transmission system. Subsection 2.2.2 describes the locations of existing corridor routes, the area involved, and land use. ER Section 3.7 describes the proposed 30.5-m (100-ft.) expansion of three existing transmission corridors to add new lines required for HAR 3. Impacts from the proposed expansion of transmission corridors are discussed in more detail in Section 4.1. A new switchyard will also be developed to transmit the additional power generation by HAR 3. The existing lines and switchyard will be used to transmit power generation by HAR 2. The use of existing transmission lines and corridors would limit the amount of new property that will need to be acquired. Once these effects are identified, appropriate measures will be taken to minimize the disturbances. Potential construction impacts along existing transmission corridors are further discussed in Subsections 4.1.2.2, 4.1.2.6.2, 4.3.1.5, and 4.3.2.5. Operational impacts on existing transmission lines and transmission towers due to increases in water levels in Harris Reservoir are discussed in Subsection 5.1.1.2.2.6.

Land use impacts to transmission corridors from operation of the HAR will be identical to impacts to existing corridors from the operation of HNP. PEC uses easements, permits, or company-owned lands for transmission line ROWs, which gives them access and control over how the land in the transmission corridor is managed. PEC ensures that land use in the corridors and underneath the high-voltage lines is compatible with the reliable transmission of electricity. Vegetation communities in these corridors are kept at an early successional stage by maintenance activities, such as mechanical clearing, hand cutting, and herbicide application. PEC's control and management of these ROWs precludes residential and industrial structures within the transmission corridors. PEC has established transmission vegetation management and line maintenance procedures that will be used to maintain potential new corridors and transmission lines. (Reference 5.1-013)

Two types of operational activities are anticipated within the transmission corridors as part of normal transmission line maintenance. These include routine vegetation inspection and clearing activities in the ROW and temporary access road construction for temporary maintenance needs. These activities would be carried out in consultation with affected landowners and appropriate measures will be taken to minimize any disturbances. Therefore, impacts to land use in transmission corridors will be SMALL and temporary and not require mitigation.

PEC employs the most economical vegetation management techniques through communication, continuous learning, and assessment of the BMPs throughout the industry. The PEC Transmission Vegetation Management Program includes visual inspection and appropriate maintenance of transmission line ROWs. Maintenance activities may include re-clearing vegetation, tree trimming/removal, danger tree cutting, and encroachment licensing/removal. For maintenance purposes, wooded sections of the ROW will be re-cleared to the full width through mechanical clearing, hand cutting, or herbicide application. (Reference 5.1-013)

Routine inspections of the ROW will be conducted periodically to monitor vegetation growth, ROW contractor effectiveness, and encroachments within the ROW. Inspections will be conducted by aircraft and ground patrols, as needed (Reference 5.1-013). Maintenance and repair inspections required by cause, such as storms that may down timber on or near the lines, will be conducted by air, road, or foot, as required by the circumstances. These occurrences are expected to be few, and will have limited impact on the land.

Should road construction become necessary (for example, if the landowner requires it as a condition of the ROW or for access to a switching structure), a road will be constructed using the guidelines presented in an approved soil erosion and sediment control plan (SESCP) and in accordance with applicable regulations.

Operation is not anticipated to impact the geologic environment. The only potential impacts would result from potential future maintenance activities that would disturb the subsurface, such as maintenance to transmission tower foundations. This potential impact on land use is SMALL and temporary and mitigation measures are discussed in ER Sections 4.6 and 5.10.

5.1.3 HISTORIC PROPERTIES

Although historic property surveys were conducted in the HNP area prior to construction of the HNP and Harris Reservoir, additional areas will be impacted by the HAR. PEC has coordinated with the North Carolina State Historic Protection Office (NCSHPO) to ensure that, prior to raising the reservoir level, the requirements of Section 106 of the National Historic Preservation Act (NHPA) are met. PEC and its consultant (New South Associates) have met with representatives from the NCSHPO's office to discuss this proposed path forward and have determined that it will be acceptable with the NCSHPO. The NCSHPO has agreed that Phase I surveys of high probability landforms, mapping and shovel testing of two known mill sites and a phased program of deep testing in areas with a potential for stratified archaeological sites will satisfy the requirement of Section 106 of the NHPA. A detailed description of surveys that have been completed and PEC's coordination with NCSHPO regarding the construction of HAR are presented in ER Subsection 4.1.3.

A list of known historic properties within 16 km (10 mi.) of the HAR site is provided in ER Section 2.5 and Table 2.5-31. Operational impacts on historic sites are not expected to differ from those resulting from construction, based on current information, and will be SMALL. Construction impacts on historic sites are discussed in Subsection 4.1.3.

5.1.4 REFERENCES

5.1-001 CH2M HILL, "Progress Energy – Harris Lake Infrastructure Impacts," Technical Memorandum prepared for Progress Energy Carolinas, Inc., May 16, 2007.

5.1-002 Spragins, Lewis, Progress Energy, "Workforce Assumptions and Construction Timeframe – HAR 2 & 3," Joint Venture Team - Request for Information 175, March 8, 2007.

5.1-003 North Carolina Department of Transportation, Traffic Survey Unit, "2005 AADT Wake County," 2005.

5.1-004 Sargent & Lundy, LLC, "Road and Lake Level Clarification," RFI 200, May 2, 2007.

5.1-005 Sargent & Lundy, LLC, "Construction Input for Makeup Water Line and HAR Units 2 & 3," RFI 158, January 26, 2007.

5.1-006 Wake County Parks and Open Space, Wake.gov, Harris Lake, Park History, 2007, Website, www.wakegov.com/NR/exeres/8AF5BFF6-28A9-44FC-8C60-F882879E62B4.htm, accessed August 3, 2007.

5.1-007 Harris Lake County Park, Personnel Communication with Tim Lisk, Bill Bratt, CH2M HILL, July 20, 2006.

5.1-008 Wake County, Harris Lake County Park Brochure, 2006, Website, www.wakegov.com/NR/rdonlyres/C27B49F6-846D-42A5-87BF-1E1478E2CCEB/0/HLCPBrochure06.pdf, accessed August 3, 2007.

5.1-009 CH2M HILL, “Progress Energy – Mitigation Planning for Potential Impacts to Public Infrastructure at Harris Lake Associated with the Change in Water Level Elevation,” Technical Memorandum prepared for Progress Energy Carolinas, Inc., May 16, 2007.

5.1-010 National Marine Manufacturers Association, “Boat Marinas and & Ramps, North Carolina, Wake County, Shearon Harris Reservoir, Holleman’s Crossing, 2007,” Website, www.discoverboating.com/boating/marinas.aspx?countyid=1980 accessed on April 25, 2007.

5.1-011 National Marine Manufacturers Association, “Boat Marinas & Ramps, North Carolina, Chatham County, Shearon Harris Reservoir, Dam Site, 2007,” Website, www.discoverboating.com/boating/marinas.aspx?countyid=1907 accessed on April 25, 2007.

5.1-012 Progress Energy Carolinas, Inc., “Applicant’s Environmental Report – Operating License Renewal Stage Shearon Harris Nuclear Plant Progress Energy, Unit 1,” Docket No. 50-400, License No. NPF-63, Final, November 2006.

5.1-013 Progress Energy Carolinas, Inc., “Vegetation Management in Transmission Corridors,” RFI 213, June 1, 2007.

5.2 WATER-RELATED IMPACTS

This section describes the analysis and assessment of anticipated hydrologic alterations and their effects on other users that may result from operation of the HAR. The topics discussed are as follows:

- Analysis of plant water needs and availability of water supply.
- Identification and description of hydrologic alterations resulting from proposed operational activities.
- The effects, description, and analysis of the hydrologic alterations on the water supply for other water users.
- Analysis of practices to minimize water use impacts.
- Conclusions of adequacy of the water supply.

The HNP withdraws water from Harris Reservoir, which is an artificial lake created by impounding Buckhorn Creek and its tributaries. Buckhorn Creek and its tributaries drain an area of 182.1 square kilometers (km^2) (70.3 square miles [$mi.^2$]) to Harris Reservoir (Reference 5.2-001). Harris Reservoir covers an area of approximately 1460 ha (3610 acres [ac.] or 5.6 $mi.^2$) and has a storage capacity of 90,000,000 cubic meters (m^3) (73,000 acre-feet [ac-ft]) (Reference 5.2-002).

The proposed project is to install and operate two new Westinghouse Electric Company, LLC (Westinghouse) AP1000 reactors at the HNP. The proposed HAR 2 and HAR 3 reactors have a combined normal net consumptive usage of approximately 1.77 cubic meters per second (m^3/s) (62.66 cubic feet per second [ft^3/s]) or 28,122 gallons per minute (gpm) during operation (Reference 5.2-003). This water is used for cooling tower evaporation, cooling tower blowdown, service water tower evaporation, service water tower blowdown, sanitary waste discharge, raw water use, demineralizer water discharge, raw water makeup to the demineralizer, and fire protection. A portion of the cooling tower use is lost to evaporation while the remainder is returned to Harris Reservoir. An additional minimum flow of 0.57 m^3/s (20 ft^3/s) or 8940 gpm over the Harris Dam would be necessary to manage water quality (Reference 5.2-004). For further discussion of radiological issues, refer to Section 5.4.

This document discusses the potential hydrologic alterations to both surface water and groundwater related to the additional water required for operation. Hydrologic alterations were evaluated with regards to domestic, commercial, municipal, agricultural, industrial, mining, recreation, navigation, and hydroelectric power. Several agencies have been contacted regarding this Combined License Application (COLA) and have been consulted about hydrologic impacts. Agency contact is summarized in ER Section 1.2.

5.2.1 HYDROLOGIC ALTERATIONS AND PLANT WATER SUPPLY

This section identifies and describes anticipated hydrologic alterations and water-related impacts resulting from the operation of the HAR after expansion and the adequacy of the water supply from Harris Lake and the Cape Fear River. The evaluation includes the following:

- Identification and description of proposed operational activities that could result in hydrologic alterations.
- Identification, description, and analysis of the resulting hydrologic alterations and the effects of these alterations on other water users.
- Analysis of proposed practices to minimize hydrologic alterations that may have adverse impacts.
- Analysis and comparison of plant water needs and the availability of water supplies to meet those needs.
- Conclusions with respect to the adequacy of water supplies to meet plant water needs.

A number of environmental effects of operation were identified in Section 5.0. Of these, only those related directly to water supply, adding volume to Harris Reservoir and withdrawing water from the Cape Fear River, are expect to cause hydrological impacts. Operating the blowdown pipe, water intake structure, makeup water pipeline, discharge structure, transmission lines, and relocating infrastructure will have a SMALL impact on water supply and water quality. The primary impacts related to these operations occur during the construction phase of the actual structures. These impacts are described in Chapter 4.

Adding the two reactors will require additional water supply for cooling tower evaporation, cooling tower blowdown, service water tower evaporation, service water tower blowdown, sanitary waste discharge, raw water use, demineralizer water discharge, raw water makeup to the demineralizer, and fire protection. It is estimated that the normal net consumptive usage for these operations is 1.77 m^3/s (62.66 ft^3/s) or 28,122 gpm (Reference 5.2-003). An additional 0.57 m^3/s (20 ft^3/s) or 8940 gpm is also required to be discharged to Buckhorn Creek for maintenance of water quality (Reference 5.2-004). To meet the additional water requirements for the HAR, the Harris Reservoir capacity will be expanded from its current normal operating level of 67.1 m (220 ft.) NGVD29 elevation to a new elevation of 73.2 m (240 ft.) NGVD29 (Reference 5.2-005).This expansion of Harris Reservoir would increase its area by 1440 ha (3570 ac. or 5.6 mi.^{2}) to 3050 ha (7540 ac. or 11.8 mi.^{2}) and its capacity an additional 130,000,000 m^3 to 220,000,000 m^3 (104,563 ac-ft to 177,563 ac-ft) (Reference 5.2-001 and Reference 5.2-002). This increase in capacity was determined to support the operation of the HNP and the addition of the HAR based on evaluation of a number of operational scenarios (Reference 5.2-005).

Water from the Cape Fear River, in addition to inflow from the existing Harris Reservoir drainage area, will be required to fill and maintain the required pool level for normal operations. The normal water withdrawal rate of 2.65 m^3/s (93.74 ft^3/s) or 42,074 gpm, for operation and water quality control, is approximately 3.6 percent (2.36 m^3/s / 65 m^3/s = 3.6 percent) of the average daily flow reported at the USGS gauge at Lillington (USGS02102500) (Reference 5.2-003 and Reference 5.2-006). The rate at which water is withdrawn will likely be based on a set of operational rules designed to meet the target flows at Lillington, as defined by the 1992 Water Control Manual for B. Everett Jordan Lake (Reference 5.2-007). A higher withdrawal rate would be used during high-flow periods to fill the lake and make up for any volume deficits. During periods of drought, Harris Reservoir would provide some or all of the required cooling water supply.

An alternative flow has been proposed to supplement the flows required from the Cape Fear River and would be to use effluent discharged from the proposed Western Wake County Regional Water Reclamation Facility (WRF). The use of WRF water has the potential for increasing nutrient loading to Harris Reservoir that is already eutrophic. It has been proposed to supplement the flows required from the Cape Fear River by using effluent discharged from the proposed Western Wake County Regional WRF to Harris Reservoir (impacts due to operation of the Western Wake County Regional WRF are not included in this discussion of water-related impacts) (Reference 5.2-008). This proposed WRF is beginning an environmental impact statement following National Environmental Policy Act requirements (Reference 5.2-008).

The potential impacts to surface water and groundwater from hydrologic alterations resulting from the operation of the HAR and the adequacy of the water supply proposed for plant water needs are described in the following subsections.

5.2.1.1 Freshwater Streams

The streams that could be affected by the operation of the HAR are the Cape Fear River and Buckhorn Creek and its tributaries: White Oak Creek, Little White Oak Creek, Tom Jack Creek, Thomas Creek, and Cary Creek.

The Cape Fear River will be primarily affected by the project from the proposed withdrawal of water to maintain Harris Reservoir at the operating level of 73.2 m (240 ft.) NGVD29. The Cape Fear River begins at the confluence of the Haw and Deep Rivers approximately 9.7 km (6 mi.) upstream of the withdrawal point and continues to the Cape Fear Estuary at Wilmington. The Cape Fear River's flow varies seasonally, with an average daily flow in 2005 of 65 m^3/s (2305 ft^3/s) or 1,034,556 gpm at Lillington (Reference 5.2-006).

Water supply is a critical issue in the Cape Fear River Basin because of the rapidly expanding population and subsequent demand for drinking water. There are four water withdrawals between Jordan Lake and Lock and Dam #1 (Figure 5.2-1, Table 5.2-1) that rely on the Cape Fear River for drinking water supply. Any significant changes in the flow volume of the Cape Fear River during low-flow conditions might affect drinking water withdrawal capacity. There are no other industrial, municipal, commercial, mining, or agricultural users of the Cape Fear water between Buckhorn Dam and Lock and Dam #1 (Reference 5.2-020).

Droughts have occurred recently in the Cape Fear River Basin, with a record drought condition currently occurring in 2007, and severe droughts that occurred in August 2002 and again in October and November 2005. The lowest mean daily flow recorded recently in the Cape Fear River at Lillington was 4.4 m^3/s (155 ft^3/s) or 69,569 gpm, during drought conditions in August 2002. The monthly mean for August 2002 was 7.75 m^3/s (273.8 ft^3/s) or 122,890 gpm (Reference 5.2-006). To support aquatic life and other downstream uses, flows into the Cape Fear River are regulated by the B. Everett Jordan Dam; the U.S. Army Corps of Engineers (USACE) operates the dam to meet a target flow of 17 m^3/s (600 ft^3/s) or 269,299 gpm at Lillington (Reference 5.2-007). The demands of the HAR units on the Cape Fear River water supply require careful evaluation of the requirements of the HAR units and the subsequent impact on water users in the basin. The mean annual flow of the Cape Fear River is 87.9 m^3/s (3103 ft^3/s) or 1,392,723 gpm (Reference 5.2-006). Harris Reservoir currently discharges to Buckhorn Creek, and the anticipated minimum discharge is 0.57 m^3/s (20 ft^3/s) or 8940. The maximum withdrawal is 3.8 m^3/s (133.68 ft^3/s) or 60,000 gpm (Table 5.2-2) (Reference 5.2-004). These levels are within the range of current flows for Buckhorn Creek; therefore, changes in geometries, flow, and circulation patterns and mixing patterns are not anticipated. Since the anticipated flows being discharged into Buckhorn Creek from Harris Reservoir are within the range of current flows, no changes in erosion, deposition, or sediment characteristics in relation to other water users are anticipated.

The 7-day, 10-year low flow (7Q10) is a commonly used measurement of low-flow conditions and is frequently the basis for determining point source discharge limits. The 7Q10 for the Cape Fear River at the USGS station near Lillington, North Carolina, from 1982-2005 was determined to be 11.72 m^3/s (414 ft^3/s) or 185,816 gpm using USGS flow data and the U.S. Environmental Protection Agency's (USEPA) DFLOW3 program. The 7Q10 at the confluence of Buckhorn Creek and the Cape Fear River was calculated as 10.82 m^3/s (382 ft^3/s) or 171,453 gpm. Table 5.2-2 summarizes the water use at the proposed facilities. (Reference 5.2-005)

State water use guidance values are based on withdrawals of 20 percent or more of the 7Q10. For the Cape Fear River at Buckhorn Creek, this would equate to 2.16 m^3/s (76.4 ft^3/s) (0.2 X 10.82 m^3/s = 2.16 m^3/s [0.2 X 382 ft^3/s = 76.4 ft^3/s]) (Reference 5.2-005). Pumping rates to maintain the target water level in Harris Reservoir will need to consider the State water use guidance and the target flow at Lillington. Alternative operation practices were evaluated to identify a method that would minimize hydrological impacts. During periods of extreme drought conditions, the HAR can operate for a time without withdrawing makeup water from the river by using water directly from the Main Reservoir. Lake levels could be drawn down approximately 6.1 m (20 ft.) from about 73.2 m to about 67.1 m (240 ft. to about 220 ft.) NGVD29, the current normal pool elevation of the existing Harris Reservoir. This ability to use stored reservoir water for a period of time without obtaining makeup water from the river allows PEC operational flexibility during drought conditions and ensures little impact on other water users. Appropriate analytical methods to evaluate impacts on Cape Fear River flow are discussed in Subsection 5.2.3. During temporary plant shutdown, any water transferred from the Cape Fear River to Harris Reservoir will be allowed to return to the Cape Fear River via Buckhorn Creek, provided that Harris Reservoir levels are above the spillway located at 73.2 m (240 ft.) NGVD29 (for discussion on Service Water System, see ER Subsection 3.3.1.1).

Alterations to White Oak Creek, Little White Oak Creek, Tom Jack Creek, Thomas Creek, and Cary Creek will be limited to stream habitat inundation due to an increase in lake level from an elevation of 67.1 m (220 ft.) to an elevation of 73.2 m (240 ft.) NGVD29. Raising the lake level will inundate approximately 25,100 m (82,300 linear feet) of ephemeral stream channels, approximately 20,000 m (65,600 linear feet) of intermittent stream channels and approximately 21,400 m (70,200 linear feet) of perennial stream along 59 drainages. Construction of the water line from the Cape Fear River would cross seven streams, with impacts limited to the temporary effects of trenching to place the pipe potentially impacting floodplain areas along these streams (Reference 5.2-010).

The area that will be inundated around the Main Reservoir and the tributaries is classified as floodplain. Article 14 of Wake County’s Unified Development Ordinance addresses flood hazard areas. The County’s definition of development includes dredging, filling, grading, construction, and site preparation activities that will impact the floodplain. Thus, PEC will need to obtain a permit from the County for these activities. The intake structure, pumphouse, and pipeline construction will impact floodplains in Chatham County. Chatham County also has a flood protection ordinance, and plans will need to be submitted to and reviewed by the County prior to construction activities. All activities will comply with Wake and Chatham counties’ flood protection ordinances.

Increased erosion during construction may slightly increase sediment concentrations and associated nutrients. These changes will be mitigated by incorporating construction erosion mitigation practices, as required by federal and state laws. Long-term impacts will be mitigated by adhering to applicable stormwater regulations including installation of stormwater BMPs. Before water is discharged to Buckhorn Creek, any sediment load increases to the Main Reservoir will be buffered by the sediment removal capability of the reservoir.

Buckhorn Creek’s flow is regulated by the dam and has a historical mean monthly flow ranging from 0.0063 m^3/s to 11.91 m^3/s (0.22 ft^3/s to 420.7 ft^3/s) or

100 gpm to 188,823 gpm (Reference 5.2-011). Average annual downstream releases from the dam to support the proposed expansion are estimated at 0.3 m^3/s (10.3 ft^3/s) or 4623 gpm (Reference 5.2-005). Additional flow may be required at times to maintain lake water quality. A minimum return flow into Buckhorn Creek of 0.57 m^3/s (20 ft^3/s) or 8940 gpm is proposed during normal-flow periods, but will fluctuate depending on PEC operations and weather and flow conditions (Reference 5.2-004). Assuming plant outages, a proposed normal pool elevation within the Main Reservoir of 73.2 m (240 ft.) NGVD29, and a continuous Cape Fear makeup water flow rate of 1.1 m^3/s (40.3 ft^3/s) or 18,088 gpm, the minimum Main Reservoir water elevation during the period of October 1939 to September 2004 was 67.1 m (220 ft.) NGVD29 with the HNP and two proposed AP1000 units operating. Using these parameters, the computed average monthly downstream releases from the Main Dam would be 0.3 m^3/s (10.3 ft^3/s) or 4623 gpm for the period from 1939 to 2004. The proposed flows over the dam are within the normal-flow regime historically seen in Buckhorn Creek. For this reason, impacts to the creek, including stream bank erosion, are expected to be SMALL.

5.2.1.2 Lakes and Impoundments

Harris Reservoir is a man-made lake that provides cooling, process, and domestic water for the HAR. There are no other industrial, municipal, commercial, or agricultural users of Harris Reservoir waters. At current normal levels, it holds approximately 90,000,000 m^3 (73,000 ac-ft) of water, occupies an area of 14.6 km^2 (5.6 $mi.^2$) or 3610 ac., and has an elevation of 67.1 m (220 ft.) NGVD29 (Reference 5.2-002). The proposed alterations are for an inundation of the area surrounding the existing reservoir to an elevation of 73 m (240 ft.), with a minimum elevation of 67 m (220 ft.) necessary for plant operations. The proposed expansion of Harris Reservoir would increase its area by 1440 ha (3570 ac. or 5.6 $mi.^2$) to 3050 ha (7540 ac. or 11.8 $mi.^2$) and its capacity an additional 130,000,000 m^3 to 220,000,000 m^3 (104,563 ac-ft to 177,563 ac-ft) (Reference 5.2-005). Recreational uses of Harris Reservoir include boat launch facilities that will be relocated during construction (Reference 5.2-012). Because boat launch facilities will be relocated and designed to accommodate fluctuating water levels during operation, the impact will be SMALL .

Normal releases of contaminants into the hydrosphere from the HAR facility will have negligible effects on surface and groundwater users and will be in strict compliance with an approved National Pollutant Discharge Elimination System (NPDES) permit issued by the North Carolina Department of Environment and Natural Resources (NCDENR) (likely a revision to NC0039586). This permit will make certain that discharges are controlled from operational activities (such as flumes, sewage treatment facilities, radwaste treatment systems, activated carbon treatment systems, water treatment waste systems, facility service water, stormwater runoff) to Harris Reservoir. The effect on water quality in Harris Reservoir from the operation of the HAR facility will be carefully monitored in full compliance with the NPDES permit that will be issued prior to startup operations.

Should an accidental release of contaminants occur, adverse impacts, if any, will be restricted to the area adjacent to the plant location (Reference 5.2-013).

During approximately 42 months of site preparation, Harris Reservoir will be filled by natural means or from water withdrawal from the Cape Fear River. Filling will occur when enough flow exists in the Cape Fear River to accommodate the minimum flow at Lillington as determined by the USACE. Prior to filling, the landscape between 67.1 m (220 ft.) NGVD29 and 73.2 m (240 ft.) NGVD29 will be cleared of most trees. Trees between 72.2 m (237 ft.) NGVD29 and 73.2 m (240 ft.) NGVD29 are suggested to be thinned, but some will remain to limit erosion. Some existing plants will remain to discourage soil erosion. During the reservoir fill time, soil between the 67.1 m (220 ft.) NGVD29 and 73.2 (240 ft.) NGVD29 contours will adjust to a natural slope. An estimated amount of 15.24 cm (6 in.) of soil will settle at the bottom of Harris Reservoir.

Surface water, water use, erosion, and sedimentation impacts associated with raising the water level in Harris Reservoir will be SMALL.

5.2.1.3 Groundwater

The water table in the vicinity of the HAR site is directly influenced by the topographic high north of the site and occurs as a ridge-like mound northwest of the HAR. The position of the groundwater ridge marks a natural recharge area from which groundwater flows west toward the Auxiliary Reservoir, south toward the Emergency Service Water Discharge Channel, and east toward the Thomas Creek Branch of the Main Reservoir. A series of stormwater drainage ditches, which will intersect the water table based on known elevations, will be constructed around and within the construction area to direct stormwater away from HAR facilities. Stormwater drainage ditches installed in the northern area of the site will have a bottom elevation of approximately 80.5 m (264 ft.) NGVD29, while drainage ditches closer to the HAR facilities will have a bottom elevation of approximately 78 m (256 ft.) NGVD29. The groundwater flow from the north will thus be intercepted by these ditches, which will prevent the continued groundwater flow towards the HAR. See FSAR Figures 2.4.1-204 and 2.4.1-205 for site drainage information.

The net effect of this lower site grade elevation and network of stormwater drainage ditches that will intersect the water table based on known groundwater elevations will be to effectively lower the existing water table around the proposed facilities. Groundwater flow within the surficial material will be redirected toward these ditches from both the north and south sides and ultimately discharge into the Main Reservoir to the east.

Expanding the width of the stormwater drainage ditches near the discharge points may provide an opportunity for the creation of additional wetlands to meet wetland mitigation requirements. Close coordination with the appropriate resource agencies will be required before a definitive mitigation strategy is developed, and the area is determined suitable. The channels and the riparian zone along the edges of the channels could be vegetated with native vegetation such as cattails, sedges, and hydrophilic grasses. Any wetlands created could provide supplemental habitat for area wildlife.

It is anticipated that surface water will be used to meet the domestic, process and cooling water needs of the HAR. Groundwater will not be used as a source of water. The anticipated hydrologic alteration impacts to groundwater from the operation of the HAR are SMALL, and any existing groundwater users within the vicinity will not be impacted.

5.2.1.4 Wetlands

Approximately 73 ha (180 ac. or 0.28 mi.^{2}) of wetlands exist along the perimeter of the reservoir and near the dam. These wetland areas were created or modified during the construction of the HNP (Reference 5.2-010). These wetlands will be inundated because of the increased water level of the reservoir. However, this inundation will also create new wetlands that should compensate impacts to existing wetlands. Potential adverse impacts on wetlands will be limited by compliance with applicable state and federal laws and will be SMALL.

5.2.1.5 Conclusion

The plant water supply will be adequate with the transfer of water from the Cape Fear River to the Main Reservoir. The proposed withdrawal is expected to have a SMALL impact on water supply to other users in the Cape Fear River. The rate at which water is withdrawn will be based on State targets for management of the Cape Fear River resource. A higher withdrawal rate may be used during high-flow periods to fill the lake and make up for any volume deficits. Erosion impacts to Buckhorn Creek are expected to be SMALL, as the proposed flow is within the normal historical flow regime. The effect on water quality in Harris Reservoir due to the operation of the HAR facility will be carefully monitored in full compliance with the NPDES permit that will be issued prior to startup operations. Should an accidental release of contaminants occur, adverse impacts, if any, will be restricted to the area adjacent to the plant location. Potential adverse hydrologic effects of the proposed project should be limited by compliance with applicable state and federal laws. The withdrawal should limit any effects to geometry, flow, and circulation patterns. These withdrawal strategies will help reduce the overall impact of the plant water use on other Cape Fear River water users.

5.2.2 WATER-USE IMPACTS

This subsection discusses the analysis and assessments of the predicted impacts of operational water use:

- Analysis of hydrologic alterations that could have impacts on water use, including water availability.

- Analysis of water quality changes that could affect water use.
- Analysis and evaluation of impacts resulting from these alterations and changes.
- Analysis and evaluation of proposed practices to minimize or avoid these impacts.
- Evaluation of compliance with federal, state, regional, local, and affected Native American tribal regulations applicable to water use and water quality.

As discussed in Subsection 5.2.1, the proposed project is to install and operate two new Westinghouse AP1000 reactors. The proposed reactors have a normal net consumptive use of approximately 1.77 m^3/s (62.66 ft^3/s) or 28,122 gpm during operation (Reference 5.2-003). An additional minimum flow of 0.57 m^3/s (20 ft^3/s) or 8940 gpm over the Harris Dam may be necessary to meet water quality needs (see Section 5.4) (Reference 5.2-004).

Harris Reservoir capacity will be expanded from a current normal operating level of 67.1 m (220 ft.) NGVD29 elevation to a new elevation of 73.2 m (240 ft.) NGVD29. Water from the Cape Fear River, in addition to the existing Harris Reservoir drainage area, will be required to fill and maintain the required pool level for normal operations. The rate at which water is withdrawn will likely be based on a set of operational rules designed to meet the target flows at Lillington, as defined by the 1992 Water Control Manual for B. Everett Jordan Lake. A high withdrawal rate would be used during high-flow periods to fill the lake and make up for any volume deficits. The withdrawal from the Cape Fear River could be reduced during below-normal flows (Reference 5.2-007).

The potential impacts to water supply adequacy and quality surface from hydrologic alterations resulting from the operation of the HAR are described in the following subsections. A summary of activities of water use in included in Table 5.2-2.

5.2.2.1 Freshwater Streams

5.2.2.1.1 Water Availability

Water supply is a critical issue in Cape Fear River Basin because of the rapidly expanding population and subsequent demand for drinking water. There are four drinking water withdrawals from the Cape Fear River between Jordan Lake and Lock and Dam #1 (Figure 5.2-1, Table 5.2-1). In addition, there are 20 point-source discharges between Jordan Lake and Lock and Dam #1 on the Cape Fear River (Figure 5.2-1, Table 5.2-3). The permits for these dischargers are based on the assimilative capacity of the river, which is directly related to flow volume. HAR will discharge into Harris Reservoir, which discharges into Buckhorn Creek, which then combines with the Cape Fear River. Any significant changes in the flow volume of the Cape Fear River during low-flow conditions may affect drinking water withdrawal capacity and discharge capabilities, but makeup water withdrawals can be decreased or halted temporarily during low-flow conditions (Reference 5.2-001).

5.2.2.1.2 Water Quality

The streams and rivers in the Harris Reservoir drainage area are Class B and Class C. Class B waters apply to waters used for primary recreation on an organized basis. Class C waters are defined as those supporting aquatic life propagation and maintenance of biological integrity, wildlife, secondary recreation, and agriculture. Buckhorn Creek upstream of Harris Reservoir is designated as Classes B and C. It is rated Class C from its source to Norfolk Southern Railroad and Class B from Norfolk Southern Railroad to the Harris Reservoir headwaters. The B and C classifications allow any type of NPDES facility as long the discharge will not violate water quality standards. Buckhorn Creek below Harris Dam is classified as C, secondary recreation waters with activities occurring infrequently and with no restrictions on the types of discharges allowed in the watershed. The water quality in these tributaries to Harris Reservoir should not be impacted by plant operations, and impacts will be SMALL. (Reference 5.2-014)

None of the affected creeks or rivers are currently listed as 303(d) impaired, according to the North Carolina Draft 2006 303(d) List of Impaired Waters (Reference 5.2-015). For this reason, none of the affected creeks or rivers has current Total Maximum Daily Load (TMDL) requirements as defined by the Water Pollution Control Act (commonly known as the Clean Water Act) (Reference 5.2-016). However, water quality may be impacted on the Cape Fear River below the intake structure because of the reduced flow. Increased turbidity may occur in Buckhorn Creek due to an increased release from Harris Reservoir. Increased turbidity may also occur in the Cape Fear River at the confluence with Buckhorn Creek due to an increase in normal flows from Buckhorn Creek. Turbidity should not increase to an amount that affects ambient water quality. In accordance with the Water Pollution Control Act, predicted changes in water quality will be evaluated with respect to the State’s Water Quality Criteria for Class WS-V waters (Reference 5.2-014). Impacts to water quality in the Cape Fear River should be SMALL, due to the localized nature of flow changes.

Water quality in Buckhorn Creek downstream of the reservoir should continue to meet criteria for Class C designated uses. Proposed minimum spillover from the dam is 0.57 m^3/s (20 ft^3/s) or 8940 gpm while keeping a minimum water level of 67.1 m (220 ft.) NGVD29; however, lower flow or no-flow periods may occur during drought periods when reservoir levels fall below the proposed normal 73.2 m (240 ft.) NGVD29 operating level (Reference 5.2-004). Since Buckhorn Creek is rated as supporting aquatic life, NCDENR will likely require a continuous minimum flow below the Main Dam to maintain aquatic habitat. The use support rating in Harris Reservoir will also need to be maintained as fully supporting aquatic life. Impacts to water quality in Buckhorn Creek will be SMALL.

5.2.2.2 Lakes and Impoundments

Harris Reservoir is a 1460 ha (3610 ac. or 5.6 mi.^{2}) impoundment that provides the HNP with its cooling water. Construction of the reservoir was completed in 1980 and was inundated by 1983 (Reference 5.2-010). Harris Reservoir is listed as a Class WS-V waters as defined by the North Carolina Schedule of Classifications and Water Quality Standards (Reference 5.2-014). Class WS-V waters are protected as water supplies that are generally upstream and draining to Class WS-IV waters or waters previously used for drinking water supply purposes or waters used by industry to supply their employees, but not municipalities or counties, with a raw drinking water supply source. No operational activities will increase or modify any structural-related impacts (e.g., impacts to the dam on Harris Reservoir) as described in ER Section 4.2. Impacts to surface water and water use will be SMALL.

5.2.2.2.1 Water Availability

Harris Reservoir capacity will be expanded from a current normal operating level of 67.1 m (220 ft.) NGVD29 elevation to a new elevation of 73.2 m (240 ft.) NGVD29. This expansion of Harris Reservoir would increase its area by 1440 ha (3570 ac. or 5.6 mi.^{2}) to 3050 ha (7540 ac. or 11.8 mi.^{2}) and its capacity an additional 130,000,000 m^3 to 220,000,000 m^3 (104,563 ac-ft to 177,563 ac-ft). This increase in capacity will allow for the operation of the HNP and the addition of the HAR. The two proposed units will require the use of water from the Cape Fear River to maintain target lake levels (Reference 5.2-005).

5.2.2.2.2 Water Quality

Harris Reservoir is not listed as impaired on the draft 2006 North Carolina Division of Water Quality (NCDWQ) 303(d) list (Reference 5.2-015). The Class WS-V use rating is fairly protective and will need to be maintained as fully supporting aquatic life and drinking water supply in accordance with requirements of the Water Pollution Control Act (Reference 5.2-016). Maintenance of the lake level through pumping from the Cape Fear River may have an impact on lake water quality. Review of water quality data compiled in Subsection 2.3.1, indicates that water quality is generally good in the Cape Fear River and similar to that of Harris Reservoir, except for some differences discussed below. However, nutrients are of critical interest in southeastern lakes due to their role in algal growth and subsequent eutrophication.

PEC monitors water quality at four surface locations in the lake as part of its annual biological monitoring program reports. The USGS, Middle Cape Fear River Basin Association, and NCDWQ monitor ambient water quality at numerous locations throughout the Cape Fear River Basin. The NCDWQ station, B4050000, near Moncure, North Carolina was selected because of its proximity to the HAR. This station is located on the Haw River just upstream of its confluence with the Deep River where it becomes the Cape Fear River. A summary of key water quality parameters collected by PEC from 1990 through 2004 for Harris Reservoir and NCDWQ at Station B4050000 from 1991 through 2006 is presented in Table 5.2-4 (Reference 5.2-009).

A number of differences exist between the Harris Reservoir and Haw River water quality that could have impacts on long-term water quality and may change the overall water quality and ecological characteristics of the lake. Average metals concentrations including magnesium, copper, lead, and zinc are moderately to significantly higher in the Haw River compared to Harris Reservoir. Nutrient concentrations are also higher in the Haw River and may increase the likelihood of algal blooms if introduced to the reservoir. Although not directly assessed, it is expected that turbidity may increase overall because of the constant inflow of water from the Cape Fear River, causing mixing and stirring up sediment from the lake bottom as well as inputs from the Cape Fear River watershed floor. Continued urban development in the Harris Reservoir watershed may also increase nutrient load and turbidity from stormwater runoff. Appropriate methods for this are discussed in Subsection 5.2.3.

An alternative lake water supply flow has been proposed to supplement the flows required from the Cape Fear River and would be to use effluent discharged from the proposed Western Wake County Regional Water Reclamation Facility (WRF). This would provide up to 0.79 m^3/s (27.85 ft^3/s) or 12,500 gpm in 2020 and up to 1.31 m^3/s (46.42 ft^3/s) or 20,834 gpm by 2030, if a decision is made to allow discharge of this water into the lake (Reference 5.2-008). Effluent characteristics and Harris Reservoir water quality characteristics would need to be evaluated to determine whether use of this water source would significantly impact the water quality and ecology of the reservoir. Protective actions to prevent of minimize impact of improper discharge would also need to be evaluated prior to accepting this discharge into the lake.

5.2.2.3 Groundwater Use

It is anticipated that surface water will be used to meet the domestic, process, and cooling water needs of the HAR. Groundwater will not be used as a source of water. There are no anticipated hydrologic alteration impacts to groundwater from the operation of the HAR and impacts will be SMALL.

5.2.2.4 Conclusions

The proposed withdrawal will have a SMALL impact on water quality and the assimilation capacity in the Cape Fear River. The river is a receiving water for a number of point source dischargers. To minimize impacts during low flow periods, makeup water withdrawals from the river would be limited for plant operations and would be substantially reduced during severe drought periods. During these severe drought periods, plant water use requirements would be met by using available reservoir storage. Detailed analyses, discussed in Subsection 5.2.3, were conducted to evaluate potential impacts. Additional analyses may be required during the state permitting process to ensure that all state water quality standards are met, that any changes made to water quality are in compliance with the Water Pollution Control Act, and that withdrawals will not negatively impact other users, such that water use impacts will be SMALL.

5.2.3 ADDITIONAL IMPACT ANALYSIS METHODS

Potential hydrology and water quality impacts from the proposed use of Cape Fear River water must be considered. A number of modeling tools have been used to assess the magnitude of the potential impacts. These impacts are described below. During permitting, PEC will continue to work with NCDWQ and NCDWR to ensure that critical management questions are addressed by the modeling analysis and that results are used to specify appropriate use of water resources in the basin.

The proposed withdrawal of water from the Cape Fear River to fill and maintain water levels in Harris Reservoir sufficient to provide cooling for the existing and two additional towers can have two main effects on Cape Fear River water. First, water supply in the Cape Fear River Basin can be in high demand, especially during drought periods. Secondly, a reduction in flow during drought conditions could affect the assimilative wastewater capacity of the river. Two models, the North Carolina Division of Water Resources' (NCDWR's) Cape Fear River Basin Hydrologic Model (CFRBHM) and the USEPA's QUAL2E (Enhanced Stream Quality Model) model can be used to evaluate the likely magnitude of these impacts.

The CFRBHM, based on HydroLogic's OASIS model and modified for NCDWR, is designed to evaluate water use in the basin. The model includes all significant water withdrawals and discharges to the Cape Fear River and its tributaries and is used to manage water demands within the Basin. The CFRBHM was used to assess the potential impacts of the plant operation on water supply in the Cape Fear River Basin. The current model developed for the NCDWR was revised to evaluate operational withdrawals under typical and low-flow conditions to determine the impacts of water use by the HAR. Withdrawal scenarios were evaluated. Impacts were SMALL when withdrawals from the Cape Fear River were managed based on the current Jordan Lake stage and instream flow at Lillington.

NPDES discharge permits for point sources in the basin are specified based on their impacts to water quality under drought conditions, usually the 7Q10 rate. Withdrawal of water during drought periods could reduce the actual assimilative capacity of the system (Reference 5.2-017). The USEPA's QUAL2E model is designed to evaluate water quality in surface waters. A version of the model setup up by NCDWQ was revised to evaluate the impact of the proposed withdrawal to water quality for the 7Q10 in the Cape Fear River (Reference 5.2-018). Review of the results showed a SMALL impact on instream water quality.

The water quality in Harris Reservoir may be affected by introduction of water from the Cape Fear River. The USACE's BATHTUB model can be used to evaluate seasonal changes in reservoir water quality due to potential inflows (Reference 5.2-019). The model provides a scoping level estimate of impacts by simulating growing season nutrient concentrations, chlorophyll *a* concentrations, and Secchi depth. A BATHTUB model for Harris Reservoir was developed to assess the potential impacts of inflows from the Cape Fear River. Evaluation of the results showed a SMALL overall impact from the introduction of Cape Fear River water to Harris Reservoir. The BATHTUB analysis also indicated that hydraulic residence time would decrease under both potential inflow alternatives compared to the existing conditions.

5.2.4 REFERENCES

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Table 5.2-1
Water Withdrawals from the Cape Fear River between Buckhorn Dam and Lock and Dam #1

Public Water Supply Type	Water Type	Function	Public Water Supply ID	System Name	Population	Address	City	State	Zip
Community	Surface	Treatment Plant	0343010	City of Dunn	10143	805 West E Street	Erwin	NC	28339
Community	Surface	Treatment Plant	0326010	Fayetteville WTP	179000	P.O Box 1089	Fayetteville	NC	28301
Community	Surface	Treatment Plant	0353010	Sanford, City of	43616	7441 Popular Springs Church Rd	Sanford	NC	27330
Community	Surface	Treatment Plant	0343045	Harnett Co Dept of Public Utilities	79058	PO Box 1119	Lillington	NC	27546

Sources: Reference 5.2-001 and Reference 5.2-020

Table 5.2-2
Summary of Water Use at Proposed Facilities

Flow Description	**Flow Volume**[(a)]
Estimated Mean Annual Flow in Cape Fear River at Buckhorn Dam (1982 – 2005)	1,392,719 gpm (3103 ft^3/s)
Estimated 7Q10 in Cape Fear River at Buckhorn Dam (1982 – 2005)	171,453 gpm (382 ft^3/s)
Assuming 20% of 7Q10 is available during drought periods Available Makeup Rate from Cape Fear River	34,291 gpm (76.4 ft^3/s)
Total or maximum lake makeup flow withdrawal from Cape Fear River	60,000 gpm (133.68 ft^3/s)
Cape Fear Makeup Pumphouse Capacity	3 pumps having 20,000 gpm (44.56 ft^3/s) capacity each
Normal water withdrawal from Harris Reservoir (HAR 2 and HAR 3): *(Cooling Tower makeup water + raw water use + Service Water Tower makeup water + demineralization makeup water)*	42,074 gpm (93.74 ft^3/s)
Normal consumptive water use from Harris Reservoir, which includes (HAR 2 and HAR 3): (*Cooling Tower makeup water + raw water use + Service Water Tower makeup water + demineralization makeup water) – (sanitary discharge + demineralization water discharge + Cooling Tower blowdown + Service Tower blowdown)*	28,122 gpm (62.66 ft^3/s)
Cooling Tower blowdown water returned to Harris Reservoir (HAR 2 and HAR 3)	13,200 gpm (29.04 ft^3/s) normal operation 26,400 gpm (58 ft^3/s) max
Service Water Tower Blowdown Returned to Harris Reservoir (HAR 2 and HAR 3)	317 gpm (<1 ft^3/s) normal operation 500 gpm (1 ft^3/s) max.
Approximate flow over the Main Dam (min. flow needed to manage water quality for operation of HNP, HAR 2, and HAR 3).	8940 gpm (20 ft^3/s) min.

Notes:

a) All flows are approximate and are subject to change based on future analyses.

gpm = gallons per minute
ft^3/s = cubic feet per second

Sources: Reference 5.2-006 and Reference 5.2-021

Table 5.2-3 (Sheet 1 of 2)
NPDES Permitted Discharges to the Cape Fear River between Buckhorn Dam and Lock and Dam #1

Permit	Owner	Facility	County	Type	Class	Subbasin	Receiving
NC0000892	Dynea USA Inc	Dynea USA Inc	Chatham	Industrial Process & Commercial Wastewater Discharge	Major	03-06-07	Haw River
NC0003522	Alamac American Knits LLC	Elizabethtown plant	Bladen	Industrial Process & Commercial Wastewater Discharge	Major	03-06-16	Cape Fear River
NC0003573	E I Dupont de Nemours & Company Inc	Dupont Fayetteville Works	Bladen	Industrial Process & Commercial Wastewater Discharge	Major	03-06-16	Cape Fear River
NC0003719	Monsanto Company	Monsanto Company	Cumberland	Industrial Process & Commercial Wastewater Discharge	Major	03-06-15	Cape Fear River
NC0023957	PWC/Fayetteville	Cross Creek WWTP	Cumberland	Municipal Wastewater Discharge Large	Major	03-06-15	Cape Fear River
NC0043176	City of Dunn	City of Dunn WWTP	Harnett	Municipal Wastewater Discharge Large	Major	03-06-13	Cape Fear River
NC0050105	PWC/Fayetteville	Rockfish Creek WWTP	Cumberland	Municipal Wastewater Discharge Large	Major	03-06-15	Cape Fear River
NC0064521	Town of Erwin	Erwin WWTP	Harnett	Municipal Wastewater Discharge Large	Major	03-06-13	Cape Fear River
NC0078344	Smithfield Packing Company Inc	Tarheel Plant	Bladen	Industrial Process & Commercial Wastewater Discharge	Major	03-06-16	Cape Fear River
NC0007684	Harnett County Public Utilities	Harnett County Regional WTP	Harnett	Water Plants and Water Conditioning Discharge	Minor	03-06-07	Cape Fear River
NC0021636	Harnett County Public Utilities	North Harnett Regional WWTP	Harnett	Municipal Wastewater Discharge <1 mgd	Minor	03-06-07	Cape Fear River
NC0026671	Town of Elizabethtown	Elizabethtown WWTP	Bladen	Municipal Wastewater Discharge <1 mgd	Minor	03-06-16	Cape Fear River

Table 5.2-3 (Sheet 2 of 2)
NPDES Permitted Discharges to the Cape Fear River between Buckhorn Dam and Lock and Dam #1

Permit	Owner	Facility	County	Type	Class	Subbasin	Receiving
NC0030091	Harnett County Public Utilities	Buies Creek WWTP	Harnett	Municipal Wastewater Discharge <1 mgd	Minor	03-06-07	Cape Fear River
NC0058297	Elizabethtown Power LLC	Elizabethtown Power LLC	Bladen	Industrial Process & Commercial Wastewater Discharge	Minor	03-06-16	Cape Fear River
NC0076783	PWC/Fayetteville	Hoffer WTP	Cumberland	Water Plants and Water Conditioning Discharge	Minor	03-06-15	Cape Fear River
NC0080560	Town of Erwin	Erwin WTP	Harnett	Water Plants and Water Conditioning Discharge	Minor	03-06-13	Cape Fear River
NC0082597	Town of Angier	Angier WWTP	Harnett	Municipal Wastewater Discharge <1 mgd	Minor	03-06-07	Cape Fear River

Sources: Reference 5.2-001

Table 5.2-4 (Sheet 1 of 2)
Comparison of Water Chemistry Data from Harris Reservoir and the Haw River at Moncure (1991 – 2006)

	Harris Reservoir				Haw R.
Parameter	**E2 Surface**[b]	**H2**[b]	**P2**[b]	**S2**[b]	**B4050000**[c]
Total Alkalinity (as $CaCO_3$) (mg/L)					
Number of Events	50	56	56	50	14
MAX	23	20	19	23	48
MIN	7	4.7	7.1	3.8	4
NC Water Quality Standards – N/A Mean[a]	13.0	12.2	12.1	12.1	33.2
Chloride (mg/L)					
Number of Events	50	56	55	50	95
MAX	14	13	13	14	28
MIN	3	2.8	2.9	2.3	5
NC Water Quality Standards – 250 Mean	9.2	8.5	8.8	8.6	14.8
Total Magnesium (mg/L)					
Number of Events	50	56	56	50	3
MAX	2.2	2.2	2.1	2.2	42
MIN	1	1.1	1	1	2.7
NC Water Quality Standards – N/A Mean	1.8	1.7	1.8	1.7	15.6
Total Ammonia Nitrogen (NH_3-N) (mg/L)					
Number of Events	55	67	67	67	111
MAX	0.22	0.16	0.19	0.24	1.1
MIN	<0.02	<0.02	<0.02	<0.02	0.01
NC Water Quality Standards – N/A Mean	0.1	0.05	0.05	0.05	0.17
Total Nitrate + Nitrite-N (mg/L)					
Number of Events	55	67	67	67	114
MAX	0.36	0.25	0.22	0.33	1.3
MIN	<0.02	0.01	<0.02	<0.02	0.01
NC Water Quality Standards – N/A Mean	0.1	0.05	0.05	0.05	0.49
Total Nitrogen (mg/L)					
Number of Events	62	74	74	74	115
MAX	1	1.1	0.9	1.5	2.0
MIN	0.29	<0.05	<0.05	<0.1	0.45
NC Water Quality Standards – N/A Mean	0.6	0.6	0.6	0.6	1.06
Total Phosphorus (mg/L)					
Number of Events	62	74	74	68	113
MAX	0.12	0.2	0.075	0.074	0.3
MIN	0.017	0.013	0.016	0.011	0.01
NC Water Quality Standards – N/A Mean	0.04	0.04	0.029	0.034	0.1

Table 5.2-4 (Sheet 2 of 2)
Comparison of Water Chemistry Data from Harris Reservoir and the Haw River at Moncure (1991 – 2006)

	Harris Reservoir				Haw R.
Parameter	**E2 Surface**[(b)]	**H2**[(b)]	**P2**[(b)]	**S2**[(b)]	**B405000**[(c)]
Total Copper (µg/L)					
Number of Events	50	56	56	50	95
MAX	<10	<10	<10	,10	35
MIN	<1	0.7	<1	<1	2
NC Water Quality Standards – 7 Mean	2.6	2.1	2.2	2.1	5.0
Total Lead (µg/L)					
Number of Events	18	24	24	18	2
MAX	<1	<1	1.2	<1	20
MIN	<1	<1	<1	<1	17
NC Water Quality Standards – 25 Mean	<1.0	<1.0	1.0	<1.0	18.5
Total Zinc (µg/L))					
Number of Events	30	35	35	29	60
MAX	40	20	30	<20	150
MIN	<20	<10	20	<10	10
NC Water Quality Standards – 50 Mean	21.7	19.7	20.3	19.7	27.5

Notes:

a) Mean values for parameters with data that were reported less than the reporting limit were calculated by using the reporting limits as the value (e.g., ≤ 1.0 to calculate the mean).

b) Collected by PEC.

c) Collected by NCDWQ.

mg/L = milligrams per liter
N/A = not available

Source: Reference 5.2-009

5.3 COOLING SYSTEM IMPACTS

5.3.1 INTAKE SYSTEM

The information presented in this section addresses the requirements of NUREG-1555, Subsection 5.3.1.1, Hydrodynamic Descriptions and Physical Impacts, and Subsection 5.3.1.2, Aquatic Ecosystems, pertaining to the operational impacts of the cooling water intake system. This information is consistent with 10 CFR 51.70. The information describing the intake system, including descriptions of the layout of the proposed plant (specifically, the layout of the main water bodies, including the locations of all intakes and discharges) and the proposed plant's expected water use, were obtained from ER Subsections 3.3.1, 3.4.1, and 3.4.2. Input related to potential water-use restrictions caused by operation of the intake system was obtained from Subsection 5.2.2. Relevant information contained in Sections 5.1 and 5.2 were used in the evaluation of the intake system's impacts. The impact analyses of raw water pumphouse operations include consideration of the spatial and temporal distribution of the surface water body flow field and the physical effects of the flow field induced by the intake system's operation, as well as a prediction of system impingement and entrainment impacts to aquatic biota and intake system physical impacts, for example, bottom scouring, induced turbidity, and silt buildup. The discussion considers the operational aspects of the Clean Water Act (CWA), Section 316(b), Phase I intake design and permitting requirements, and a brief discussion of alternative intake system designs.

Nuclear power plants that use closed-cycle, re-circulating cooling systems (cooling towers) withdraw significantly less water for condenser cooling than open-cycle or once-through units. Depending on the type of cooling tower installed and the quality of the makeup water, power plants with closed-cycle, re-circulating (versus "helper") cooling towers withdraw only 5 to 10 percent as much water as plants of the same size with once-through cooling systems. That is the case with the HAR. The closed-cycle system also minimizes the makeup water requirements from the Cape Fear River. The two new intakes (one on Harris Reservoir and the other on the Cape Fear River) will be designed with low through-screen velocities less than 0.15 meters per second (mps) (0.5 feet per second [fps]) to minimize physical and biological effects of water withdrawal (Reference 5.3-001).

5.3.1.1 Hydrodynamic Descriptions and Physical Impacts

The operation of cooling water intakes results in the creation of velocity flow fields in front of, and adjacent to, the raw water pumphouse that hold the potential to cause bottom scouring, induced localized turbidity, and silt buildup. The potential for these impacts to occur depends on the velocities induced by the water withdrawal pumps, the size of the induced flow field, the nature of the substrates adjacent to the raw water pumphouse, the sediment load characteristics of the water body, and the location and design features of the intake structure. This subsection describes the proposed cooling system design and discusses potential impacts from the cooling system's design and operation.

Two new intake structures are part of the cooling tower makeup water system designed for the new unit cooling water systems. The Harris Lake makeup water system includes the intake channel in the Cape Fear River, the Cape Fear River makeup water intake, the makeup water discharge structure on Harris Reservoir, and the raw water pumphouse that draws cooling water from the reservoir to the new units. The flow rate to be produced by the Harris Lake makeup system intake structure and pumphouse will be approximately 3.8 m^3/s (133.68 ft^3/s) or 60,000 gpm, based on a conceptual design of three pumps drawing 1.26 m^3/s (44.56 ft^3/s) or 20,000 gpm each (Reference 5.3-001).

The raw water pumphouse proposed for the HAR will be in compliance with Phase I regulations implementing Section 316(b) of the CWA by virtue of its closed-cycle design, less than 0.15 mps (0.5 fps) through-screen velocities, and fish return system, which incorporates these measures to mitigate impacts to aquatic biota (Reference 5.3-002). The deepwater intake port supplying water to the raw water pumphouse is to be located at the 12-m (40-ft.) depth contour and supported above the lake bottom (Reference 5.3-001). This location of the actual water withdrawal point is designed to obtain cooler water to maximize unit thermal efficiencies and to minimize the potential effects on local physical bottom habitat and biota.

Makeup water to the lake to replace evaporative losses from the cooling towers will be withdrawn from the Cape Fear River via a shoreline-sited Harris Lake makeup water system intake structure and pumphouse. The Harris Lake makeup water system intake structure and pumphouse is proposed to be located in a small cove on the east side of the Cape Fear River, just north of the Buckhorn Dam. With dredging of the intake channel in the cove, the dam provides sufficient water depth for proper operation of the pumps. However, if the Buckhorn Dam was lost (for whatever reason), a minimum of 3.4 m (11 ft.) of headwater depth would be lost at the pumphouse. Also, during low-flow conditions in the absence of the dam, the width of the river would be narrower than its present width (approximately 335.3 m [1100.0 ft.]), eliminating the water flow in the river from reaching the intake forebay. To address Cape Fear River changing hydrodynamics that might occur due to the removal of Buckhorn Dam (for whatever reason), the following design items are proposed. The invert elevation in the pumphouse forebay is set sufficiently low to create sufficient net positive suction head (NPSH) to operate the pumps during low river flow in the absence of the dam. A permanent channel is proposed from the low point in the river cross section to the forebay to ensure river water can reach the pumphouse. The channel consists of a 30.5-centimeter- (cm) (12.0-inch [in.]) thick reinforced concrete slab with sloped riprap sides. The slab is proposed to facilitate dredging as required to remove river sediment buildup. It should be noted that a regular maintenance program may be required to dredge the intake channel (Reference 5.3-001).

The Harris Lake makeup water system pumphouse is designed to Hydraulic Institute Guidelines and sized to meet the Phase I “less than 0.15 mps (0.5 fps) through-screen velocity” requirements (Reference 5.3-002). The traveling water screens are sized, based on USEPA Final Rule 316(b) flow velocity, to accommodate three 1.26 m^3/s (44.56 ft^3/s) or 20,000-gpm pumps (Reference 5.3-001). The Harris Lake makeup water system pumphouse will incorporate a number of design features that will reduce impingement and entrainment of aquatic organisms and minimize physical changes to the adjacent river bottom, including the following:

- Orientating the Harris Lake makeup water system pumphouse and canal perpendicular to the river and its flow.
- Low approach velocities (less than 0.15 mps (0.5 fps) through screen velocities at the intake screens) at the traveling screens to the makeup water pumps.
- A submerged weir across the intake canal (Figure 4.0-5).
- Screens with 3/8-in. mesh in each bay.

Each pumphouse bay includes two through-flow traveling water screens with associated screen wash pumps of 0.016 m^3/s (0.57 ft^3/s) or 256.0 gpm at 7 kilograms per square centimeter (kg/cm^2) (100 pound-force per square inch [psi]) discharge pressure. Screens with 3-m (10-ft.) wide baskets, with standard 0.95-cm (3/8-in.) mesh in each bay, will provide compliance with the USEPA Rule 316(b), which requires the flow velocity through the screen to be less than or equal to 0.15 mps (0.5 fps). The traveling water screens can be provided with “Ristroph” type basket design, separate fish and trash spray wash, and separate fish and trash return troughs back to the Cape Fear River (Reference 5.3-001).

NUREG-1555 suggests that calculations or modeling of the flow fields caused by the new raw water pumphouse should be undertaken, where appropriate, to describe impacts to the physical habitats and aquatic biota. Evaluations of the impacts to physical habitats, aquatic biota of water withdrawal, impingement, and entrainment in this section do not include development of calculations or modeling predictions of the induced potential flow fields. This is because development of flow field velocity profiles is not required to evaluate impacts, since the facility will be designed to meet the stringent intake design through-screen velocity requirements of less than 0.15 mps (0.5 fps) required by the CWA Section 316(b) Phase I regulations for new raw water pumphouse (Reference 5.3-002). Since modeling would not produce different results than this criterion, the through-screen velocity of 0.15 mps (0.5 fps) was used to evaluate the impacts at the HAR site.

The Harris Reservoir operational intake port, its associated lake-shore raw water pumphouse, and the Harris Lake makeup water system pumphouse on the Cape Fear River are not anticipated to cause adverse physical effects (bottom scouring or induced turbidity) to the bottom habitats at each intake location. While modeling has not been used to describe the actual induced flow field, the relatively low intake volumes (less than 5 percent mean annual flow of the Cape Fear River), the low approach and less than 0.15 mps (0.5 fps) through-screen approach design velocities of the proposed intakes, and the 12.2-m (40-ft.) depth contour location of the Harris Reservoir intake port will combine to minimize physical changes to the associated bottom habitats (Reference 5.3-001).

Placing the Harris Lake makeup water system pumphouse in the Cape Fear River near-shore and above the dam is anticipated to cause some localized accumulation of river sediments following high flow and high sediment load periods, possibly requiring periodic dredging in front of the intake and in the intake canal to maintain the full low velocity design features (Reference 5.3-001). The 12.2-m (40-ft.) depth of the Harris Reservoir intake port and its low design approach velocities should not result in increased sediment buildup that would affect intake design performance, and periodic sediment removal is not anticipated. The amounts of anticipated sediment at the Harris Lake makeup water system pumphouse have not been predicted and would be based on actual operating conditions. Periodic maintenance dredging would be used to maintain acceptable design operational parameters and efficient Harris Lake makeup water system pumphouse operations.

The estimated physical impacts of the raw water pumphouse and the Harris Lake makeup water system pumphouse are SMALL.

5.3.1.2 Aquatic Ecosystems

The location and design of a raw water pumphouse for the HAR are subject to the requirements of CWA, Section 316(b), Phase I regulations, “National Pollutant Discharge Elimination System [NPDES]: Regulations Addressing Cooling Water Intake Structures for New Facilities; Final Rule”. This Final Rule applies to new standalone facilities that use a raw water pumphouse to withdraw water from waters of the United States. New facilities subject to this regulation include those that have a design intake flow greater than 7.6 million liters per day (mld) (2 million gallons per day [mgd]) (Reference 5.3-002). The estimated 3.78 m^3/s (133.68 ft^3/s) or 60,000 gpm needed for makeup water for the HAR means that the new power generating facility is subject to the provisions of the Phase I regulations.

CWA Section 316(b) Phase I regulations describe the basic systems that are to be used for new power plant intakes to reduce impacts to aquatic communities to an acceptable minimum (Reference 5.3-002). These include restrictions on water body flows and prescribed intake design features, including design minimums for through-screen velocities. This discussion of the effects of the cooling water intakes is limited to the HAR.

The permitting of a raw water pumphouse will be covered by the NPDES permitting process, using the applicable Phase I regulations. Two regulatory tracks are available to applicants: Track 1 establishes national intake capacity and velocity requirements, as well as location and capacity-based requirements to reduce flow below certain proportions of certain water bodies; Track 2 allows permit applicants to conduct site-specific studies to demonstrate that alternatives to the Track 1 requirements will effect the same protection of aquatic resources (primarily fish and shellfish species) (Reference 5.3-002). Potential cooling system alternatives include once-through cooling and alternative intake designs and velocity profiles. Due to the limited thermal dissipation of Harris Reservoir and the limited makeup water available from the Cape Fear River, feasible alternatives to a closed-cycle cooling water system are not available for the HAR. PEC has proposed closed-cycle cooling for the circulating water system (CWS). PEC will use Track 1 for the cooling water system and a raw water pumphouse design.

Track 1 requirements are as follows (Reference 5.3-002):

- Cooling water intake flow must be at a level commensurate with that achievable with a closed-cycle, re-circulating cooling system.
- Through-screen intake velocity must be less than or equal to 0.15 mps (0.5 fps).
- Location and capacity-based limits must be met:
    - For reservoirs and lakes (none).
    - For rivers, intake volume must not exceed 5 percent of mean annual flow.
- Additional intake design fish protection technologies must be selected and implemented where the location of a raw water pumphouse is in “areas where fish and shellfish need additional protection.” These technologies could include those that minimize both impingement and entrainment, but most likely would apply to the reduction of entrainment in an estuarine setting.

The design of the cooling water system proposed for the HAR will meet each of the applicable Phase I, Track 1 requirements.

5.3.1.2.1 Flow Capacity-Based Limits

As previously noted, there are no flow restrictions for cooling water reservoirs, except that the flow volumes and resulting thermal discharges meet established water quality standards. The proposed cooling water system requirements and resulting compliance with water quality limits will be met by the expanded reservoir volumes.

The Phase I flow restriction for proposed new units on rivers is that the facility must withdraw less than 5 percent of mean annual flow. The HAR will withdraw a maximum of 3.78 m^3/s (133.68 ft^3/s) or 60,000 gpm of makeup water through the proposed Harris Lake makeup water system pumphouse (Reference 5.3-001). The calculated mean annual flow of the Cape Fear River at the proposed Harris Lake makeup water system pumphouse is 88 m^3/s (3103 ft^3/s) or 1,392,719 gpm (Reference 5.3-003). Therefore, the proposed water withdrawal volumes are approximately 4.3 percent of mean annual flow, meeting the Phase I flow restriction requirements.

5.3.1.2.2 Impingement

Site-specific aquatic ecology studies were not conducted in the Cape Fear River adjacent to the proposed Cape Fear River cooling water intake structure (CWIS) raw water pumphouse, since an Impingement Mortality and Entrainment Characterization Study at the Cape Fear Power Plant was conducted in 2005 - 2006 in support of the Comprehensive Demonstration Study (Reference 5.3-004). Cape Fear Power Plant is located on the Cape Fear River in Moncure, Chatham County, North Carolina. The Cape Fear Power Plant, owned and operated by PEC, withdraws cooling water from the Cape Fear River just downstream of the confluence of the Haw River and the Deep River. The Buckhorn dam, a decommissioned hydropower generation facility, is located approximately 8851 m (5.5 mi.) downriver of the facility and creates a backwater pool that extends upriver of the facility. Since the Cape Fear Power Plant is located approximately 8047 m (5 mi.) upstream of the proposed CWIS location, comparable water body and biological conditions to HAR are expected. Therefore, these impingement and entrainment data were used to evaluate potential impingement mortality and entrainment at HAR. The following summarizes the results of the Impingement Mortality and Entrainment Characterization Study at the Cape Fear Power Plant and evaluates potential impingement and entrainment impacts of the proposed HAR CWIS.

Both the raw water pumphouse and the Harris Lake makeup water system pumphouse are designed to meet the Phase I “less than 0.15 mps (0.5 fps) through-screen velocity” requirements (Reference 5.3-002). Since the through-screen design velocity is approximately twice the approach velocity, the approach velocities designed for both the raw water pumphouse and the Harris Lake makeup water system pumphouse are approximately, 0.076 mps (0.25 fps), a very low approach velocity that will allow most healthy fish to avoid impingement. Impingement rates are estimated to be low and to have no measurable adverse impacts to populations of fish and shellfish in either the Harris Reservoir or the Cape Fear River.

The anticipated impingement impacts of the proposed raw water pumphouse and the Harris Lake makeup water system pumphouse are SMALL.

5.3.1.2.2.1 Impingement Mortality

Impingement mortality studies were conducted at Cape Fear Power Plant from September 2005 through August 2006. Impinged organisms were collected in a 0.95-cm (3/8-in.) mesh basket placed in the debris return trough for a 24-hour sampling event. The 0.95-cm (3/8-in.) mesh traveling screens were rotated and cleaned prior to the impingement mortality sampling event. During the 24-hour sampling event, the screens were fixed for a period of 6 hours then rotated with debris and aquatic organisms being washed into the sluiceway. Sampling from the sluiceway occurred at 6-hour intervals such that two samples each were collected during the day and night. Organisms were identified, counted, measured, and weighed. Length and weight measurements were randomly recorded for at least 30 individuals of a species from each 6-hour sample. Extremely large samples were sub-sampled. Immediate mortality was noted and recorded.

Twenty-nine fish species representing 10 families were collected during impingement sampling at the Cape Fear Power Plant. Five species accounted for over 98 percent of the total number of fish collected and 94 percent of the fish biomass collected: threadfin shad (*Dorosoma petenense*), gizzard shad (*Dorosoma cepedianum*), bluegill (*Lepomis macrochirus*), channel catfish (*Ictalurus punctatus*), and white perch (*Morone americana*) (Figure 5.3-1). Threadfin shad comprised over 86 percent of the total number of individuals, followed by gizzard shad (5 percent). Threadfin shad and channel catfish have been widely introduced throughout the Eastern United States since the 1960's and late 1970s and, therefore, are not native to the Cape Fear River drainage. These two species together comprised approximately 89 percent of the total number and 54 percent of the total biomass collected during the study period. No threatened or endangered fish species were collected during the study period.

Invertebrate species incidentally collected during impingement sampling were dominated by Asiatic clam (*Corbicula fluminea*), an exotic introduced species, comprising approximately 92 percent of the total number of invertebrates and 76 percent of the total biomass collected during the study period.

Diurnal and temporal variations in impingement were observed during the impingement study. Greater numbers and biomass were collected during night compared to day sampling for all fish species collected. Impingement at night accounted for 70 percent of the impingement total. Highest impingement occurred during January 2006 and coincided with cooler winter water temperatures. Dominant species impinged at this time due to cold stress were threadfin and gizzard shad. The 3 months of December through February accounted for 70 percent of all impinged fish, with 95 percent of the impinged fish during those months being threadfin shad and gizzard shad (Reference 5.3-004). Threadfin shad and gizzard shad are subject to winter kills at the northern parts of their range, often resulting in large numbers of moribund shad becoming impinged on power station intakes (Reference 5.3-005).

Immediate mortality of the five numerically dominant fish species collected ranged from a low of 18 percent for bluegill to a high of 84 percent for threadfin shad. Zero mortality was recorded for six additional species but sample size was relatively low. No latent mortality studies were conducted.

Impingement rates and mortality are directly correlated with finfish community composition and abundance, species-specific swimming speeds, intake velocities, the volume of water withdrawn by the power station and the type of intake screening technology (Reference 5.3-006 and Reference 5.3-007). In order to evaluate potential impingement impacts at the proposed CWIS, the following data were assessed:

- Species-specific impingement rates at Cape Fear Power Plant.
- Finfish impingement composition and density at Cape Fear Power Plant.
- Flow requirements of Cape Fear Power Plant and HAR.
- Approach and through-screen intake velocities at Cape Fear Power Plant and HAR.
- Fish survival rates using Ristroph screen systems.

Flow requirements at the two power plants were compared to estimate the effect of differing water volumes on impingement rates from the same water body. The proposed CWIS has a design capacity of 327,059,579.5 liters per day (lpd) (86.4 mgd) and a design annual intake volume of 119,142,808,075.6 liters (31,474.2 million gallons). Cape Fear Power Plant has a design capacity of 1,294,610,835.6 lpd (342.0 mgd) and a design annual intake volume of 472,809,290,055.4 liters (124,903 million gallons) (Pumps 1E, 1W, 2E, 2W, 5A, 5B, 6A, and 6B) (Reference 5.3-008). Based on these data, four times (124,903/31,474.2) more water volume is required at Cape Fear Power Plant as compared to HAR. Therefore, impingement impacts are expected to be significantly lower at HAR due to water volume alone.

Velocities at the two power plant intake structures were compared to estimate the effect of differing through-screen and approach velocities on impingement rates from the same water body. The raw water pumphouse and the Harris Lake makeup water system pumphouse are designed to meet the 316(b) Phase I regulations requiring “less than 0.15 mps (0.5 fps) through-screen velocity” requirements (Reference 5.3-002). Since the through-screen design velocity is approximately twice the approach velocity, the approach velocities designed for both the raw water pumphouse and the Harris Lake makeup water system pumphouse are approximately 0.08 mps (0.25 fps). The average design intake velocities at Cape Fear Power Plant were calculated to be approximately 0.17 mps (0.57 fps) at Screens 1 and 2 and 0.48 mps (1.56 fps) at Screens 5A-5C (Reference 5.3-008).

The very low approach velocity of 0.08 mps (0.25 fps) at HAR will allow most healthy fish to avoid impingement while the higher velocities of 0.48 mps (1.56 fps) at Cape Fear Power Plant may not allow healthy fish to avoid impingement. Table 5.3-1 displays experimentally derived maximum intake velocities that different species can escape at different temperatures (Reference 5.3-006). The pelagic species showed higher swimming speeds as compared to the demersal species. All fish species, regardless of age or temperature, possess swimming capabilities to maintain position in front of the HAR CWIS. While the data in Table 5.3-1 are for European fish species, it is expected that similar results would be obtained from experiments conducted on North American fish species. Most fish that encounter the intake structure or that enter the intake forebay possess swimming capabilities greater than the encountered approach velocities 0.08 mps (0.25 fps) or through screen velocity 0.15 mps (0.5 fps), thereby contributing to the low impingement rates estimated at the proposed raw water pumphouse. While the impingement of healthy fish is projected to be a very small number, it should be recognized that the majority of impingement will occur due to moribund and winter kill fish. Based on the Cape Fear Power Plant impingement data, these moribund or dead fish are anticipated to be threadfin and gizzard shad.

The use of modified Ristroph screens and a fish return system at HAR will also reduce the impingement of resident fish species. Healthy impinged fish collected by the proposed modified Ristroph screens and returned to the Cape Fear River using a fish return system are expected to have high survival rates based on technical literature on fish survival using modified Ristroph screens. The effectiveness of 0.95-cm (3/8-in.) mesh modified Ristroph traveling screens in reducing impingement varies by species. Survival data indicate that hardier species are more tolerant of impingement stresses and have higher survival rates than sensitive species. Research in 2003 by the Electric Power Research Institute (EPRI) at other power stations has shown that 0.95-cm (3/8-in.) mesh modified Ristroph traveling screens can effectively reduce average impingement between 10 and 98 percent for the dominant fish species that inhabit the Cape Fear River (Table 5.3-2) (Reference 5.3-007). The extended survival rates at the proposed CWIS are expected to be higher than the EPRI study results because the velocity at the proposed CWIS will be lower than the CWIS of which the EPRI results are based.

While a quantitative estimate of the impingement impacts of the proposed raw water pumphouse and the Harris Lake makeup water system pumphouse cannot be developed in advance of operational monitoring, the impacts are predicted to be SMALL due to the relatively low flow requirements, low velocity design and use of modified Ristroph screens and a fish return system.

5.3.1.2.3 Entrainment

The overall reduction in entrainment due to the incorporation of the 316(b) Phase I Track 1 approach to the cooling water system and intake design is approximately 95 percent (Reference 5.3-002).This is the result of the closed-cycle cooling tower-based system that results in water withdrawal requirements designed to replace evaporative losses. The discussion of the potential impacts of entrainment requires that both the raw water pumphouse and the Harris Lake makeup water system pumphouse be addressed.

Entrainment studies were conducted at Cape Fear Power Plant from September 2005 through August 2006. Entrainment samples were collected in the intake forebay with a half-meter, 505-micrometer mesh plankton net fished below the water surface. Two day and night samples each were collected to assess potential diel variations.

Five taxa comprised approximately 92 percent of the total number of organisms collected with entrainment sampling. Dominant taxa entrained in order of abundance were Asiatic clam (*Corbicula fluminea*), fingernail clam (*Eupera cubensis*), Dorosoma spp. larvae, and unidentified fish eggs (Figure 5.3-2). The greatest daily entrainment rates generally occurred during May and June due primarily to high abundances of shad eggs and larvae and unidentified fish eggs. No threatened or endangered species were collected with entrainment sampling during the study period (Reference 5.3-004).

Development of the annual entrainment estimate for the proposed raw water pumphouse on the Cape Fear River is based on entrainment data collected in 2005 – 2006 at the Cape Fear Power Plant located approximately 8047 m (5 mi.) upstream of the proposed CWIS. The annual mean density (number of organisms entrained per million gallons of water) was used to calculate the annual number entrained with respect to design cooling water flow. The annual mean density at Cape Fear Power Plant was multiplied by the HAR annual intake volume to estimate the annual entrainment at HAR. The annual entrainment estimate under design flow at HAR is 29,760,111 shellfish and ichthyoplankton (Table 5.3-3) (Reference 5.3-004). Shellfish (Asiatic clam and fingernail clam) account for 59 percent of the estimated annual entrainment and ichthyoplankton comprise 41 percent of the estimated annual entrainment. Unidentified eggs, Dorosoma eggs, and Dorosoma larvae account for 88 percent of the ichthyoplankton entrainment estimate.

The Cape Fear River entrainment effects are anticipated to be SMALL for several reasons. Resident fish species in the Cape Fear River in the vicinity of the proposed Harris Lake makeup water system pumphouse who are pelagic spawners and most susceptible to entrainment include only forage species with high regenerative rates. These species include the threadfin shad, white perch, and gizzard shad (Reference 5.3-007). These species are protected from entrainment impacts due to the fact that the seasonal periods with the highest concentrations of eggs and larvae correspond to the higher flow periods in the river. Also, since the proposed makeup water intake is located on one side of the Cape Fear River and will take only a very small portion of the total average flow during the spring spawning season for pelagic spawners, which generally corresponds to high river flows, potential impacts to local populations are anticipated to be too small to be measured. Most other riverine species are either nest builders or prefer hard rocky substrates for egg deposition, and the larvae and young-of-the-year (yoy) for these nest builders and substrate spawners will not generally be present at the Harris Lake makeup water system pumphouse, except for very localized and limited populations.

Many of the important estuarine species (American shad [*Alosa sapidissima*], blueback herring [*Alosa aestivalis*], hickory shad [*Alosa mediocris*], alewife [*Alosa pseudoharengus*], and striped bass [*Morone saxatilis*]) that are pelagic spawners or whose eggs and larvae would be subject to entrainment are not present above Buckhorn Dam, due to blocking of upstream migration by Buckhorn Dam and several other downstream locks and dams. Therefore, the potential effects of entrainment on those important commercial and recreational estuarine species are essentially non-existent.

Due to the entrainment of a small percentage of the produced eggs, larvae, and yoy of resident fish populations, presence of forage species with high regenerative rates, and absence of many commercially and recreationally important estuarine species, the impacts to the biota of the Cape Fear River are considered SMALL.

The Harris Reservoir entrainment effects are also anticipated to be SMALL for several reasons. First, the water from the Harris Reservoir will be withdrawn from the 12.2-m (40.0-ft.) depth contour. Many of the fish species in the Harris Reservoir are nest builders. These fish build nests in shallow water (generally less than 1 m [3.3 ft.] of water) and for most species their larvae and yoy inhabit those shallow waters, thereby avoiding exposure to the deepwater intake port (Reference 5.3-009). Important nest-building species include the black bass, also known as largemouth bass (*Micropterus salmoides*), black crappie (*Pomoxis nigromaculatus*), and sunfish (*Centrarchidae spp.* primarily *Lepomis*) species (Reference 5.3-010).

Due to the 12.2-m (40.0-ft.) depth of the Harris Reservoir intake port, it is anticipated that few fish eggs, larvae, or yoy will be entrained into the flow to the new cooling towers. The anticipated entrainment impacts to the biota of the Harris Reservoir are SMALL.

5.3.1.2.4 Protected Species and Enhanced Harris Lake Makeup Water System Pumphouse Design Features

A review of available data has been conducted for fish and shellfish species resident to the Cape Fear River in the reach of river proposed for the Harris Lake makeup water system pumphouse and for Harris Reservoir. With the exception of the Cape Fear Shiner found in the Cape Fear River, the review has not shown the presence of any other protected aquatic species. The Harris Lake makeup water system pumphouse will be designed to meet the Phase I through-screen velocity requirement of 0.15 mps (0.5 fps) or less, and will be designed to be protective with respect to 316(b) for impingement mortality (Reference 5.3-002). A standard 0.95-cm (3/8-in.) mesh or similar size should be acceptable

(Reference 5.3-001). Reduction of entrainment beyond that already obtained by the use of cooling towers is not required by the applicable Phase I regulations and the impacts will be SMALL.

5.3.1.2.5 Impacts Due to Fluctuations in Lake Level

Assuming plant outages, a proposed normal pool elevation within the Main Reservoir of 73.2 m (240 ft.) NGVD29, and a continuous Cape Fear makeup water flow rate of 1.1 m^3/s (40.3 ft^3/s) or 18,088 gpm, the minimum Main Reservoir water elevation during the period of October 1939 to September 2004 was 67.1 m (220 ft.) NGVD29 with the HNP and two proposed AP1000 units operating. This would mean that a maximum difference in lake levels from normal pool elevation to minimum pool elevation during drought situations would be 6.1 m (20 ft.). Normal fluctuations in lake level would be less than this value and would likely be approximately 2m (6 ft.) over several weeks or months. These fluctuations will influence the shallow littoral communities at the lake edge. These communities currently experience such fluctuations and the impacts will therefore be SMALL.

5.3.2 DISCHARGE SYSTEM

This subsection describes the impact of the thermal heat discharge system for the HAR on the aquatic ecology and the physical impacts, such as scouring, silt buildup, and shoreline erosion induced by the discharge system flows during station operation.

Subsection 5.3.2.1 describes the physical impacts associated with thermal discharges to the Harris Reservoir. Subsection 5.3.2.2 describes the impacts of the thermal discharges on the aquatic ecosystems. Overall, the impacts associated with the operation of the discharge system are SMALL.

5.3.2.1 Thermal Description and Physical Impacts

The CWS and service water system (SWS) for the HNP, as described in ER Sections 2.3 and 3.4, discharges into a common blowdown pipe, which discharges to the Harris Reservoir. The blowdown for the HNP is discharged into the Main Reservoir through a single port jet at a point approximately 5.6 km (3.5 mi.) south of the plant and about 1.6 km (1.0 mi.) north of the Main Dam. Due to the distance of the discharge from the location of the raw water pumphouse for the HNP and HAR, the effects of the heated discharge plume are expected to dissipate before reaching the raw water pumphouse. The exit diameter of the blowdown pipe is 121.9 cm (48 in.). The blowdown pipe at the discharge point is flat. (Reference 5.3-011)

For the HAR, heated water discharged to the Harris Reservoir will be from blowdown of the two new cooling towers and the SWS to control dissolved solids in the closed-cycle system. The cooling tower blowdown water will be discharged into Harris Reservoir through two new blowdown pipelines, one for each of the new cooling towers, installed parallel to the existing discharge pipe for the HNP cooling tower blowdown water. PEC plans either to construct a new discharge flume as a discharge path for cooling tower blowdown and other facility discharges, including service water tower blowdown, or to modify the existing flume, as necessary, to accommodate discharges from HAR to the Harris Reservoir.

The proposed location for the new Harris Lake makeup water system discharge structure is the fourth arm or “finger” on the west side of Harris Reservoir (Reference 5.3-012). This location is well upstream of the existing (and probable new) cooling tower blowdown pipe discharge, thereby not interfering with the mixing issues for water in Harris Reservoir. This location not only provides sufficient slope for the discharge structure spillway but also is accessible from county and public roads. The discharge structure for the new makeup water from the Cape Fear River to the lake will be built at the terminating end of the lake makeup water piping at the fourth arm from the west end of the dam. The structure will consist of a reinforced concrete structure composed of a stilling basin followed by a sloped discharge chute and a second stilling basin terminating with a riprap apron. The configuration of this discharge structure will ensure dissipation of water energy so that erosion of the surrounding area is minimized, as well as resuspension of lake-bottom sediments. A 5.2-m (17-ft.) long slab at lake-bottom grade from the pipe discharge point is anticipated to minimize erosion of the surrounding area of the lake bottom. (Reference 5.3-001)

NUREG-1555 suggests that a mathematical model of temperature distributions and a physical model of the discharge plume and flow rates caused by the new heated discharge should be undertaken to describe impacts to the physical habitats and aquatic biota. The USEPA's VISUAL PLUMES model was used to evaluate the impacts of adding the discharge from the two proposed HAR units to Harris Reservoir. VISUAL PLUMES is capable of simulating single and merging submerged aquatic plumes in arbitrarily stratified ambient flow and buoyant surface discharges. It has been used for assisting and preparation of mixing zone analyses, total maximum daily loads, and other water quality applications. The pipelines will discharge to a location near the Main Dam (Figure 4.0-10). The new discharges are represented in the model as two 24-in. pipelines running parallel to the existing HNP pipeline. Given the lack of pipeline designs at this stage of the project, it was assumed that the proposed pipelines would have the same outlet design as the existing pipeline and would run along the lake bottom. It was also assumed that there would be about 3000 feet of separation between the HNP discharge and the HAR discharge. The monthly discharge temperatures were approximated by adding 14°F to the ambient wet bulb temperature.

The results of the modeling indicate that the discharge plume is approximately 300 ft. in diameter. The temperature difference between the plume and ambient water temperature is less than 0.5°F, which meets the NPDES criteria of no increase greater than 5°F, as discussed below.

The North Carolina NPDES permit program acknowledges the necessity of allowing for a mixing zone for cooling tower blowdown. According to the permit program regulations, a mixing zone may be established in the area of a discharge in order to provide reasonable opportunity for the mixture of the discharge with the receiving waters. Water quality standards will not apply within regions defined as mixing zones. The limits of such mixing zones will be defined by the NCDWQ on a case-by-case basis after consideration of the magnitude and character of the discharge and the size and character of the receiving waters. For the discharge of heated wastewater, compliance with federal rules and regulations pursuant to Section 316(a) of the CWA, as amended, shall constitute compliance with Subparagraph (b) of this Rule (Reference 5.3-013). Thermal wastewater discharges in North Carolina are subject to effluent limitations under the North Carolina Administrative Code (NCAC) §15A NCAC 02B.0211 (3) (j). This rule limits thermal discharges to approximately 2.8°C (5°F) above the natural water temperature and includes further restrictions based on geographic regions of the state. Exceptions to these limits are allowed under the temperature variance provisions of the CWA, under Section 316(a). Under this provision, permittees must demonstrate that the variance for the thermal component of the discharge assures the protection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife in the receiving water (Reference 5.3-013 and Reference 5.3-014).

The primary surface water classification assigned by the NCDWQ for Harris Reservoir is water supply–V (WS-V). This classification lists waters protected as water supplies that are generally upstream and draining to Class WS-IV waters or waters used by industry to supply their employees with drinking water or as waters formerly used as water supply. WS-V has no categorical restrictions on watershed development or wastewater discharges, unlike other WS classifications, and local governments are not required to adopt watershed protection ordinances. These waters are also protected for Class C uses (Reference 5.3-015). Under Section 15A NCAC 02B.0211 (3) (j) of the state's surface water quality standards, Class C surface waters are not to exceed 2.78°C (5.0°F) above the natural water temperature and at no time exceed 29°C (84.2°F) for mountain and upper piedmont waters and 32°C (89.6°F) for lower piedmont and coastal plain waters, due to the discharge of heated liquids (Reference 5.3-013). Additionally, as discussed in Subsection 5.3.1, flow volumes and resulting thermal discharges must meet established state water quality standards. The proposed cooling water system requirements for closed-cycle systems and resulting compliance with water quality limits will be met by the expanded reservoir volumes.

The existing discharge point for the HNP discharge is on the bottom of Harris Reservoir at an approximate 12.2-m (40-ft.) depth (Reference 5.3-011). This location is the probable location of the HAR two-unit blowdown discharge.

The NPDES permit acknowledges the necessary mixing zone for cooling tower blowdown. A discharge rate of 113 mld (30 mgd) results in a maximum mixing zone of 48.6 ha (120 ac. or 0.19 mi.^{2}) in the winter and in the more critical summer months, approximately 8.1 ha (20 ac. or 0.031 mi.^{2}) The mixing zone is the area of the reservoir that temperature could be permitted by the state to rise above the assumed discharge maximum temperature (outside of the mixing zone) of 32.2°C (90°F) or 2.78°C (5°F) above ambient reservoir temperature. A mixing zone of 48.6 ha (120.0 ac. or 0.19 mi.^{2}) in the winter and 8.1 ha (20.0 ac. or 0.031 mi.^{2}) in the summer is small compared with the size of the reservoir (approximately 1460 ha [3610 ac. or 5.6 mi.^{2}]) and represents less than 3 percent of the lake surface acreage in winter and less than 1 percent of the lake surface acreage during the thermally critical summer period (Reference 5.3-011).

As discussed in Subsection 3.3.2.2, on an average, the makeup requirement to the cooling tower from the Main Reservoir constitutes a major plant use during normal plant operation. Cooling tower makeup is estimated to be 2.54 m^3/s (89.61 ft^3/s) or 40,220 gpm operating at peak evaporative rates (evaporation, blowdown, drift – based on two AP1000 units). The net consumptive use of Harris Reservoir water is estimated to be 1.77 m^3/s (62.66 ft^3/s) or 28,122 gpm (that is, cooling tower makeup water + raw water use + service water tower makeup water, + demineralization makeup water – sanitary discharge – demineralization system water discharge – cooling tower blowdown – service tower blowdown – based on two AP1000 units).

A heat rejection system optimization study was conducted for the proposed two-unit AP1000 pressurized water reactor plant to be located at the HAR (Reference 5.3-016). This evaluation was to determine the projected performance of the integrated heat removal systems (condenser, circulating water, and cooling tower, net of associated auxiliary power requirements) for hourly intervals over 1 meteorological year. Cooling tower blowdown options for hot months were evaluated by applying cooling tower manufacturer's information (tower design performance curves) to site meteorology by compiling the maximum daily wet bulb temperatures and averaging them for every month out of 30 years. This evaluation involved assessing three different cooling tower options (single shell natural draft hyperbolic cooling tower per one AP1000 unit, two shell natural draft hyperbolic cooling tower per one AP1000 unit, and three round mechanical draft cooling towers per one AP1000 unit) with three different cooling water flow rates of 31.6 m^3/s (1114 ft^3/s) or 500,000 gpm, 3.79 m^3/s (133.68 ft^3/s) or 60,000 gpm, and 39.8 m^3/s (1403.7 ft^3/s) or 630,000 gpm, using two different weather profiles (the representative "hot" year and the "average" year) (Reference 5.3-016).

Blowdown from the towers, whether of natural or mechanical draft design, is required to maintain tower water chemistry within design limits. It is expected that blowdown will be regulated by the NPDES and other environmental permits and that a maximum blowdown temperature will be established.

Because the HAR site is located on a large reservoir system that will provide sufficient heat rejection capacity for two new units, plant operation is not expected to have significant thermal impacts to aquatic/marine ecology and water quality.

As stated in Subsection 5.3.1, the HAR will use the existing Harris Reservoir as the source for raw water and cooling tower makeup water. Additional makeup water will be pumped from the Cape Fear River intake to the Harris Reservoir. The HAR will discharge cooling tower blowdown from the proposed two new units to the Harris Reservoir. PEC currently monitors the water quality of Harris Reservoir to satisfy various environmental regulations, licenses, and permits associated with operation of the HNP. PEC has also monitored water quality in the HNP site area since 1972 in support of the original development of the HNP facility. Information from the monitoring programs includes 5 years of monitoring data prior to construction of the HNP (1972 to 1977), 9 years of water quality data during construction of the HNP (1978 through 1986), and roughly 20 years of data since the HNP began operation (1987 to present).

PEC has monitored water quality and biological communities in Harris Reservoir since the reservoir filled in the early 1980s in an effort to evaluate the water body’s health, track changes in water quality, document the appearance of non-native plants and animals, and assess the state of the recreational fishery (Reference 5.3-010). Water quality (including temperature, dissolved oxygen, hydrogen concentration [pH], and turbidity), water chemistry (including major nutrients and, until 2002, a suite of trace metals), and fish are sampled quarterly; aquatic vegetation is surveyed once a year, in the fall (Reference 5.3-017).

The existing thermal database is sufficient to describe the thermal conditions in Harris Reservoir. The HNP conducted additional pre-application monitoring to verify and update the background conditions at the time of the HAR COL Application. Pre-application monitoring sites are described in Subsection 6.1.1.2. Additional locations and more frequent measurements during summer may be incorporated into the monitoring program as the engineering design progresses. It is expected that these data will provide the necessary information to supplement the existing database and support descriptions of background conditions in Harris Reservoir.

Continued implementation of pre-application monitoring will provide data necessary to assess alterations of surface water flow fields in Harris Reservoir (namely the cooling loop), sediment transport, floodplains, or wetlands. The program may be modified based on the evaluation of monitoring data and other information collected for the operation of HAR.

The operational monitoring program for Harris Reservoir will be designed to identify impacts from the operation of HAR. Monitoring may be modified based on consultations with the NCDENR and the HNP. Data from this program will be evaluated to determine changes in the cooling system flows, water levels in Harris Reservoir, and discharges from Harris Reservoir to Buckhorn Creek.

Surface water, physical sedimentation, and erosion impacts associated with thermal effluents and discharge flow will be SMALL.

5.3.2.2 Aquatic Ecosystems

Discharges from the plant heat rejection system may affect the receiving body of water through heat loading and chemical contaminants, most notably chlorine or other biocides. More detail on biocides can be found in Subsection 3.6.1. Heated effluents may also result in mortality of aquatic organisms directly by either heat shock or cold shock. In addition, a number of indirect or sublethal stresses are associated with thermal discharges that have the potential to alter aquatic communities (for example, increased incidence of disease, predation, or parasitism, as well as changes in dissolved gas concentrations, as well as combined thermal and chemical effects). Additionally, as stated above in Subsection 5.3.2.1, all effluent discharges are regulated by the CWA and standards established by the USEPA and the individual states. Conditions and limits for the heated discharge will be specified in the NPDES permit issued for the HAR.

Potential effects of discharging heated water are effectively minimized by using a closed-cycle cooling system and cooling towers. The majority of waste heat is expected to be discharged to the atmosphere through evaporation and not to the Harris Reservoir. In using a closed-cycle system, increased evaporation from the cooling towers causes a buildup of minerals in the water. By discharging some effluent and bringing in makeup water, the total dissolved solids are expected to be kept within design parameters. However, limited thermal effects may be associated with the discharge of heated blowdown water to the reservoir.

The NRC studies evaluated the potential impacts of discharging heated water to an aquatic system including the following:

- Thermal discharge effects.
- Cold or heat shock.
- Effects on movement and distribution of aquatic biota.
- Premature emergence of aquatic insects.
- Stimulation of nuisance organisms.
- Losses from predation.
- Parasitism and disease.
- Gas super saturation of low dissolved oxygen in the discharge.
- Accumulation of contaminants in sediments or biota.

In general, for plants employing closed-cycle cooling systems and cooling tower systems, the impacts were found to be minor. The thermal plume discharged by the HAR will have SMALL adverse impacts to biota in Harris Reservoir.

Harris Reservoir is considered to be a biologically productive reservoir, similar to several other impoundments in the region. PEC has monitored water quality and biological communities in Harris Reservoir quarterly since the creation of the reservoir in the early 1980s, in order to evaluate the water body's health, track changes in water quality, document the appearance of non-native plants and animals, and assess the state of recreational fishery. Water quality (including temperature, dissolved oxygen, pH, and turbidity), water chemistry (including major nutrients and, until 2002, a suite of trace metals), and fish are sampled quarterly; aquatic vegetation is surveyed annually in the fall (Reference 5.3-017).

Harris Reservoir is classified by the NCDENR NCDWQ as eutrophic in the agency's most recent Basinwide Assessment Report. NCDENR recently sampled Harris Reservoir in 2003 (Reference 5.3-018). Although it has many of the characteristics of eutrophic southeastern reservoirs (for example, elevated nutrient concentrations, extensive growth of aquatic vegetation in shallows, and oxygen-deficient hypolimnetic water in summer), it also has characteristics of a mesotrophic reservoir, such as good water clarity and low turbidity (Reference 5.3-017).

5.3.2.2.1 Thermal Effects

Overall, the thermal impact from this plant is anticipated to be minimized through plant design. The use of a closed-cycle cooling system and cooling towers is expected to limit the thermal impact on the aquatic communities of the reservoir. All discharges from the HAR will be required to meet NPDES permit requirements within the reservoir. As noted in Subsection 5.3.2.1, the anticipated size of the mixing zone for the HAR heated discharge is expected to be small – less than 3 percent of lake surface acreage in winter and less than 1 percent in summer – because of the use of closed-cycle cooling and cooling towers and the deep-water location of the discharge flume (Reference 5.3-011). As discussed in Subsection 5.3.2.2, many of the fish species in the Harris Reservoir are nest builders. The species build their nests in shallow water and the produced growth stages of these fish generally inhabit those shallow waters, thereby avoiding exposure to the deepwater discharge. Consequently, anticipated temperature differentials and regimes resulting from the discharge plume are not expected to significantly affect the metabolic, growing, and reproduction activities of the various fish and aquatic species in Harris Reservoir. Additionally, it is unlikely that the small volumes of makeup water withdrawn and discharged by the closed-cycle cooling systems with cooling towers would interfere with the aquatic biota, the various life stages, or their habitats.

HNP currently employs a cooling tower-based heat dissipation system for the existing unit, rather than a once-through or cooling pond-based system. As a consequence, the thermal discharge is limited to a relatively small volume of warm water associated with cooling tower blowdown (Reference 5.3-017). PEC proposes to employ a similar closed-cycle cooling system and cooling tower-based heat dissipation system for the HAR. Because most of the water column is unaffected by the blowdown, even under worst-case conditions, the thermal plume is not expected to adversely affect preferred in-lake habitats or create a barrier to normal seasonal and diurnal movements of important fish species, including black crappie, bluegill, largemouth bass, redear sunfish, common carp, white perch, and gizzard shad. Thermal impacts are projected to be limited to some individual thermally sensitive species, such as white perch, possibly avoiding the immediate area of the discharge opening. It is expected that impacts to aquatic communities will be SMALL and will not warrant mitigation.

Because the HAR is proposing to use a closed-cycle cooling water system, the potential for thermal discharges to cause thermal discharge mortalities (that is, heat shock) is considered SMALL. Heat shock effects are expected to be SMALL at HAR because of the use of a closed-cycle cooling water system and a flume discharge structure that will potentially encourage rapid mixing and discourage aquatic species residence in the plume (Reference 5.3-017). In the case of a reactor shutdown, the potential for cold shock to affect the fish in the reservoir is expected to be SMALL. The continuous blowdown and open water discharge allow for slow temperature change and re-acclimation of the fish during the shutdown. In addition, the fish are able to leave the small heated area and use other areas of the reservoir. The effect of the resulting changes in water temperature on the plankton and benthic macroinvertebrate community (e.g., worms and midges) will be negligible, since it is restricted to a small area. Due to the expected low volumes of heated blowdown discharged and the temperature limitations of the NPDES permit, the effect of periodic shutdowns will be SMALL and restricted to a relatively small area of the reservoir.

In the winter, some fish may be attracted by the elevated temperature of the plume, with some species possibly residing in the plume for extended periods. This, in turn, could result in accelerated spawning, possibly leading to increased larval mortality due to developmental asynchrony with food source development or cold shock of migrant larvae. Because the heated water plume is expected to be small and relatively deep in comparison to the reservoir size, these impacts will be SMALL, having a negligible effect on total reservoir populations.

During the breeding season, many fish migrate to spawning grounds in rivers and reservoirs. Actual spawning grounds within the Harris Reservoir are not known for any species. Due to the expected small size of the discharge plume and its deep-water location, interference with migration or breeding areas of fish within the Harris Reservoir will be SMALL.

Populations of drifting benthos, plankton, and larval fish typically have a higher density in spring and early summer months. Because the temperature differential between the thermal plume and ambient reservoir is greater in winter, individuals passing through the thermal plume at the site may be influenced to a greater extent in winter months. However, given the plume's depth and expected small size within the reservoir, impacts to drifting organisms will be SMALL.

Elevated water temperatures from discharges have been suggested to increase the susceptibility of fish to diseases and parasites, making them susceptible to increased predation. As previously discussed, monitoring data show that a stable and strong healthy fish population exists within Harris Reservoir. There are no known exotic parasites that could affect fish populations with the predicted thermal discharge. Therefore, the susceptibility of fish to diseases, parasites, and increased predation from HAR discharges will be SMALL.

Although heated discharges can lead to premature emergence of aquatic insects that inhabit the bottom areas influenced by the thermal plume, a small part of the total Harris Reservoir bottom area available for production of aquatic insects is expected to be affected by the heated discharge plume. Additionally, a variety of nuisance organism species may become established as a result of heated discharges; however, these effects are generally considered operational problems. A closed-cycle cooling system and cooling towers will likely minimize these effects; therefore, the effects from premature emergence of aquatic insects and nuisance organism species will be SMALL.

Effects of increased saturation levels of dissolved gases (i.e., gas bubble disease) and low dissolved oxygen levels will be SMALL to populations of aquatic organisms in the vicinity of the heated discharge in Harris Reservoir because the HAR will be a closed-cycle cooling system.

5.3.2.2.2 Chemical Impacts

Second to thermal impacts to aquatic organisms in potential significance are chemical impacts due to chemicals present in blowdown water from the cooling towers. Chemicals are commonly used in cooling water systems to prevent, at some point from intake to discharge, the buildup of bacteria, algae, scale, and other unwanted organisms, such as mollusks. Chemical additives intended to disperse silt, inhibit corrosion, and adjust pH to acceptable discharge levels are also frequently used. The current NPDES Permit NC0039586 limits priority pollutants and chlorine within blowdown water for HNP, and a new NPDES permit will contain limits to minimize and potentially prevent acute or chronic toxicity, bioaccumulation, biomagnification, and behavioral effects to aquatic biota that might result from the common chemical pollutants associated with power plants.

Water quality parameters and water chemistry data for the HNP and HAR are discussed in ER Sections 2.3 and 3.4. A turbine island chemical feed system will inject the required chemicals into the SWS. The chemicals typically used for the feed system can be divided into six categories based upon function: biocide, algicide, pH adjustor, corrosion inhibitor, scale inhibitor, and silt dispersant. Specific chemicals used within the system, other than the biocide, are determined by the site water conditions. The pH adjustor, corrosion inhibitor, scale inhibitor, and dispersant are metered into the system continuously or as required to maintain proper concentrations. A sodium hypochlorite treatment system is provided for use as the biocide and controls microorganisms that cause fouling. The biocide application frequency may vary with seasons. Algicide is applied, as necessary, to control algae formation on the cooling tower. Table 3.3-4 lists chemicals added to liquid effluent streams for each unit.

As discussed in ER Subsection 6.1.1.2, pre-application monitoring and data are considered sufficient to describe the thermal conditions in Harris Reservoir. Although PEC and NCDENR have conducted monitoring in Harris Reservoir quarterly since the mid-1980s, specific data comparing chemical concentrations at the HNP discharge location with chemical concentrations in the Harris Reservoir ambient waters are discussed in ER Subsection 5.5.1.1.1.

Chemical concentrations in sediments and bioaccumulation of chemicals in aquatic organisms can be measured through analysis of grab samples and bioassay testing. Chlorine residual is measured to monitor the effectiveness of the biocide treatment. Addition of water treatment chemicals is performed by chemical feed system injection metering pumps and is adjusted as required. Consequently, the heated blowdown discharge is expected to have minimal effects, if any, on aquatic populations from the standpoint of chlorine, biocides, and other chemical additives in the discharge. Therefore, chemical effects, such as bioaccumulation, biomagnifications, and sublethal or behavioral, on aquatic biota of Harris Reservoir will be SMALL.

Performing toxicity tests using live organisms is perhaps more important than limiting chemical concentrations within blowdown water. Toxicity can be tested only using live organisms as a gauge. Bioassay testing required by the NPDES permit will assess the potential toxicity of the discharge and provide for corrective action if necessary. A 24-hour acute toxicity test performed quarterly is mandated by the current NPDES permit. Emissions of unregulated toxic chemicals in toxic amounts will cause the HAR to fail the lethal concentration 25 percent (LC25) limitation (Reference 5.3-019). Because a mandatory acute toxicity assay using effluent is performed quarterly, chemical impacts within effluent will be SMALL.

Concentrations of heavy metals and other priority pollutants in the discharge are expected to be within NPDES permit limits and are expected to dilute quickly or be flushed from the discharge area by the large volumes of the receiving water. Additionally, the discharge of priority pollutants may be subject to additional state control strategies developed to control specific toxic pollutants in specific water bodies. The HAR discharge will require a NPDES permit from NCDENR and will comply with applicable state water quality standards. Therefore, chemical effects to the aquatic biota in the Harris Reservoir are expected to be SMALL and will not warrant mitigation. As noted in ER Subsection 5.3.2, because of the expected discharge plume size and location, the biological losses that might result from the chemical stresses of the heated discharge in Harris Reservoir are expected to be SMALL. Additionally, because of the closed-cycle cooling system with cooling towers and the location and anticipated size of the discharge, combined chemical and thermal effects on the aquatic biota will be SMALL.

5.3.2.2.3 Physical Impacts

Physical impacts such as scouring, siltation, sediment transport, increased dissolved oxygen, eutrophication, and increased turbidity associated with discharging water into the Harris Reservoir are expected to be SMALL because of the proposed low discharge flows of the closed-cycle cooling system for HAR. The existing (and probable) discharge point for the new two-unit blowdown discharge is on the reservoir bottom at an approximate 12.2-m (40.0-ft.) depth; therefore, reservoir shorelines are not expected to be affected by the discharge (Reference 5.3-011). Thermal blowdown associated with the HNP is discharged directly into Harris Reservoir and has not affected any wetlands in the near-shore area. Therefore, impacts from the HAR discharge to wetlands or bottomland floodplain are expected to be SMALL.

The impacts of scouring will be localized but are expected to be SMALL. Although there is a potential for increased siltation, turbidity, and alteration to sediment transport patterns from the discharge, these are expected to be localized and are considered SMALL. Although temperature-induced stratification can alter dissolved oxygen concentrations in water bodies, a facility, such as the HAR that proposes to operate with a closed-cycle cooling system and cooling towers, is not likely to significantly alter stratification as to substantially affect water quality or aquatic biota in the mixing zone.

It is expected that other than a local reduction in numbers of benthic organisms in the immediate area of the proposed discharge from the HAR CWS and SWS blowdown discharge, there should be no measurable overall population effects on macrobenthos or fish in Harris Reservoir. Therefore, physical impacts to aquatic communities will be SMALL and will not warrant mitigation.

5.3.3 ATMOSPHERIC HEAT-DISSIPATION SYSTEM

There will be two new natural draft cooling towers, one each for HAR 2 and HAR 3 to provide a heat sink during normal operation. The AP1000 reactor does not rely on site service water as a safety grade ultimate heat sink (UHS) and meteorological design parameters for the cooling tower during normal operation have been established. The proposed cooling towers will be a hyperbolic natural draft design similar to the existing cooling tower that is used as a heat sink for HNP, with an overall height of 183 m (600 ft.). This subsection contains a brief description of the normal operation heat sink system for HAR 2 and HAR 3 and an assessment of the potential impacts on terrestrial ecological systems in the area surrounding the HAR site.

5.3.3.1 Heat Dissipation to the Atmosphere

5.3.3.1.1 Length and Frequency of Elevated Plumes

The natural draft cooling towers that will be used to dissipate waste heat from HAR 2 and HAR 3 to the atmosphere is not expected to have a significant influence on the local environment. This is a result primarily of the proposed height of the tower (approximately 183 m [600 ft.] above plant grade). After leaving the cooling tower, the plume will typically rise another 305 to 914 m (1000 to 3000 ft.), depending on wind speed and atmospheric temperature conditions. At these elevations, the additional water and heat added to the atmosphere by the cooling tower plumes should not significantly affect conditions at ground level. (Reference 5.3-020)

Under full power, it is expected that each HAR cooling tower will evaporate a maximum of 51,141 liters per minute (l/min.) (13,510 gallons per minute [gpm]) of water per unit. Under most meteorological conditions, the discharge will condense upon leaving the tower, and the length of the visible plume will depend on the temperature and humidity of the atmosphere. Colder and more humid weather is conducive to longer plumes. Most of the time, the visible plume will extend only a short distance from the tower and then disappear by evaporation. A study of cooling tower plumes at Keystone Power Plant reported that plume lengths were less than 1524 m (5000 ft.) over 97 percent of the time (as described in the HNP FSAR). On very humid days, when longer plumes are expected, there may be a naturally occurring overcast. On such occasions, it is difficult to distinguish the cooling tower plume from the overcast cloud layer. (Reference 5.3-020)

Long, persistent, visible cooling tower plumes occur during stable conditions where vertical mixing is limited. Under these conditions, plumes tend to flatten or spread out horizontal due to extremely limited vertical mixing (Reference 5.3-020).

An extensive analysis of cooling tower plume behavior was presented in the FSAR that was developed for HNP (Reference 5.3-020). An analytical cooling tower plume model was used to predict plume lengths and plume orientation with respect to the HNP for all hours with visibilities greater than 0.8 km (0.5 mi.) using 3 years of on-site data (January 14, 1976, to December 31, 1978). The percent occurrence of visible plumes was calculated in 250-m (820-ft.) plume length intervals. Plume characteristics were categorized by season and annual average (Reference 5.3-020).The results of the analysis, which were documented in the HNP FSAR, indicated that 99.6 percent of visible plumes would be less than 2.5 km (1.6 mi.) in length. The maximum predicted plume length was 3.5 km (2.1 mi.) and occurred on average only once in 3 years. Plumes 3 km (1.9 mi.) in length were predicted to occur only about 1 hour per year, and 2 km (1.2 mi.) plume lengths were predicted to occur only about 10 hours per year (Reference 5.3-020).

The nearest major airport to the plant is the Raleigh-Durham Airport, located 29 km (18 mi.) northeast of the plant. The operation of the cooling tower for HAR 2 and HAR 3 is not expected to result in an air traffic safety hazard at any location (Reference 5.3-020).

Predicted seasonal frequencies of 1-km, 2-km, and 3-km (0.62-mi., 1.25-mi., and 4.8-mi.) visible plumes from the HNP cooling tower as a function of wind direction are provided in the HNP FSAR. The greatest frequency of visible plumes occurs during the winter and fall months. The longest visible plumes are expected during the winter because condensation is enhanced and plume lengths increase with increasing ambient moisture content and decreasing temperature. The greatest frequency of predicted visible plumes is associated with north-to-northeast and south-to-southwest winds, which indicates the importance of colder temperatures (winds with northerly components) and greater moisture (winds with southerly components) in producing plumes. (Reference 5.3-020)

Due to the release elevation and plume rise, the additional water and heat released to the atmosphere by the cooling tower plumes is expected to have a SMALL impact on the local environment and additional mitigation is not required.

5.3.3.1.2 Ground-Level Fogging and Icing

Ground fogging could occur if ground elevations in the plant vicinity were comparable to plume heights. However, the release elevation of the cooling tower plume will be approximately 262 m (860 ft.) NGVD29, and the highest ground elevations in the general area surrounding the HAR site are approximately 131 m (430 ft.) NGVD29 (8 km [5 mi.] southeast of the site) and 122 m (400 ft.) NGVD29 (10 km [6 mi.] west of the site). Plumes will easily clear these areas without considering the rise of the plume above the release elevation (Reference 5.3-020). As a result, ground fogging attributable to cooling tower operation is not expected to occur.

Extended visible plumes from the cooling towers will likely occur during periods of high humidity when restricted visibility occurs naturally. Observations of heavy fog (less than 0.4-km [0.25-mi.] visibility) have been reported an average of 25 to 32 days per year at the four meteorological observation stations located within 192 km (120 mi.) of the site (i.e., Charlotte, Greensboro, Raleigh-Durham, and Wilmington) (Reference 5.3-021, Reference 5.3-022, Reference 5.3-023, and Reference 5.3-024). Table 2.7-70 summarizes the occurrence of fog at the Charlotte, Greensboro, and Raleigh-Durham meteorological observation stations. The greatest number of fog days typically occurs in the fall and winter, with approximately 3 days per month in November through February. However, fog can be a very localized phenomenon, and the information provided in Table 2.7-70 is used as a regional estimate for fog occurrence. The most common type of fog occurring near the HAR site is believed to be ground fog resulting from nighttime radiational cooling. The operation of the additional cooling tower is not expected to result in a significant increase in ground-level fog at these locations.

Ice formation is not expected to occur on structures in the vicinity of the plant, either on-site or off-site. The proposed cooling towers for HAR 2 and HAR 3 will be 183-m (600-ft.) high, and the cooling tower plumes will normally rise at least 305 m (1000 ft.) above the tower in the most stable case. The tallest plant structure at the HAR site (the containment building) will be less than 250 ft. high (refer to DCD Figure 3.7.2-12) and there are no known tall structures in the site vicinity. In general, the cooling tower plumes are not expected to intersect any structures on or in the vicinity of the site. The only exception is during high winds. Cooling tower plumes tend to be short because of turbulent diffusion when winds are strong. Occasionally, the wake effect of the tower can cause the plume to curl below the lip. Flow around the cylindrical natural draft tower is designed to minimize downwash effects, and the plume will either ascend or evaporate. (Reference 5.3-020)

There are no large safety-related plant structures or other nearby structures that are expected to be affected by icing from the cooling tower plumes. During times of naturally occurring snowfall, it is conceivable that snow conditions could conceivably be more intense under the plume and cause greater accumulation on the surrounding area and roadways. However, this should not create any greater hazard, since normal precautions taken by travelers in such circumstances would be adequate. Such an effect is expected to be very local, if it occurs. (Reference 5.3-020)

Based on the operational experience at HNP, there have been only very limited observations of icing or fogging attributable to cooling tower operation on HNP property. There have been no reported occurrences of fogging or icing attributable to cooling tower operation at any off-site locations, including public roads.

The impacts attributable to fogging and icing as a result of the operation of the HAR facility will be SMALL and additional mitigation is not warranted.

5.3.3.1.3 Solids Deposition

A very small fraction of the water circulating through the cooling towers would be carried into the plume as small water droplets. These water droplets, referred to as “cooling tower drift” (typically defined as kilograms [kg] of water per second leaving the tower top divided by the kg of water per second circulating through the tower heat exchange section) would average about 0.002 percent for the HNP cooling tower and is expected to be similar for the HAR cooling towers (Reference 5.3-020). Because modern cooling towers have almost no drift losses, this is not considered to be a critical design parameter. Site wind velocities and direction will be considered in designing the natural draft cooling tower to minimize any recirculation of air and vapor exiting the tower and to provide adequate tower capacity should any recirculation occur.

Water droplets from the cooling towers will contain the same concentration of dissolved and suspended solids as the water within the cooling tower basin. The dissolved and suspended solid concentrations in the cooling tower basins will be controlled via use of the makeup and blowdown water lines from and to Harris Reservoir. The most recently available 10-year average (1995-2004) of total dissolved solids at Harris Reservoir was 66.1 parts per million (ppm) (Reference 5.3-010).

The amount of dissolved solids expected to escape from the cooling towers in drift from the existing HNP cooling tower is estimated to be 0.0006 m^3/s (0.022 ft^3/s) or 10 gpm. Using this estimation, the equilibrium reservoir value for total dissolved solids in the plant intake, and a concentration factor of 2.0, an estimate of approximately 18 kilograms (kg) (40 pounds [lb.]) of dissolved solids per day could be dispersed in the drift (Reference 5.3-011). Based on the assumption that the operation of the proposed HAR cooling towers will result in a similar amount of drift (per unit), approximately 54 kg (120 lb.) of total dissolved solids per day could be released and dispersed over the area surrounding the HNP and HAR facilities once all three units are operational.

The impacts from solids deposition attributable to the operation of the HAR facility cooling tower will be SMALL and additional mitigation will not be required.

5.3.3.1.4 Cloud Shadowing and Additional Precipitation

Although there will be visible plumes during some periods of operation of the proposed HAR facility, adverse effects attributable to cloud shadowing or additional precipitation are not expected to be significant. There have been no reported adverse impacts of this nature reported as a result of the operation of the existing HNP facility since it began operation. No mitigation is expected to be required.

5.3.3.1.5 Interaction with Existing Pollution Sources

No synergistic effects of cooling tower plumes mixing with plant radiological (see Section 5.4) or any other releases (see Section 5.5.1.3) are expected to occur. Any gaseous effluents released from the plant during operation would be at elevations well below the top of the cooling tower. Any such releases would be at or near ambient temperature, and no significant plume rise from those releases would occur. Because the cooling tower plume would be at a much higher elevation, the potential for the mixing of the plumes is expected to be minimal and well downwind of where any water droplets in the cooling tower plume would still be present. (Reference 5.3-020)

Interactions with existing pollution sources are expected to be SMALL and mitigation is not justified.

5.3.3.1.6 Ground-Level Humidity Increase

Due to the high elevation of the cooling tower plumes, no discernible increase in humidity is expected as a result of the operation of the HAR facility. Mitigation is not warranted.

5.3.3.2 Terrestrial Ecosystems

The heat dissipation system proposed for the HAR facility has only a very small potential to have any discernible impact on local terrestrial ecosystems. The operation of the HAR cooling tower will result in only very small amounts of salt and particle drift from the tower, visible vapor plumes, and a very small potential for icing in the immediate vicinity of the tower. The potential for local precipitation modification is considered to be almost non-existent. There will be an increase in noise in the immediate vicinity of the tower (due to the operation of circulating water pumps and water flow at the base of the tower), but these noise impacts will be minimal. There will be a potential for avian collisions with the cooling tower, but operational experience at HNP indicates that this is minimal. Refer to Subsection 5.1.1.1.3 for further discussion on impacts and the Generic Environmental Impact Statement for License Renewal of Nuclear Plants (GEIS) prepared by the NRC.

It is important to note that the existing natural draft cooling tower at the HNP facility has been in operation since 1983. There are no reported or documented observations that this cooling tower has had any adverse impacts on the terrestrial ecosystem.

Several important terrestrial species exist within the vicinity of the proposed cooling tower, as discussed in ER Sections 2.4 and 4.3. As discussed previously, operation of the proposed HAR cooling tower is not expected to have a significant or adverse impact on any terrestrial species due to the height of plume release, the small amount of cooling tower drift and the associated limited amount of solids deposition. Based on the operational experience at the existing HNP facility and cooling tower, no mitigation is warranted.

5.3.3.2.1 Salt Drift

Cooling tower drift, as discussed above, normally contains small amounts of salt that can ultimately deposit at ground level. The original plan for the HNP facility included four natural draft cooling towers serving four reactors. Using on-site meteorological data, a maximum deposition rate of 0.15 kilogram per hectare per year (kg/ha/yr) (0.8 pounds per acre per year [lb/ac/yr]) was predicted at any location. This is well below the threshold limit of 10 kilograms per hectare per month (kg/ha/mo) (9 pounds per acre per month [lb/ac/mo]) provided in NUREG-1555.which is a threshold above which an adverse impact on vegetation could potentially occur. Salt deposition impacts from the existing HNP cooling tower and the proposed HAR cooling towers are considered to be considerably less than these levels. Therefore, no adverse effects to vegetation attributable to salt drift emissions from the existing cooling tower plumes from the HNP and HAR facilities are expected and no mitigation is warranted.

5.3.3.2.2 Vapor Plumes and Icing

As discussed in Subsection 5.3.3.1.1, there will be visible plumes resulting from the operation of the proposed HAR cooling towers. These plumes will have a similar frequency of occurrence and similar physical characteristics to the vapor plumes from the existing HNP cooling tower plumes. As discussed in Subsection 5.3.3.1.2, there could also be icing impacts in the immediate vicinity of the cooling tower. It is noted, however, that there have been no observations of adverse impacts attributable to cooling tower plumes or icing as a result of the operation of the existing HNP cooling tower and none are expected for the proposed HAR cooling towers.

Therefore, the impact of cooling tower plumes to terrestrial ecosystems is expected to be SMALL and no mitigation is warranted.

5.3.3.2.3 Precipitation Modifications

As discussed in Subsection 5.3.3.1.4, no significant increase in local precipitation is expected to occur as a result of cooling tower operation at the HAR facility. Any additional precipitation will be small in comparison with the 30-year average precipitation of 109 cm (43 in.) in nearby Raleigh/Durham (Reference 5.3-024).

Because no significant increase in precipitation is expected, no mitigation is warranted.

5.3.3.2.4 Noise

Although there will be an increase in noise levels as a result of the operation of the proposed HAR cooling towers, mainly due to circulating water pumps and water flow, it will be limited to the area immediately surrounding the tower, with little or no impact to local species. Operational cooling tower noise is further discussed in Subsection 5.3.4.2.

Noise impacts to terrestrial ecosystems will be SMALL and will not warrant mitigation.

5.3.3.2.5 Avian Collisions

The proposed natural draft cooling towers will be 183 m (600 ft.) high, moderately higher than the existing HNP cooling tower. Observations of avian collisions with the existing HNP cooling tower are rare; thus, collisions with the proposed HAR cooling tower is also expected to be minimal. NRC has also noted in NUREG-1437 that the occurrence of bird collisions with cooling towers at nuclear plants is minimal.

Impacts to bird species from collisions with the proposed cooling tower will be SMALL and will not warrant mitigation.

5.3.3.2.6 Reservoir Expansion

The shoreline vegetation is expected to develop along the proposed perimeter of the expanded Harris Reservoir over time and will be congruent with current shoreline vegetation.

5.3.4 IMPACTS TO MEMBERS OF THE PUBLIC

This subsection describes the potential human health impacts associated with the cooling system proposed for the new units. Specifically, potential impacts to human health from thermophilic microorganisms from the aerosolization of waterborne pathogens and the potential impacts of noise generated by the cooling towers to humans residing outside the property boundary are discussed. As described in Subsection 5.3.1, a closed-cycle cooling system will be used for the operational cooling of the new HAR units. Because the system will use a natural draft cooling tower, most of the thermal discharge and most of the thermophilic organisms, if any, will be released to the atmosphere.

5.3.4.1 Thermophilic Mircoorganism Impacts

Microorganisms associated with cooling towers and thermal discharges can impair human health. These organisms are called thermophilic organisms, because their presence and numbers can be increased by the addition of heat to their habitats. Thermophilic organisms with the potential to affect human health include *Salmonella* sp., *Shingella* sp., *Legionella* sp., *Naegleria* sp. (particularly *Naegleria fowleri*) and *Acanthamoeba* sp.

Salmonella and *Shingella* are enteric (digestive system) pathogens and must be ingested to produce symptoms. Other microorganisms normally present in surface water include the bacteria *Legionella* sp., which is manifested as Legionnaires' disease, so named for the first documented cases at a Legionnaires' convention in Philadelphia some years ago and traced to improperly cleaned air conditioning systems, and the free-living amoebae of the genera *Naegleria* and *Acanthamoeba*. *Naegleria fowleri* causes primary amoebic meningoencephalitis (PAM) and *Acanthamoebic keratitis* and *Acanthamoebic uveitis* cause granulomatious amoebic encephalitis (GAE). GAE is a particular risk for persons who are immuno-deficient, although infections have occurred in otherwise healthy individuals (Reference 5.3-025). The primary infection site is thought to be the lungs. The organisms that are in the brain are generally associated with blood vessels, suggesting vascular dissemination (Reference 5.3-025). Only 100 to 200 reports of PAM have occurred worldwide. Sources of infection for PAM generally include heated swimming pools, thermal springs, and a variety of naturally or artificially heated surface waters. During 1993 to 1994, only one case of PAM was reported by the Centers for Disease Control and Prevention (CDC) (Reference 5.3-026).

Contact was made with several North Carolina state and local agencies, as well as the CDC, to inquire if past outbreaks of thermophilic pathogenic organisms have occurred in the immediate vicinity of the site and in the two counties (Wake and Chatham counties) surrounding the HNP. The agencies and divisions contacted include the following:

- North Carolina Department of Health and Human Services, Division of Public Health.
- North Carolina Department of Environment and Natural Resources, Environmental Health Division.
- North Carolina Department of Environment and Natural Resources, Division of Public Water Supply.
- North Carolina Department of Environment and Natural Resources, Division of Water Quality.
- Wake County Public Health Department.
- Chatham County Public Health Department.

No one contacted in the CDC or the listed state and local agencies had knowledge of recorded outbreaks or incidents of thermophilic pathogenic organisms in the vicinity of the HNP or the surrounding two counties.

A study of cooling waters from 11 nuclear power plants and associated control source waters indicated that only two sites were positive for the pathogenic *Naegleria fowleri*. In addition to testing for pathogenic amoebae in cooling waters, the 11 nuclear power plants in the 1981 study were also studied for the presence of *Legionella* sp. In general, the artificially heated waters showed only a slight increase (that is, <10 fold) in concentrations of *Legionella* sp. relative to source water. In a few cases, source waters had higher levels than did heated waters. Infectious *Legionella* sp. was found in 7 of 11 test waters and 5 of 11 source waters. An additional study of *Legionella* sp. presence in the environs of coal-fired electric power plants showed that *Legionella* was only infrequently found in locations that were not adjacent to cleaning operations. It was concluded that exposure to *Legionella* sp. from power plant operations was a potential problem for part of the workforce, but that it would not be a public health issue because concentrated aerosols of the bacteria would not traverse plant boundaries. Because the route of infection with *Naegleria* sp. is through inhalation, workers exposed to aerosols that could harbor this pathogen should have respiratory protection.

An extensive cooling tower plume analysis is presented in the FSAR for the existing HNP facility and is discussed in Subsection 5.3.3.1.1. This analysis is representative of plume behavior from the proposed HAR cooling towers.

The study predicts that most of the visible cooling tower plumes will be restricted to within the power plant property boundaries and that the longest plumes will generally be restricted to the cooler months of the year. Coupled with planned biocide treatment of the cooling tower basin and the low probability of aerosol pathogen formation, the lack of recorded thermophilic pathogen disease incidents at the HNP, the predicted impacts of cooling tower dispersed thermophilic pathogens on the public is expected to be SMALL.

As noted above, the potential for pathogen exposure to site workers, particularly those workers maintaining the cooling tower system or those working in areas where cooling tower mist is present, is unknown, but higher than for the general public. Because the route of infection with *Naegleria* sp. is through inhalation, on-site workers exposed to aerosols that could harbor this pathogen should have respiratory protection. Recommended procedures included in applicable HAR Heath and Safety plans that could provide increased protection for facility workers and construction crews for the HAR should be followed.

5.3.4.2 Noise Impacts from Cooling Tower Operation

The principal sources of noise from the proposed plant operations will include noise from the natural-draft cooling tower, transformers, and loudspeakers. In most cases, the sources of noise are sufficiently distant from critical receptors outside the plant boundaries that the noise is attenuated to nearly ambient levels and is scarcely noticeable. In no case is the off-site noise level from a plant sufficient to cause hearing loss.

Natural-draft cooling towers emit noise of a broadband nature, and the frequencies with important intensities are 120, 240, 360, and 480 hertz (Hz). Because of the broadband character of the cooling towers, the noise associated with them is largely indistinguishable and less obtrusive than transformer noise or loudspeaker noise. Cooling tower and transformer noises do not change appreciably with time. Cooling towers generate approximately 55 dBA at a distance of 1000 ft. during operation (NUREG-1817).

A background survey of noise at the HNP was conducted on June 30, July 1-2, and July 9, 1979. Both daytime and nighttime noise level readings were taken. At the time of the survey, the HNP was under construction. Both daytime and nighttime noise measurements were taken to establish ambient noise levels within an 8-km (5-mi.) radius of the plant site, as recommended in NRC Regulatory Guide 4.2. Fourteen measurements were taken at seven different locations corresponding to plant property boundary lines. Since 1979, U.S. Highway 1 has expanded from two lanes to four lanes and traffic has significantly increased along the corridor. The land use around the perimeter of the HNP has changed little since the original noise surveys in 1979 and no known new sensitive receptors (churches, schools, assisted living facilities, and similar uses) are located near the site perimeter.

The background noise survey indicated that the residual sound level near the perimeter of the site was relatively low, with various transportation noises accounting for the higher level, short duration noises. The HNP was under construction at the time of this survey; however, all construction activities were terminated during the specified observation periods. No recent post-construction noise surveys have been conducted at the HNP, since noise complaints have been received only from area residents about the testing of emergency sirens, a required and necessary operational condition.

Historically, the only noise complaints received by HNP during its operation were from a local livestock-raising operation. The complaints were found to correlate with the testing of emergency sirens, a required and necessary part of the HNP operations. Given the harmonic blending nature of the noise generated by the proposed hyperbolic cooling towers, the relatively long distance from the location of the cooling towers to the site perimeter, and the lack of sensitive receptors near the site perimeter, the most likely operational noise impacts to area residents will be periodic testing of emergency sirens. This temporary and occasional noise impact is unavoidable and, in fact, the sound generated by the emergency sirens is intended to be loud enough to be readily heard by area residents and noticeable from ordinary background sounds. Noise impacts from operation of the proposed cooling towers are anticipated to be SMALL.

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Table 5.3-1
Fish Swimming Speeds

	Age Group 0 and older	**Min Length**				**Age Group 1 and older**			
Temp °C Species	**2.5**	**7.5**	**12.5**	**17.5**	**Age 1**	**2.5**	**7.5**	**12.5**	**17.5**
	fps	**inches**				**fps**			
Sprat	0.984	1.313	1.64	1.968	3.15	1.64	2.099	2.559	3.018
Herring	0.984	1.313	1.64	1.968	4.72	1.64	2.133	2.625	3.084
Cod	0.492	0.984	1.313	1.805	5.91	0.984	1.706	2.428	3.117
Whiting	0.328	0.82	1.313	1.64	5.91	1.148	1.804	2.592	3.346
Pout	0.262	0.492	0.656	0.951	7.87	1.115	1.968	2.723	3.445
Poor Cod	0.328	0.82	1.148	1.64	3.94	0.853	1.313	1.936	2.395
Plaice	0.262	0.492	0.656	0.984	3.15	0.919	1.575	2.198	3.018
Flounder	0.328	0.656	0.984	1.313	4.72	0.919	1.509	2.165	2.822
Dab	0.066	0.328	0.656	0.853	3.94	0.394	0.755	0.115	1.509
Sole	0.164	0.492	0.656	0.984	4.33	0.722	1.313	1.87	2.362
Bass	0.656	1.148	1.64	2.165	3.54	1.214	1.937	2.725	3.578
Grey Mullets	0.656	1.148	1.64	1.968	3.94	0.984	1.64	2.265	2.922
Sand Smelt	0.328	0.656	0.984	1.313	2.76	0.788	1.313	1.74	2.297
	Age Group 1 or older					**Age Group 2 or older**			
Salmon Smolts	1.476	1.968	2.297	2.625	5.91	1.804	2.231	2.592	2.986

Source: Reference 5.3-006

Table 5.3-2
Initial Survival Rates of Dominant Fish Species on Conventional Screens at the Cape Fear Power Plant and Extended Survival Rates on Modified Ristroph Screens at Other Power Plants

Common Name	Latin Name	Initial Survival Rate on Conventional Screens at Cape Fear Power Plant	Surrogate	Extended Survival Rate on Ristroph Screen
Threadfin shad	*Dorosoma petenense*	0.16	Alosa sp.	0.40 - 0.80
Gizzard shad	*Dorosoma cepedianum*	0.50	Gizzard shad	0.10
Bluegill	*Lepomis macrochirus*	0.82	Bluegill	0.98
Channel catfish	*Ictalurus punctatus*	0.33	White catfish	0.84
White perch	*Morone americana*	0.38	White perch	0.87 – 0.95

Source: Reference 5.3-007

TABLE 5.3-3
Estimated Annual Entrainment at Design Flow at HAR

Taxa	Density[(a)] (No. per MG)	Estimated Annual Entrainment at Design Flow[(b)]
Total entrainment	945.63	29,760,111
Total shellfish	561.95	17,685,241
Total ichthyoplankton	383.68	12,074,870
Total eggs	159.54	5,020,915
Unidentified eggs	131.75	4,146,331
Dorosoma spp. egg	27.79	874,585
Total larvae	224.14	7,053,955
Dorosoma spp. larvae	179.24	5,640,898
Channel catfish larvae	5.92	186,310
Lepomis spp larvae	3.23	101,652
Other larvae	35.75	1,125,095

Notes:
a) Densities at the Cape Fear Power Plant

b) design annual intake volume = 86.4 mgd * 364.25 = 31,471.2 mgd

Source: Reference 5.3-004

5.4 RADIOLOGICAL IMPACTS OF NORMAL OPERATION

This section describes the radiological impacts of normal plant operation on members of the public, plant workers, and biota. ER Subsection 5.4.1 describes the exposure pathways by which radiation and radioactive effluents could be transmitted from the HAR to organisms living near the plant. ER Subsection 5.4.2 estimates the maximum doses to the public from the operation of one new AP1000. ER Subsection 5.4.3 evaluates the effects of these doses by comparing them to regulatory limits for one unit and describes the radiation doses to plant workers from the new units. In addition, the impact of two new units in conjunction with the one existing unit is compared to the corresponding regulatory limit. ER Subsection 5.4.4 considers the effect to non-human biota.

Significant Radionuclides in Liquid Releases

HNP and HAR operations will have small radiological releases to Harris Reservoir and the combined effect of these releases on water quality within the aquatic ecosystem of Harris Reservoir and downstream of Harris Reservoir is discussed in this section. During routine reactor operations, it is conservatively assumed that radioactive liquid effluents will be released from the plant to the aquatic environment via waste liquid processing systems.

Cesium (Minimum Flow Criteria) – PEC's release of radionuclides in liquid effluents from the HAR and subsequent dilution in Harris Reservoir will not exceed 10 CFR 50, Appendix I, regulatory requirements. To provide for a bounding assessment, the maximum quantity of radionuclides presented in Westinghouse Electric Company, LLC, AP1000 Design Control Document (DCD) Table 11.2-7 was released in the radioactive liquid wastes to the discharge line and then to Harris Reservoir. For conservatism, a Decontamination Factor was not applied to the values to ensure the doses calculated were bounding. Using the NRC sanctioned LADTAP II computer program, as described in NUREG/CR-4013 (results presented in the sections that follow), it was determined that the majority of the dose to a Maximally Exposed Individual (MEI) was from the limiting fish ingestion pathway and was primarily due to the contribution from two controlling radionuclides, Cesium-134 (Cs-134) and Cesium-137 (Cs-137).

The average annual dilution flow rate through the reservoir plays a role in controlling doses to the MEI. The discharge concentration was conservatively estimated based on an average daily discharge for 292 days per year with a 0.57 m^3/s (20 ft^3/s) dilution flow. For these two controlling radionuclides, Cs-134 and Cs-137, Appendix I dose criteria can be met (see Table 5.4-8) if a dilution flow rate of 20 ft^3/s is maintained.

The MEI calculated total body dose is 2.00 mrem/yr. Of this total, 1.98 mrem/yr is from the limiting fish ingestion pathway with 99 percent of this dose contribution due to the two controlling radionuclides, Cs-134 and Cs-137. The MEI calculated worst-case organ dose is 3.07 mrem/yr (Teen Liver Dose). Of this total, 3.04 mrem/yr is from the fish ingestion pathway with 99 percent of this dose due to Cs-134 and Cs-137.

Tritium – In support of the management of tritium releases to Harris Reservoir, HNP not only tracks the activity of liquid tritium released, but also tracks and trends the tritium levels in the reservoir in accordance with their Radiological Environmental Monitoring Program. The average annual tritium release to Harris Reservoir from HNP operations is 465 Curies/year (Ci/yr). Tritium releases from the HAR units are conservatively estimated to be 1010 Ci/yr per unit. The average annual tritium release to Harris Reservoir is the sum of the tritium releases from HNP and HAR or 2485 Ci/yr. Harris Lake is the primary source drinking water for employees working at the HNP and will be the primary source of drinking water for the HAR. As such, tritium concentrations within the reservoir should be maintained below the USEPA drinking water standard of 20,000 pCi/l. Operations at HAR will require additional makeup water from Harris Reservoir. The normal water level of the Main Reservoir will be raised from 67.1 m to 73.2 m (220 ft. to 240 ft.) NGVD29 to accommodate HAR operations. The HAR Reservoir Makeup Water System will minimize tritium buildup in the Harris Reservoir by (1) adding and maintaining additional volume of water required for HAR operations and (2) by providing a minimum flow rate through the reservoir. PEC will monitor water quality in the reservoir to ensure tritium concentrations are maintained below the USEPA drinking water standard.

Tritium releases to and concentrations in the Cape Fear River are dependant on discharge flow rates over the dam. Tritium concentrations at the Lillington sampling station (first public water supply downstream of the facility) are also influenced by this discharge rate. PEC currently monitors water quality in Harris Reservoir and several downstream locations, including Lillington. Reported values are well below the USEPA drinking water standard of 20,000 pCi/l and will remain so with HAR operations.

5.4.1 EXPOSURE PATHWAYS

A radiological exposure pathway is the vehicle by which a receptor may become exposed to radiological releases from nuclear facilities. The major pathways of concern are those that could cause the highest calculated radiological dose. These pathways are determined from the type and amount of radioactivity released, the environmental transport mechanism, and how the station environs are used (e.g., residence, gardens). The environmental transport mechanism includes the historical meteorological characteristics of the area that are defined by wind speed and wind direction. This information is used to evaluate how the radionuclides will be distributed within the surrounding area. The most important factor in evaluating the exposure pathway is the use of the environment by the residents in the area around the new units. Factors such as location of homes in the area, use of cattle for milk, and the growing of gardens for vegetable consumption are considerations when evaluating exposure pathways.

Routine radiological effluent releases from the HAR are a potential source of radiological exposure to man and biota. The potential exposure pathways include aquatic (liquid) and gaseous particulate effluents. The radioactive gaseous effluent exposure pathways include direct radiation, deposition on plants and soil, and inhalation by animals and humans. The radioactive liquid effluent exposure pathways include fish consumption and direct exposure from radionuclides that may be deposited in Harris Reservoir.

The description of the exposure pathways and the calculational methods utilized to estimate doses to the maximally exposed individual and to the population surrounding the HAR site are based on NRC Regulatory Guides 1.109 and 1.111. The source terms used in estimating exposure pathway doses are based on the values provided in ER Chapter 3.

5.4.1.1 Liquid Pathways

In accordance with plant procedures, small amounts of liquid radioactive effluents (below regulatory limits) will be mixed with the cooling water and discharged to Harris Reservoir. The most significant exposure pathways include the following:

- Internal exposure from ingestion of water at Lillington (first potable water supply location downstream from Harris Reservoir).
- Internal exposure from ingestion of fish caught in Harris Reservoir.
- External exposure from the surface of contaminated water or from shoreline sediment.
- External exposure from immersion in contaminated water.

The LADTAP II computer program, as described in NUREG/CR-4013, and the liquid pathway parameters presented in Tables 5.4-1 and 5.4-2, were used to calculate the maximum exposed individual dose and the population doses from this pathway. This program implements the radiological exposure models described in Regulatory Guide 1.109 for radioactivity releases in liquid effluent.

PEC maintains USEPA drinking water standards for water taken from Harris Lake for use as drinking water at the Harris Site. PEC will continue to maintain drinking water standards for use at the site.

A discussion pertaining to doses calculated for liquid pathway is presented in ER Subsection 5.4.2.1.

5.4.1.2 Gaseous Pathways

The methodology contained in the GASPAR II program (described in NUREG/CR-4653) was used to determine the doses for gaseous pathways. This program implements the radiological exposure models described in Regulatory

Guide 1.109 for radioactivity releases in gaseous effluent. The code calculates the radiation exposure to people through the following potential pathways:

- External exposure to airborne radioactivity.
- External exposure to deposited activity on the ground.
- Inhalation of airborne radioactivity.
- Ingestion of contaminated agricultural products.

Tables 5.4-3, 5.4-4, 5.4-5, and 5.4-22 present the gaseous pathway parameters used by the code to calculate doses for both the maximum exposed individual and for the population. A discussion pertaining to doses calculated for these gaseous pathways is presented in Subsection 5.4.2.2.

5.4.1.3 Direct Radiation from the HAR

Contained sources of radiation at the new units will be shielded. The AP1000 is expected to provide shielding that is at least as effective as existing light water reactors (LWR). An evaluation of all operating plants by the NRC in NUREG-1437, Section 4.6.1.2 states that:

> ...because the primary coolant of an LWR is contained in a heavily shielded area, dose rates in the vicinity of light water reactors are generally undetectable and are less than 1 mrem/year at the site boundary. Some plants [mostly BWRs] do not have completely shielded secondary systems and may contribute some measurable off-site dose.

The direct radiation from normal operation will result in small contributions at site boundaries. Therefore, direct dose contribution from the new units will be SMALL and will not warrant additional mitigation.

5.4.2 RADIATION DOSES TO MEMBERS OF THE PUBLIC

This subsection provides an evaluation of the calculated doses to the maximum exposed individual from liquid and gaseous effluents from one new unit using the methodologies and parameters specified in Section 5.4.1.

5.4.2.1 Liquid Pathways Doses

Dose rate estimates to the maximally exposed individual due to liquid effluent releases were determined for the following:

- Eating fish or invertebrates caught in Harris Reservoir.
- Using the shoreline for activities, such as sunbathing or fishing.

- Swimming and boating on Harris Reservoir.
- Drinking water downstream from Harris Reservoir.

The estimates for total-body and critical organ doses from these interactions are presented in Table 5.4-6. These dose rates would only occur under conditions that maximize the resultant dose. It is unlikely that any individual would receive doses of the magnitude calculated.

5.4.2.2 Gaseous Pathways Doses

Dose rate estimates were calculated for hypothetical situations involving individuals of various ages exposed to gaseous radioactive effluents through the following pathways:

- Direct radiation from immersion in the gaseous effluent plume and from particulates deposited on the ground.
- Inhalation of gases and particulates.
- Ingestion of milk contaminated through the grass-cow-milk pathway.
- Ingestion of foods contaminated by gases and particulates.

Table 5.4-7 provides the estimated whole-body and critical organ doses for the identified gaseous effluent pathways.

5.4.3 IMPACTS TO MEMBERS OF THE PUBLIC

In this subsection, the radiological effects to individuals and population groups from liquid and gaseous effluents are presented using the methodologies and parameters specified in Subsection 5.4.1. The maximum exposed individual dose calculated from the liquid effluents was compared to 10 CFR 50, Appendix I criteria as shown in Table 5.4-8. The maximum exposed individual dose calculated from the gaseous effluents was compared to 10 CFR 50, Appendix I criteria as shown in Table 5.4-9. The maximum exposed individual dose calculated from the liquid and gaseous effluents was compared to 40 CFR 190 criteria as shown in Table 5.4-10. As indicated in NUREG-1555, Section 5.4.3, demonstration of compliance with the limits of 40 CFR 190 is considered to be in compliance with the 0.1-Roentgen equivalent man (rem) limit of 10 CFR 20.1301.

The population dose due to gaseous effluents to individuals living within an 80-km (50-mi.) radius of HAR was also calculated. For these doses, the population data were projected to the year 2020. The population dose for the various pathways (immersion, inhalation, ingestion, and ground deposition) is provided in Table 5.4-11.

Population doses resulting from natural background radiation to individuals living within an 80-km (50-mi.) radius of HAR is presented in Table 5.4-12 for comparison. Comparing the values from Tables 5.4-11 and 5.4-12 demonstrates that the calculated person-rem/yr exposure from the plant is much less than the estimated person-rem/yr exposure from natural radiation.

Impacts to members of the public from operation of the new units will be SMALL and will not warrant additional mitigation.

5.4.4 IMPACTS TO BIOTA OTHER THAN MEMBERS OF THE PUBLIC

Radiation exposure pathways to biota other than man or members of the public are examined to determine if the pathways could result in doses to biota greater than those predicted for man. This assessment uses surrogate species that provide representative information on the various dose pathways potentially affecting broader classes of living organisms. Surrogates are typically used for judging doses to biota since important attributes are well defined and accepted.

Important biota considered are state- or federally listed species that are endangered, threatened, commercial, recreationally valuable, or important to the local ecosystem. Table 5.4-16 identifies important biota from Section 2.4 and the surrogates used in this assessment. Surrogate biota include algae (also taken as aquatic plants), invertebrates (taken as freshwater mollusks and crayfish), fish, muskrat, raccoon, duck, and heron. In addition, doses are determined for the important terrestrial biota in Table 5.4-16 that do not have identified surrogates. These terrestrial biota derive their foods from terrestrial vegetation and insect pathways not readily associated with aquatic pathways.

This assessment uses pathway models adopted from Regulatory Guide 1.109. Pathways included are:

- Ingestion of aquatic foods including fish, invertebrates, and aquatic plants.
- Ingestion of water.
- External exposure from water immersion and shoreline sediment.
- Inhalation of airborne nuclides.
- External exposure to immersion in gaseous effluent plumes.
- Surface exposure from deposition of iodine and particulates from gaseous effluents.
- Ingestion of terrestrial vegetation and insects.

Internal exposures to biota from the accumulation of radionuclides from aquatic food pathways are determined using element-dependent bioaccumulation factors. Doses to surrogate biota are calculated as total body doses resulting from the consumption of aquatic plants, fish, and invertebrates; other doses to important biota are calculated based on the consumption of terrestrial vegetation and insects.

Terrestrial doses are the result of the amount of food ingested and the previous uptake of radioisotopes by the “living” food organism. The total body doses are calculated using the bioaccumulation factors corresponding to the “living” food organisms and dose conversion factors for adult humans modified for body mass and size. The use of the adult-dose conversion factors is conservative since the full 50-yr dose commitment predicted by the adult ingestion factors would not be received by biota due to their shorter life spans. These models show that the largest contributions to biota doses are typically from liquid effluents through the aquatic food, swimming and sediment pathways.

As described here and in the following subsections, dose impacts to biota will be SMALL.

5.4.4.1 Liquid Effluents

The concentrations of radioactive effluents in Harris Reservoir are estimated using a partially mixed impoundment model. The impoundment receives plant effluents and allows additional time for radiological decay before release of effluents to the receiving water body. Mixing occurs due to drawing water from the impoundment for discharge of the plant’s liquid effluents. The model used for estimating nuclide concentrations is similar to that used in the analysis for doses to man described in Subsection 5.4.2. Table 5.4-1 summarizes parameters used in the calculation of nuclide concentrations in the lake.

The calculation of biota doses in lakeshore environments was performed using LADTAP II. Doses to biota are estimated at Harris Reservoir (within the impoundment), and no credit is taken for dilution or transit time from the outflow. Downstream of the Harris Lake Dam, additional credit for dilution and radio decay occur, resulting in lower nuclide concentrations and doses to biota. This assessment, however, is made for the higher doses occurring in or near Harris Reservoir.

Food consumption, body mass, and effective body radii used in the calculations are shown in Table 5.4-17. Residence times for the surrogate species are shown in Table 5.4-18. Surrogate biota doses from liquid effluents are shown in Table 5.4-19.

5.4.4.2 Gaseous Effluents

Gaseous effluents also contribute to terrestrial total body doses. External doses occur due to immersion in a plume of noble gases and deposition of radionuclides on the ground. Internal doses result from the consumption of food and water.

Doses to biota from gaseous effluents are determined using GASPAR II with the normal operating releases described in Subsection 5.4.3. Doses are calculated for biota residing near Harris Reservoir or in the vicinity of the site. The biological site vicinity extends out to 10 miles. Doses in the vicinity of the site use dispersion and deposition coefficients averaged over the 0.8-km (0.5-mi.) to 16.09-km (10-mi.) distance. Harris Reservoir doses are based on 0.8 km (0.5 mi.). Meteorological data from Section 2.7 for the worst sector are used in both cases.

This assessment uses the dose in air calculated by GASPAR to bound total body doses to biota from immersion and inhalation of gaseous effluents. These annual doses are also adjusted for residence time near or in the vicinity of Harris Reservoir based on Table 5.4-18.

Biota assessments are typically made using total body doses derived from total body doses in man (Reference 5.4-001). GASPAR's total body immersion doses are determined at gamma and beta penetration depths that may be inappropriate to some biota. For example, the gamma dose rates are calculated at a depth of 5 cm corresponding to blood forming organ locations in man. The gamma and beta dose rates in air are used as the immersion dose rate since they neglect shielding due to body (gamma) or skin (beta) thicknesses.

Inhaled noble gases do not deposit in the lung and are only poorly absorbed in blood. Hence, the inhaled noble gas contribution is essentially the same as the noble gas plume total body contribution in GASPAR. Inhalation and uptake in the lung of gaseous non-noble effluents can also contribute to the total body dose. The contribution, however, is only about 10 percent of the total body dose in man from the noble gases. The non-noble inhalation contributions can be neglected since they are well bounded when using the dose in air for the combined immersion and inhalation dose.

The Lemmer's pinion moth, southeastern bat, red-cockaded woodpecker, and white-tailed deer derive their food from non-aquatic plants and insects.

The total body dose from immersion and inhalation is taken as the air immersion gamma and beta dose calculated by GASPAR II. This approach is warranted since the inhalation total body doses are very small and can be neglected; it is conservative since it does not account for body dimensions and mass, which can reduce total body doses. Doses from gaseous effluents to terrestrials (heron and duck) near Harris Reservoir are also adjusted for residence time based on Table 5.4-18.

Some terrestrial biota in Table 5.4-16 derive their food from non-aquatic plants and insects. The ingested doses are estimated from the equilibrated concentrations of gaseous tritium and radiocarbon C-14 that accumulate in vegetation and in open pools of water. The approach is reasonable since

GASPAR II calculations show that tritium and radiocarbon C-14 effluents account for 95 percent of the dose in humans from vegetation and meat.

Concentrations of tritium and radiocarbon C-14 in air tend to set the ingested concentrations in terrestrial biota. If terrestrials feed on vegetation with given tritium and radiocarbon C-14 specific activities, the specific activities in the terrestrials in the steady state will be the same as the activities occurring in the vegetation. The vegetation-specific activities, however, are in equilibrium with the specific activity concentrations in air. Similarly, terrestrials consuming insects will have tritium and radiocarbon C-14 specific activities that are the same as those in the vegetation consumed by insects. These conditions occur under steady state conditions and conservatively assume that the food (vegetation or insect) is produced and consumed at the same location. For consumption of water by terrestrials, the specific tritium activity of the water is conservatively taken to be the same as the tritiated water vapor in air.

The specific activity concentrations in vegetation and water are calculated using guidance in Regulatory Guide 1.109.

Vegetation concentrations tend to set the ingested concentrations in biota owing to its prominence at the front of the plant-insect-insectivore and plant-herbivore pathways. The dominance is expected since GASPAR II calculations show these effluents account for 95 percent of the vegetation and meat doses in humans. Insects consumed by insectivores are assumed to eat sufficient vegetation to have equilibrium tritium and radiocarbon concentrations comparable to vegetation. The ingested biota doses are developed from the equilibrium-specific activities using the total body dose conversion factors for adult humans and the biota consumption and external doses to the pinion moth, southeastern bat, red-cockaded woodpecker, and white-tailed deer are shown in Table 5.4-20. Doses are based on the consumption rates and masses in Table 5.4-17. The approach is similar to that used in LADTAP II to determine ingested doses in biota.

5.4.4.3 Biota Doses

The following discussion is based on the cumulative effects from HNP and HAR operations. Doses to surrogate biota from liquid and gaseous effluents are shown in Table 5.4-19. Table 5.4-20 shows the total doses to surrogate and important biota identified in Table 5.4-16. In Table 5.4-20, the total body dose is taken as the sum of the internal and external dose. Contributions from HNP included in Tables 5.4-19 and 5.4-20 are taken from the SHNPP Environmental Report, Subsections 5.2.3 and 5.2.4.

Table 5.4-20 shows that the dose to the white-tailed deer and Lemmer’s pinion moth meet the 25 millirem per year (mrem/yr) whole body dose equivalent criterion in 40 CFR 190. The criteria for thyroid and next highest organ in 40 CFR 190 are not used in this assessment -since all doses in the models are based on total body doses.

Use of exposure guidelines, such as 40 CFR 190, which apply to members of the public in unrestricted areas, are considered very conservative when evaluating calculated doses to biota. The International Council on Radiation Protection states that "...if man is adequately protected then other living things are also likely to be sufficiently protected," and uses human protection to infer environmental protection from the effects of ionizing radiation (Reference 5.4-001). This assumption is appropriate in cases where humans and other biota inhabit the same environment and have common routes of exposure. It is less appropriate in cases where human access is restricted or if pathways exist that are much more important for biota than for humans. Conversely, it is also known that biota with the same environment and exposure pathways as humans can experience higher doses without adverse effects.

Species in most ecosystems experience dramatically higher mortality rates from natural causes than humans. From an ecological viewpoint, population stability is considered more important to the survival of the species than the survival of individual organisms. Thus, higher dose limits could be permitted. In addition, no biota have been discovered that show significant changes in morbidity or mortality to radiation exposures predicted for nuclear power plants.

An international consensus has been developing with respect to permissible exposures to biota. The International Atomic Energy Agency (IAEA) evaluated available evidence and found that appreciable effects in aquatic populations would not be expected at doses lower than 1 rad/day and that limiting the dose to the maximally exposed individual organisms to less than 1 rad/day would provide adequate protection of the population (Reference 5.4-002). The IAEA also concluded that chronic dose rates of 0.1 rad/day or less do not appear to cause observable changes in terrestrial animal populations (Reference 5.4-002). The lower threshold for terrestrials is assumed because some species of mammals and reptiles are considered more radiosensitive than aquatic organisms. The permissible dose rates are considered screening levels and higher species-specific dose rates could be acceptable with additional study or data.

The calculated total body doses for biota are compared in Table 5.4-21 to the dose criteria evaluated in the *Effects of Ionizing Radiation on Plants and Animals at Levels Implied by Current Radiation Protection Standards*. The biota doses meet the dose guidelines by a large margin. In these cases, the annual dose to biota is much less than the daily allowable doses to aquatic and terrestrial organisms.

5.4.5 OCCUPATIONAL RADIATION EXPOSURES

This subsection provides a discussion of the anticipated occupational radiation exposure to HAR operating personnel. Estimates of these radiation doses are intended to provide a quantitative basis for the regulatory assessment of the potential risks and health effects to operating personnel.

Similar to current plant designs, occupational exposure from the operation of advanced reactor designs will continue to result from exposure to direct radiation from contained sources of radioactivity and from the small amounts of airborne sources typically resulting from equipment leakages. Past experience demonstrates that, for commercial nuclear power reactors, the dose to operating personnel from airborne activity is not a significant contributor to the total occupational dose. This experience is expected to continue to apply to the HAR.

As indicated in NUREG-1437, for the purpose of assessing radiological effects to workers, NRC has concluded that impacts are of small significance if doses and releases do not exceed permissible levels in the NRC's regulations. The standards for acceptable dose limits are given in 10 CFR Part 20. For AP1000 units at the HAR site, the radiation exposures to operating personnel will be maintained within the limits of 10 CFR 20 and will also satisfy the As Low As Reasonably Achievable (ALARA) guidance contained in Standard Review Plan, Chapter 12.1 and Regulatory Guide 8.8.

Administrative programs and procedures governing Radiation Protection and Health Physics in conjunction with the radiation protection design features will be developed with the intent to maintain occupational radiation exposures to ALARA levels.

The average annual collective occupational dose information for LWR plants operating in the United States between 1973 and 2005 are given in Table 5.4-13, based on data provided in NUREG-0713. The more recent dose data presented in this report are based on 35 operating boiling water reactors (BWRs) and 69 pressurized water reactors (PWRs). The data show that, historically (since 1974), the average collective dose and average number of workers per BWR type plant have been higher than those for PWRs and that the values for both parameters, in general, continued to rise until 1983. Thereafter (data through 2005), the average collective dose per LWR dropped by about 85 percent. The overall decreasing trend in average reactor collective doses since 1983 is indicative of successful implementation of ALARA dose reduction measures at commercial power reactor facilities.

The variation in annual collective dose at operating reactors results from a number of factors such as the amount of required maintenance, the amount of reactor operations, and required in-plant surveillances. These factors have varied in the past, but are expected to improve with the AP1000 advanced design concepts.

The 3-year average collective doses per reactor is one of the metrics that the NRC uses in the Reactor Oversight Program to evaluate the effectiveness of a licensee's ALARA program. Tables 5.4-14 and 5.4-15 show the BWR and pressurized water reactor (PWR) commercial reactor sites in operation for at least 3 years as of December 31, 2005 and detail the occupational exposure statistics. As shown in Table 5.4-14, the BWR average annual collective total effective dose equivalent (TEDE) per reactor, average measurable TEDE per worker, and average collective TEDE per megawatt year (MW-yr) are 163 person-rem, 0.17 rem, and 0.19 person-rem per MW-yr, respectively. Similarly, as presented in Table 5.4-15, the PWR average annual collective TEDE per reactor, average measurable TEDE per worker, and average collective TEDE per MW-yr are 81 person-rem, 0.13 rem, and 0.09 person-rem per MW-yr, respectively.

Using this metric and the distribution of occupational exposures, a conservative estimate for the HAR is expected to be less than the recent PWR average collective TEDE dose per reactor of 81 person-rem. The average annual dose of less than 0.2 rem per nuclear plant worker at operating BWRs and PWRs is well within the limits of 10 CFR 20. The exposure impacts are considered to be SMALL and pose a risk that is comparable to the risks associated with other industrial occupations.

5.4.6 REFERENCES

5.4-001 International Commission on Radiological Protection, “Recommendations of the International Commission on Radiological Protection,” ICRP Publication 60, 1991.

5.4-002 Oak Ridge National Laboratory Workshop Discussion of “International Atomic Energy Agency (IAEA) Effects of Ionizing Radiation on Plants and Animals at Levels Implied by Current Radiation Protection Standards,” Oak Ridge National Laboratory, 1995.

Table 5.4-1
Liquid Pathways Parameters

Description	Parameter
Freshwater Site	Selected
Discharge Flow Rate from plant to Harris Reservoir (gallons per minute [gpm])	6,000 per unit
Minimum Discharge Flow From Harris Reservoir to Cape Fear River (cubic feet per second [ft^3/s])	20
Annual Average Flow in Cape Fear River at Lillington (cubic feet per second [ft^3/s]))	3363
Source Term	Table 3.5-1
Reconcentration Model	Partial mixing
Shore Width Factor	0.3
Distance to Drinking Extraction (mi.)	17 (Lillington)
Transit Time – Drinking (hr)	1(a)
Dilution Factor for Drinking	168 (Lillington)(a) 1.0 (Site Workers)(b)
Lillington Population(c)	4328
Dunn Population(c)	13,654
Fayetteville Population(c)	133,084
50-Mile Residential Population(c)	3,003,458
Dilution Factor for Recreational	1
Dilution Factor for Fish	1
Transit time – Fish and Recreational Uses (hr)	0
Recreational Exposure for Shoreline, Swimming, and Boating (person-hrs/yr)	1,379,591
Sport Fish Catch at Harris Reservoir (kg/yr)	53,710

Notes:

a) Dilution factor for Lillington conservatively used for Dunn and Fayetteville even though both are further downstream with more dilution and longer transit times.

b) Site worker population conservatively estimated at 1000 for Units 2 and 3.

c) Population data projected to year 2020.

Table 5.4-2
Liquid Pathways Consumption Factors for the Maximum Exposed Individual

Pathway	Adult	Teen	Children	Infant
Drinking Water[(a)]	730 liters per year (L/yr)	510 L/yr	510 L/yr	330 L/yr
Fish consumption[(a)]	21 kilograms per year (kg/yr)	16 kg/yr	6.9 kg/yr	N/A
Shoreline usage[(a)]	12 hours per year (hr/yr)	67 hr/yr	14 hr/yr	N/A
Swimming exposure (assumed same as shoreline)	12 hr/yr	67 hr/yr	14 hr/yr	N/A
Boating (assumed)	100 hr/yr	67 hr/yr	14 hr/yr	N/A

Notes:

a) LADTAP default values

Table 5.4-3
GASPAR II Input

Input Parameter	Value
Site Specific Data Values	
Distance from site to NE Corner of the United States (mi.)	1100
Fraction of the year leafy vegetables are grown	0.42
Fraction of the year milk cows are on pasture	0.67
Fraction of max individual's vegetable intake from own garden	1.0
Fraction of milk-cow feed intake from pasture while on pasture	1.0
Humidity over growing season (g/m^3) (Absolute Humidity)	8
Average temperature over growing season	0 (Value not used)
Fraction of the year goats are on pasture	0.75
Fraction of goat feed intake from pasture while on pasture	1.0
Fraction of the year beef cattle are on pasture	0.67
Fraction of beef-cattle feed intake from pasture while on pasture	1.0
Population Data	Table 2.5-2 and 2.5-4
Total Agriculture Production Rate (50-mile)	
– Vegetables (kg/yr)	Table 5.4-5
– Milk (L/yr)	Table 5.4-5
– Meat (kg/yr)	Table 5.4-5
Source Term	
Source Term Multiplier	1
Nuclide Release Data	Table 3.5-3
Meteorological Data	
Met Data for Input to GASPAR(a)	Sector Average Table 5.4-22
Special Location Data:	
Annual Average (X/Q)(b)	Table 2.7-76
Annual Average (D/Q)(c)	Table 2.7-77
Annual Average Decayed (2.26 day) (X/Q)	Table 2.7-78
Annual Average Depleted and Decayed (8-day) (X/Q)	Table 2.7-79

Notes:

a) NUREG/CR-2919 describes the technique for computing the χ/Q segment values as given by the following relationship:

$$\overline{\chi}/Q_{Seg}(K) = \frac{R_1 \bullet \chi/Q(R_1,K) + r_1 \bullet \chi/Q(r_1,K) + \ldots + r_n \bullet \chi/Q(r_n,K) + R_2 \bullet \chi/Q(R_2,K)}{R_1 + r_1 + \ldots + r_n + R_2}$$

where

$\chi/Q_{Seg}(K)$ = average value of χ /Q for the segment for the directional sector K

$\chi/Q(R_1, K)$ = χ /Q value at downwind distance R_1 for the directional sector K

R_1, R_2 = downwind distance of the segment boundaries

r_1, r_n = selected radii between R_1 and R_2.
b) X/Q - Chi/Q or atmospheric dilution factors
c) D/Q - relative deposition

Table 5.4-4
Gaseous Pathways Consumption Factors for the Maximum Exposed Individual

Pathway	Adult	Teen	Children	Infant
Leafy Vegetables	64 kg/yr	42 kg/yr	26 kg/yr	N/A
Meat	110 kg/yr	65 kg/yr	41 kg/yr	N/A
Milk	310 L/yr	400 L/yr	330 L/yr	330 L/yr
Vegetable	520 kg/yr	630 kg/yr	520 kg/yr	N/A

Table 5.4-5 (Sheet 1 of 5)
Agricultural Statistics

From Degree	To Degree	Compass Direction	Radial Distance (miles)	Milk Production (liters)	Vegetable Production (kg)	Meat Production (kg)
78.75	101.25	E	0 - 1	725	484	3,197
78.75	101.25	E	1 - 2	1,939	1,296	8,556
78.75	101.25	E	2 - 3	3,159	2,111	13,938
78.75	101.25	E	3 - 4	4,379	2,926	19,319
78.75	101.25	E	4 - 5	5,599	3,741	24,701
78.75	101.25	E	5 - 10	46,292	30,928	204,224
78.75	101.25	E	10 - 20	183,597	128,484	850,137
78.75	101.25	E	20 - 30	246,055	901,265	6,171,639
78.75	101.25	E	30 - 40	308,648	1,672,464	11,482,193
78.75	101.25	E	40 - 50	553,886	3,680,578	13,639,829
56.25	78.75	ENE	0 - 1	725	484	3,197
56.25	78.75	ENE	1 - 2	1,939	1,296	8,556
56.25	78.75	ENE	2 - 3	3,159	2,111	13,938
56.25	78.75	ENE	3 - 4	4,379	2,926	19,319
56.25	78.75	ENE	4 - 5	5,599	3,741	24,701
56.25	78.75	ENE	5 - 10	46,292	30,928	204,224
56.25	78.75	ENE	10 - 20	184,071	122,980	812,055
56.25	78.75	ENE	20 - 30	306,054	204,478	1,350,197
56.25	78.75	ENE	30 - 40	414,539	508,605	3,293,039
56.25	78.75	ENE	40 - 50	578,437	8,199,854	9,392,317
101.25	123.75	ESE	0 - 1	725	484	3,197
101.25	123.75	ESE	1 - 2	1,939	1,296	8,556
101.25	123.75	ESE	2 - 3	3,159	2,111	13,938
101.25	123.75	ESE	3 - 4	4,379	2,926	19,319
101.25	123.75	ESE	4 - 5	5,599	3,741	24,701
101.25	123.75	ESE	5 - 10	46,292	30,928	204,224
101.25	123.75	ESE	10 - 20	203,920	322,315	2,669,307
101.25	123.75	ESE	20 - 30	224,094	1,194,094	8,239,908
101.25	123.75	ESE	30 - 40	308,608	1,672,929	11,485,417
101.25	123.75	ESE	40 - 50	710,357	2,410,430	32,467,820
348.75	11.25		0 - 1	725	484	3,197
348.75	11.25	N	1 - 2	1,939	1,296	8,556
348.75	11.25	N	2 - 3	3,148	2,107	14,402
348.75	11.25	N	3 - 4	6,990	2,637	58,416
348.75	11.25	N	4 - 5	12,395	2,990	126,447
348.75	11.25	N	5 - 10	140,140	20,569	1,609,386

Table 5.4-5 (Sheet 2 of 5)
Agricultural Statistics

From Degree	To Degree	Compass Direction	Radial Distance (miles)	Milk Production (liters)	Vegetable Production (kg)	Meat Production (kg)
348.75	11.25	N	10 - 20	553,490	65,026	4,645,438
348.75	11.25	N	20 - 30	1,272,827	106,258	2,861,079
348.75	11.25	N	30 - 40	2,278,090	157,683	3,960,558
348.75	11.25	N	40 - 50	1,786,888	118,584	4,784,669
33.75	56.25	NE	0 - 1	725	484	3,197
33.75	56.25	NE	1 - 2	1,939	1,296	8,556
33.75	56.25	NE	2 - 3	3,159	2,111	13,938
33.75	56.25	NE	3 - 4	4,379	2,926	19,319
33.75	56.25	NE	4 - 5	5,599	3,741	24,701
33.75	56.25	NE	5 - 10	46,292	30,928	204,224
33.75	56.25	NE	10 - 20	184,071	122,980	812,055
33.75	56.25	NE	20 - 30	306,054	204,478	1,350,197
33.75	56.25	NE	30 - 40	538,071	616,451	2,789,167
33.75	56.25	NE	40 - 50	728,407	1,289,674	5,600,052
11.25	33.75	NNE	0 - 1	725	484	3,197
11.25	33.75	NNE	1 - 2	1,939	1,296	8,556
11.25	33.75	NNE	2 - 3	3,159	2,111	13,938
11.25	33.75	NNE	3 - 4	4,379	2,926	19,319
11.25	33.75	NNE	4 - 5	5,599	3,741	24,701
11.25	33.75	NNE	5 - 10	46,292	30,928	204,224
11.25	33.75	NNE	10 - 20	224,900	106,615	1,043,576
11.25	33.75	NNE	20 - 30	523,824	117,190	2,585,067
11.25	33.75	NNE	30 - 40	959,972	589,585	2,847,281
11.25	33.75	NNE	40 - 50	1,436,242	951,231	3,669,154
326.25	348.75	NNW	0 - 1	725	484	3,197
326.25	348.75	NNW	1 - 2	2,242	1,262	13,080
326.25	348.75	NNW	2 - 3	9,639	469	3,099
326.25	348.75	NNW	3 - 4	15,930	1,651	192,267
326.25	348.75	NNW	4 - 5	20,367	2,111	245,824
326.25	348.75	NNW	5 - 10	168,396	17,451	2,032,473
326.25	348.75	NNW	10 - 20	1,069,687	73,845	5,557,371
326.25	348.75	NNW	20 - 30	2,812,489	2,812,489	2,812,489
326.25	348.75	NNW	30 - 40	3,192,346	203,416	4,645,657
326.25	348.75	NNW	40 - 50	1,329,386	284,500	6,333,520
303.75	326.25	NW	0 - 1	725	484	3,197
303.75	326.25	NW	1 - 2	4,707	991	49,994

Table 5.4-5 (Sheet 3 of 5)
Agricultural Statistics

From Degree	To Degree	Compass Direction	Radial Distance (miles)	Milk Production (liters)	Vegetable Production (kg)	Meat Production (kg)
303.75	326.25	NW	2 - 3	11,493	1,191	138,710
303.75	326.25	NW	3 - 4	15,930	1,651	192,267
303.75	326.25	NW	4 - 5	20,367	2,111	245,824
303.75	326.25	NW	5 - 10	168,396	17,451	2,032,473
303.75	326.25	NW	10 - 20	683,551	69,545	7,993,798
303.75	326.25	NW	20 - 30	1,201,592	159,099	5,980,547
303.75	326.25	NW	30 - 40	573,929	259,261	7,540,915
303.75	326.25	NW	40 - 50	2,632,101	410,996	6,891,257
168.75	191.25	S	0 - 1	725	484	3,197
168.75	191.25	S	1 - 2	1,939	1,296	8,556
168.75	191.25	S	2 - 3	5,617	1,839	50,728
168.75	191.25	S	3 - 4	15,929	1,651	192,253
168.75	191.25	S	4 - 5	20,367	2,111	245,824
168.75	191.25	S	5 - 10	140,396	88,096	1,976,719
168.75	191.25	S	10 - 20	522,764	483,037	8,077,423
168.75	191.25	S	20 - 30	801,778	825,228	12,389,899
168.75	191.25	S	30 - 40	373,552	1,396,317	5,783,580
168.75	191.25	S	40 - 50	518,682	1,502,437	8,299,224
123.75	146.25	SE	0 - 1	725	484	3,197
123.75	146.25	SE	1 - 2	1,939	1,296	8,556
123.75	146.25	SE	2 - 3	3,159	2,111	13,938
123.75	146.25	SE	3 - 4	4,379	2,926	19,319
123.75	146.25	SE	4 - 5	6,034	4,204	34,038
123.75	146.25	SE	5 - 10	101,710	89,843	1,393,022
123.75	146.25	SE	10 - 20	520,331	480,450	8,025,219
123.75	146.25	SE	20 - 30	778,203	858,287	12,698,154
123.75	146.25	SE	30 - 40	650,066	4,069,607	36,679,272
123.75	146.25	SE	40 - 50	962,788	8,877,010	80,944,108
146.25	168.75	SSE	0 - 1	725	484	3,197
146.25	168.75	SSE	1 - 2	1,939	1,296	8,556
146.25	168.75	SSE	2 - 3	3,159	2,111	13,938
146.25	168.75	SSE	3 - 4	9,599	2,349	97,481
146.25	168.75	SSE	4 - 5	18,673	4,685	233,629
146.25	168.75	SSE	5 - 10	132,111	119,674	2,031,413
146.25	168.75	SSE	10 - 20	522,764	483,037	8,077,423
146.25	168.75	SSE	20 - 30	754,812	840,614	11,665,140
146.25	168.75	SSE	30 - 40	432,458	2,090,647	13,099,454

Table 5.4-5 (Sheet 4 of 5)
Agricultural Statistics

From Degree	To Degree	Compass Direction	Radial Distance (miles)	Milk Production (liters)	Vegetable Production (kg)	Meat Production (kg)
146.25	168.75	SSE	40 - 50	722,986	5,466,851	44,948,404
191.25	213.75	SSW	0 - 1	725	484	3,197
191.25	213.75	SSW	1 - 2	1,939	1,296	8,556
191.25	213.75	SSW	2 - 3	7,527	1,628	79,342
191.25	213.75	SSW	3 - 4	15,930	1,651	192,267
191.25	213.75	SSW	4 - 5	20,367	2,111	245,824
191.25	213.75	SSW	5 - 10	123,665	77,741	1,592,818
191.25	213.75	SSW	10 - 20	456,121	453,138	6,623,946
191.25	213.75	SSW	20 - 30	780,313	744,197	12,854,317
191.25	213.75	SSW	30 - 40	544,027	320,728	11,800,400
191.25	213.75	SSW	40 - 50	793,342	73,850	9,518,127
213.75	236.25	SW	0 - 1	725	484	3,197
213.75	236.25	SW	1 - 2	1,939	1,296	8,556
213.75	236.25	SW	2 - 3	7,360	1,647	76,826
213.75	236.25	SW	3 - 4	15,930	1,651	192,267
213.75	236.25	SW	4 - 5	20,367	2,111	245,824
213.75	236.25	SW	5 - 10	118,544	84,615	1,542,294
213.75	236.25	SW	10 - 20	402,585	429,119	546,342
213.75	236.25	SW	20 - 30	464,565	522,784	11,666,778
213.75	236.25	SW	30 - 40	344,082	446,547	20,188,701
213.75	236.25	SW	40 - 50	454,893	573,006	25,237,383
258.75	281.25	W	0 - 1	725	484	3,197
258.75	281.25	W	1 - 2	5,408	913	60,488
258.75	281.25	W	2 - 3	11,493	1,191	138,710
258.75	281.25	W	3 - 4	15,930	1,651	192,267
258.75	281.25	W	4 - 5	20,367	2,111	245,824
258.75	281.25	W	5 - 10	160,502	28,086	1,954,854
258.75	281.25	W	10 - 20	666,004	74,227	8,046,406
258.75	281.25	W	20 - 30	1,113,329	115,374	13,437,396
258.75	281.25	W	30 - 40	3,132,684	281,352	21,824,740
258.75	281.25	W	40 - 50	4,853,066	431,094	29,359,101
281.25	303.75	WNW	0 - 1	725	484	3,197
281.25	303.75	WNW	1 - 2	5,659	354	2,335
281.25	303.75	WNW	2 - 3	11,493	1,191	138,710
281.25	303.75	WNW	3 - 4	15,930	1,651	192,267
281.25	303.75	WNW	4 - 5	20,367	2,111	245,824
281.25	303.75	WNW	5 - 10	168,396	17,451	2,032,473

Table 5.4-5 (Sheet 5 of 5)
Agricultural Statistics

From Degree	To Degree	Compass Direction	Radial Distance (miles)	Milk Production (liters)	Vegetable Production (kg)	Meat Production (kg)
281.25	303.75	WNW	10 - 20	669,594	69,390	8,081,710
281.25	303.75	WNW	20 - 30	1,063,735	120,208	12,880,008
281.25	303.75	WNW	30 - 40	2,341,436	271,095	16,624,808
281.25	303.75	WNW	40 - 50	4,955,384	463,062	18,715,266
236.25	258.75	WSW	0 - 1	725	484	3,197
236.25	258.75	WSW	1 - 2	3,487	1,125	31,722
236.25	258.75	WSW	2 - 3	11,439	1,196	137,917
236.25	258.75	WSW	3 - 4	15,930	1,651	192,267
236.25	258.75	WSW	4 - 5	20,367	2,111	245,824
236.25	258.75	WSW	5 - 10	115,294	88,994	1,510,341
236.25	258.75	WSW	10 - 20	486,436	316,150	6,280,809
236.25	258.75	WSW	20 - 30	630,945	348,605	12,809,160
236.25	258.75	WSW	30 - 40	604,825	421,404	20,245,891
236.25	258.75	WSW	40 - 50	527,794	526,373	19,855,837

Note:

Statistics were calculated from county level statistics. If a county was bisected by a sector, thus parts of the same county fell in two or more sectors, agricultural production statistics were proportioned by percent county area. This implicitly assumes production is fairly uniform in the county. Since production data was only available at the county level, the assumption that production is fairly uniform was used.

Table 5.4-6 (Sheet 1 of 2)
Liquid Pathways – Maximum Exposed Individual Dose Summary Based on One AP1000 Unit (mrem/year)

Pathway	Total Body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
				Adult				
Fish Consumption	1.98E+00	9.35E-02	2.04E+00	2.94 E+00	1.02 E+00	3.55E-02	3.62E-01	-
Drinking Water	8.37E-03	8.22E-03	2.27E-04	8.47E-03	8.27E-03	8.17E-03	8.20E-03	-
Shoreline	3.75E-03	3.75E-03	3.75E-03	3.75E-03	3.75E-03	3.75E-03	3.75E-03	4.38E-03
Swimming	9.09E-06	9.09E-06	9.09E-06	9.09E-06	9.09E-06	9.09E-06	9.09E-06	-
Boating	3.79E-05	3.79E-05	3.79E-05	3.79E-05	3.79E-05	3.79E-05	3.79E-05	-
Total	2.00E+00	1.06E-01	2.04E+00	2.95E-00	1.03E+00	4.75E-02	3.74E-01	4.38E-03
				Teenager				
Pathway	Total Body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
Fish Consumption	1.11E+00	7.15E-02	2.18E+00	3.04E+00	1.05E+00	2.73E-02	4.23E-01	-
Drinking Water	5.86E-03	5.79E-03	2.20E-04	6.04E-03	5.85E-03	5.76E-03	5.79E-03	-
Shoreline	2.10E-02	2.10E-02	2.10E-02	2.10E-02	2.10E-02	2.10E-02	2.10E-02	-
Swimming	5.07E-05	5.07E-05	5.07E-05	5.07E-05	5.07E-05	5.07E-05	5.07E-05	2.44E-02
Boating	2.54E-05	2.54E-05	2.54E-05	2.54E-05	2.54E-05	2.54E-05	2.54E-05	-
Total	1.14E+00	9.83E-02	2.20E+00	3.07E+00	1.07E+00	5.41E-02	4.50E-01	2.44E-02
				Child				
Pathway	Total Body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
Fish Consumption	4.38E-01	4.01E-02	2.73E+00	2.74E+00	9.03E-01	2.26E-02	3.39E-01	-
Drinking Water	1.11E-02	1.11E-02	6.36E-04	1.17E-02	1.13E-02	1.11E-02	1.11E-02	-
Shoreline	4.38E-03	4.38E-03	4.38E-03	4.38E-03	4.38E-03	4.38E-03	4.38E-03	5.11E-03
Swimming	1.06E-05	1.06E-05	1.06E-05	1.06E-05	1.06E-05	1.06E-05	1.06E-05	-

Table 5.4-6 (Sheet 2 of 2)
Liquid Pathways – Maximum Exposed Individual Dose Summary Based on One AP1000 Unit (mrem/year)

Pathway	**Total Body**	**GI-Tract**	**Bone**	**Liver**	**Kidney**	**Thyroid**	**Lung**	**Skin**
Boating	5.30E-06	5.30E-06	5.30E-06	5.30E-06	5.30E-06	5.30E-06	5.30E-06	-
Total	4.54E-01	5.56E-02	2.74E+00	2.75E+00	9.19E-01	3.81E-02	3.55E-01	5.11E-03
				Infant				
Pathway	Total Body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
Fish Consumption	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-
Drinking Water	1.09E-02	1.09E-02	6.47E-04	1.16E-02	1.11E-02	1.09E-02	1.09E-02	-
Shoreline	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-
Total	1.09E-02	1.09E-02	6.47E-04	1.16E-02	1.11E-02	1.09E-02	1.09E-02	-

Table 5.4-7 (Sheet 1 of 2)
Gaseous Pathways – Dose Summary Maximum Exposed Individuals
Based on One AP1000 Unit

Pathway		T.Body (mrem/yr)	GI-Tract (mrem/yr)	Bone (mrem/yr)	Liver (mrem/yr)	Kidney (mrem/yr)	Thyroid (mrem/yr)	Lung (mrem/yr)	Skin (mrem/yr)	Location
Plume		3.84E-01	3.84E-01	3.84E-01	3.84E-01	3.84E-01	3.84E-01	4.14E-01	2.14E+00	EAB(a)
Ground		6.25E-02	6.25E-02	6.25E-02	6.25E-02	6.25E-02	6.25E-02	6.25E-02	7.34E-02	EAB(a)
Cow Milk	Adult	1.60E-02	1.56E-02	6.13E-02	1.63E-02	1.61E-02	8.33E-02	1.56E-02	1.55E-02	Nearest Milk Cow(b)
	Teen	2.73E-02	2.69E-02	1.13E-01	2.81E-02	2.77E-02	1.34E-01	2.68E-02	2.67E-02	
	Child	6.25E-02	6.19E-02	2.77E-01	6.40E-02	6.34E-02	2.75E-01	6.20E-02	6.18E-02	
	Infant	1.26E-01	1.25E-01	5.41E-01	1.30E-01	1.28E-01	6.42E-01	1.25E-01	1.25E-01	
Goat Milk	Adult	2.05E-02	1.93E-02	6.28E-02	2.11E-02	2.02E-02	1.10E-01	1.93E-02	1.91E-02	Nearest Goat Milk(c)
	Teen	3.29E-02	3.16E-02	1.15E-01	3.49E-02	3.33E-02	1.76E-01	3.18E-02	3.14E-02	
	Child	7.07E-02	6.94E-02	2.83E-01	7.51E-02	7.22E-02	3.55E-01	6.98E-02	6.92E-02	
	Infant	1.38E-01	1.36E-01	5.49E-01	1.48E-01	1.41E-01	8.31E-01	1.37E-01	1.36E-01	
Vegetable	Adult	6.76E-02	6.78E-02	2.69E-01	6.76E-02	6.69E-02	1.94E-01	6.59E-02	6.57E-02	Nearest Garden(d)
	Teen	1.05E-01	1.05E-01	4.48E-01	1.06E-01	1.05E-01	2.81E-01	1.03E-01	1.03E-01	
	Child	2.37E-01	2.36E-01	1.08E+00	2.39E-01	2.37E-01	5.78E-01	2.34E-01	2.34E-01	
Inhalation	Adult	8.02E-03	8.09E-03	1.07E-03	8.17E-03	8.29E-03	6.65E-02	1.01E-02	7.81E-03	Nearest Residence(e)
	Teen	8.11E-03	8.17E-03	1.30E-03	8.37E-03	8.54E-03	8.25E-02	1.13E-02	7.88E-03	
	Child	7.17E-03	7.09E-03	1.58E-03	7.44E-03	7.58E-03	9.54E-02	9.78E-03	6.96E-03	
	Infant	4.14E-03	4.05E-03	7.94E-04	4.42E-03	4.41E-03	8.52E-02	5.97E-03	4.00E-03	
Meat	Adult	1.69E-02	1.76E-02	7.42E-02	1.69E-02	1.68E-02	2.12E-02	1.68E-02	1.67E-02	Nearest Meat Cow(f)
	Teen	1.37E-02	1.41E-02	6.27E-02	1.38E-02	1.37E-02	1.69E-02	1.37E-02	1.37E-02	
	Child	2.50E-02	2.51E-02	1.18E-01	2.50E-02	2.50E-02	2.98E-02	2.49E-02	2.49E-02	

Table 5.4-7 (Sheet 2 of 2)

Gaseous Pathways – Dose Summary Maximum Exposed Individuals Based on One AP1000 Unit

Pathway		T.Body (mrem/yr)	GI-Tract (mrem/yr)	Bone (mrem/yr)	Liver (mrem/yr)	Kidney (mrem/yr)	Thyroid (mrem/yr)	Lung (mrem/yr)	Skin (mrem/yr)	Location
Total without Plume	Adult	1.92E-01	1.91E-01	5.31E-01	1.93E-01	1.91E-01	5.38E-01	1.90E-01	1.98E-01	
	Teen	2.50E-01	2.48E-01	8.03E-01	2.54E-01	2.51E-01	7.53E-01	2.49E-01	2.56E-01	
	Child	4.65E-01	4.62E-01	1.82E+00	4.73E-01	4.68E-01	1.40E+00	4.63E-01	4.70E-01	
	Infant	3.31E-01	3.28E-01	1.15E+00	3.45E-01	3.36E-01	1.62E+00	3.30E-01	3.38E-01	
	MAX	4.65E-01	4.62E-01	1.82E+00	4.73E-01	4.68E-01	1.62E+00	4.63E-01	4.70E-01	
Total with Plume	Adult	5.76E-01	5.75E-01	9.15E-01	5.77E-01	5.75E-01	9.22E-01	6.04E-01	2.34E+00	
	Teen	6.34E-01	6.32E-01	1.19E+00	6.38E-01	6.35E-01	1.14E+00	6.63E-01	2.40E+00	
	Child	8.49E-01	8.46E-01	2.21E+00	8.57E-01	8.52E-01	1.78E+00	8.77E-01	2.61E+00	
	Infant	7.15E-01	7.12E-01	1.54E+00	7.29E-01	7.20E-01	2.00E+00	7.44E-01	2.48E+00	
	MAX	8.49E-01	8.46E-01	2.21E+00	8.57E-01	8.52E-01	2.00E+00	8.77E-01	2.61E+00	

Notes:

a) EAB – 0.99 mi SSW

b) Nearest Milk Cow – 5.28 mi SSW

c) Nearest Goat – 5.28 mi SSW

d) Nearest Garden – 4.08 mi SSW

e) Nearest Residence – 4.08 mi SSW

f) Nearest Meat Cow – 3.06 mi SW

Table 5.4-8
Liquid Pathways – Comparison of Maximum Individual Dose Compared to 10 CFR 50, Appendix I Criteria (One AP1000 Unit)

Type of Dose	Appendix I Criteria Dose Objective	Point of Dose Evaluation[a]	Calculated Doses (mrem/yr) [b]
Liquid Effluents			
Dose to total body from all pathways	3 mrem/yr each unit	Harris Reservoir	2.00 Adult
Dose to any organ from all pathways	10 mrem/yr each unit	Harris Reservoir	3.07 Teen Liver

Notes:

a) Location of the highest dose off-site.

b) Calculated doses presented in ER Table 5.4-6, Liquid Pathways – Maximum Exposed Individual Dose Summary Based on One AP1000 Unit.

Table 5.4-9
Gaseous Pathways – Comparison of Maximum Individual Dose Compared to 10 CFR 50, Appendix I Criteria (One AP1000 Unit)

Type of Dose	Design Objective	Point of Evaluation	Calculated Dose
Gaseous Effluents (Noble Gases Only)			
Gamma Air Dose	10 mrad	Exclusion area boundary	0.64 mrad
Beta Air Dose	20 mrad	Exclusion area boundary	3.03 mrad
Total Body Dose	5 mrem	Exclusion area boundary	0.38 mrem
Skin Dose	15 mrem	Exclusion area boundary	2.14 mrem
Radioiodines and Particulates			
Dose to any organ from all pathways	15 mrem	Varies[a]	2.21 mrem (child-bone)

Notes:
a) Locations of highest pathway doses off-site.

mrad = millirad

Table 5.4-10
Comparison of Maximum Exposed Individual Doses from the HAR Site with the 40 CFR 190 Criteria (mrem/yr)

Type of Dose	Design Objective (40 CFR 190)	SHNPP U1 Total Liquid and Gaseous Dose[a]	HAR Calculated Liquid Dose (two units)	HAR Calculated Gaseous Dose (two units)	Total Site Dose
Whole Body Dose Equivalent	25	0.53	5.08[b]	1.42[b]	7.0
Dose to Thyroid	75	0.54	0.11 (teen)	4.00 (infant)	4.7
Dose to Any Other Organ	25	0.54	6.14 (teen liver)	4.42 (child bone)	11.1

Notes:

a) HNP operating data.

b) Whole body dose equivalent assumed equal to TEDE

Table 5.4-11

Calculated Doses to the Population within 80.5 km (50.0 mi.) of the HAR Site from Gaseous and Liquid Pathways (person-rem/yr)

Pathway	Total Body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
Gaseous Effluents								
Plume	2.77E+00	2.77E+00	2.77E+00	2.77E+00	2.77E+00	2.77E+00	3.24E+00	2.97E+01
Ground	3.89E-01	3.89E-01	3.89E-01	3.89E-01	3.89E-01	3.89E-01	3.89E-01	4.56E-01
Inhalation	8.32E-01	8.35E-01	9.41E-02	8.46E-01	8.55E-01	6.09E+00	1.01E+00	8.15E-01
Vegetable	3.67E-01	3.67E-01	1.54E+00	3.67E-01	3.64E-01	3.70E-01	3.63E-01	3.62E-01
Cow Milk	2.61E-01	2.57E-01	1.09E+00	2.66E-01	2.63E-01	1.08E+00	2.57E-01	2.56E-01
Meat	1.90E+00	1.93E+00	8.53E+00	1.90E+00	1.89E+00	2.16E+00	1.89E+00	1.89E+00
Total	6.52E+00	6.55E+00	1.44E+01	6.54E+00	6.53E+00	1.29E+01	7.15E+00	3.34E+01
Liquid Effluents								
Fish Consumption	4.82E+00	2.44E-01	6.50E+00	8.70E+00	2.99E+00	9.66E-02	1.09E+00	
Drinking Water[(a)]	1.39E+00	1.37E+00	2.56E-02	1.42E+00	1.38E+00	1.36E+00	1.37E+00	
Hydrosphere Tritium	7.70E-03	7.70E-03	-	7.70E-03	7.70E-03	7.70E-03	7.70E-03	
Shoreline	4.31E-01	-	-	-	-	4.31E-01		5.03E-01
Swimming	1.04E-03		-	-	-	1.04E-03		
Boating	5.22E-04	-	-	-	-	5.22E-04		
Total	6.65E+00	1.62E+00	6.53E+00	1.01E+01	4.37E+00	1.89E+00	2.46E+00	5.03E-01

TABLE 5.4-12
Natural Background – Estimated Whole Body Dose to the Population within 80.5 km (50.0 mi.) of the HAR Site

Source	Annual Individual Dose (mrem/yr)	Annual Population Dose[a] (person-rem/yr)
Estimated total background radiation dose	360[b]	1.1E+06

Notes:

a) Annual population dose based on projected residential population of 3,003,458 in year 2020 from Tables 2.5-2 and 2.5-4.

b) About 360 mrem/yr taken from NRC Fact Sheet, "Biological Effects of Radiation."

Table 5.4-13 (Sheet 1 of 3)
Summary of Information Reported by Commercial Light Water Reactors (1973 – 2005)

Year	Number of Reactors Included[(a)]	Annual Collective Dose (person-rem)	No. of Workers With Measurable Dose[(b)]	Electricity Generated (MW-yrs)	Average Measurable Dose Per Worker (rem)	Average Collective Dose Per Reactor (person –rem)	Average No. Personnel With Measurable Doses Per Reactor[(c)]
1973	24	13,962	14,780	7,164.1	0.95	582	616
1974	33	13,650	18,139	10,590.9	0.75	414	550
1975	44	20,901	28,234	17,768.9	0.74	475	642
1976	52	26,105	34,515	21,462.9	0.76	502	664
1977	57	32,521	42,393	26,448.3	0.77	571	744
1978	64	31,785	46,081	31,696.5	0.69	497	720
1979	67	39,908	64,253	29,926.0	0.62	596	959
1980	68	53,739	80,457	29,157.5	0.67	790	1,183
1981	70	54,163	82,224	31,452.9	0.66	774	1,175
1982	74	52,201	84,467	32,755.2	0.62	705	1,141
1983	75	56,484	85,751	32,925.6	0.66	753	1,143
1984	78	55,251	98,309	36,497.6	0.56	708	1,260
1985	82	43,048	92,968	41,754.7	0.46	525	1,134

Table 5.4-13 (Sheet 2 of 3)
Summary of Information Reported by Commercial Light Water Reactors (1973 – 2005)

Year	Number of Reactors Included[(a)]	Annual Collective Dose (person-rem)	No. of Workers With Measurable Dose[(b)]	Electricity Generated (MW-yrs)	Average Measurable Dose Per Worker (rem)	Average Collective Dose Per Reactor (person –rem)	Average No. Personnel With Measurable Doses Per Reactor[(c)]
1986	90	42,386	100,997	45,695.1	0.42	471	1,122
1987	96	40,406	104,403	52,116.3	0.39	421	1,088
1988	102	40,772	103,294	59,595.1	0.40	400	1,013
1989	107	35,931	108,278	62,223.0	0.33	336	1,012
1990	110	36,602	108,667	68,291.7	0.34	333	988
1991	111	28,519	98,782	73,448.4	0.29	257	890
1992	110	29,297	103,155	74,012.0	0.28	266	938
1993	106	25,597	93,749	70,704.9	0.27	241	884
1994	107	21,672	83,454	74,536.6	0.26	203	780
1995	107	21,233	85,671	78,875.2	0.25	198	801
1996	109	18,883	84,644	79,660.0	0.22	173	777
1997	109	17,149	84,711	71,851.4	0.20	157	777

Table 5.4-13 (Sheet 3 of 3)
Summary of Information Reported by Commercial Light Water Reactors (1973 – 2005)

Year	Number of Reactors Included[a]	Annual Collective Dose (person –rem)	No. of Workers With Measurable Dose[b]	Electricity Generated (MW-yrs)	Average Measurable Dose Per Worker (rem)	Average Collective Dose Per Reactor (person –rem)	Average No. Personnel With Measurable Doses Per Reactor[c]
1998	105	13,187	71,485	77,069.9	0.18	126	681
1999	104	13,666	75,420	83,197.6	0.18	131	725
2000	104	12,652	74,108	86,006.8	0.17	122	713
2001	104	11,109	67,570	87,552.8	0.16	107	650
2002	104	12,126	73,242	88,829.7	0.17	117	704
2003	104	11,956	74,813	87,015.0	0.16	115	719
2004	104	10,368	69,849	89,823.5	0.15	100	672
2005	104	11,456	78,127	89,177.7	0.15	110	751

Notes:
a) Includes only those reactors that had been in commercial operation for at least one full year as of December 31 of each of the indicated years.

b) Figures are not adjusted for the multiple reporting of transient individuals.

c) Electricity generated reflects the gross electricity generated for the years 1973–1996. Beginning in 1997, it reflects the net.

Source: NUREG-0713, Vol. 27

Table 5.4-14 (Sheet 1 of 2)
Three-Year Totals and Averages Listed in Ascending Order of Collective TEDE per BWR (2003 – 2005)

Site Name[(a)]	Reactor Years	Collective TEDE per Reactor	Collective TEDE per Site	Number of Workers with Measurable TEDE	Average TEDE per Worker	Total MW-Years	Average TEDE per MW-Year
LIMERICK 1,2	6	81	484	4,023	0.12	6,601.4	0.07
HATCH 1,2	6	93	556	3,792	0.15	4,809.7	0.12
DUANE ARNOLD	3	94	283	1,928	0.15	1,533.8	0.19
OYSTER CREEK	3	99	298	2,078	0.14	1,762.1	0.17
FITZPATRICK	3	100	300	1,771	0.17	2,330.9	0.13
SUSQUEHANNA 1,2	6	117	704	5,976	0.12	6,196.2	0.11
GRAND GULF	3	119	357	2,859	0.13	3,553.7	0.10
FERMI 2	3	125	375	3,047	0.12	2,885.7	0.13
CLINTON	3	125	376	2,292	0.16	2,890.4	0.13
MONTICELLO	3	126	379	2,056	0.18	1,605.4	0.24
BRUNSWICK 1,2	6	133	799	5,878	0.14	5,022.4	0.16
HOPE CREEK 1	3	149	446	4,918	0.09	2,390.1	0.19
COOPER STATION	3	153	458	2,629	0.17	1,884.8	0.24
PEACH BOTTOM 2,3	6	154	927	4,864	0.19	6,323.2	0.15
VERMONT YANKEE	3	155	464	2,843	0.16	1,412.6	0.33
PILGRIM	3	166	497	3,076	0.16	1,865.9	0.27
DRESDEN 2,3	6	166	996	6,148	0.16	4,512.2	0.22
RIVER BEND 1	3	170	509	3,172	0.16	2,607.4	0.20
LASALLE 1,2	6	193	1,158	6,716	0.17	6,392.7	0.18

Table 5.4-14 (Sheet 2 of 2)
Three-Year Totals and Averages Listed in Ascending Order of Collective TEDE per BWR (2003 – 2005)

Site Name[(a)]	Reactor Years	Collective TEDE per Reactor	Collective TEDE per Site	Number of Workers with Measurable TEDE	Average TEDE per Worker	Total MW-Years	Average TEDE per MW-Year
COLUMBIA GENERATING	3	199	596	4,052	0.15	2,827.7	0.21
NINE MILE POINT 1,2	6	204	1,225	4,229	0.29	4,794.0	0.26
BROWNS FERRY 1,2,3[(b)]	9	212	1,912	9,593	0.20	6,163.4	0.31
QUAD CITIES 1,2	6	318	1,910	6,201	0.31	4,529.4	0.42
PERRY	3	366	1,097	4,110	0.27	3,010.9	0.37
Totals and Averages	105		17,106	98,251	0.17	87,906.0	0.19
Averages per Reactor-Yr		163		936		837.2	

Notes:
a) Sites where not all reactors had completed 3 full years of commercial operation as of December 31, 2005, are not included.

b) Browns Ferry 1 remains in the count of operating reactors but was placed on Administrative Hold in June 1985.

BWR = boiling water reactor

Table 5.4-15 (Sheet 1 of 3) Three-Year Totals and Averages Listed in Ascending Order of Collective TEDE per PWR (2003 – 2005)

Site Name	Reactor Years	Collective TEDE per Reactor	Collective TEDE per Site	Number of Workers with Measurable TEDE	Average TEDE per Worker	Total MW-Years	Average TEDE per MW-Year
SEABROOK	3	43	129	2,306	0.06	3,290.9	0.04
HARRIS	3	45	134	1,697	0.08	2,524.7	0.05
FARLEY 1,2	6	48	286	2,739	0.10	4,653.6	0.06
PRAIRIE ISLAND 1,2	6	48	289	2,562	0.11	2,899.0	0.10
SUMMER 1	3	51	153	1,679	0.09	2,625.7	0.06
GINNA	3	52	155	1,185	0.13	1,385.9	0.11
VOGTLE 1,2	6	53	316	2,670	0.12	6,408.5	0.05
POINT BEACH 1,2	6	54	323	2,105	0.15	2,612.0	0.12
KEWAUNEE	3	56	168	1,101	0.15	1,260.9	0.13
INDIAN POINT 3	3	58	174	2,029	0.09	2,777.0	0.06
ROBINSON 2	3	63	188	1,852	0.10	2,043.7	0.09
NORTH ANNA 1,2	6	63	376	2,692	0.14	5,006.2	0.08
BYRON 1,2	6	63	376	3,272	0.12	6,747.8	0.06
WOLF CREEK 1	3	66	199	1,769	0.11	3,171.2	0.06
PALO VERDE 1,2,3	9	68	610	5,281	0.12	9,393.4	0.07

Table 5.4-15 (Sheet 2 of 3)
Three-Year Totals and Averages Listed in Ascending Order of Collective TEDE per PWR (2003 – 2005)

Site Name	Reactor Years	Collective TEDE per Reactor	Collective TEDE per Site	Number of Workers with Measurable TEDE	Average TEDE per Worker	Total MW-Years	Average TEDE per MW-Year
CATAWBA 1,2	6	70	417	3,551	0.12	6,297.7	0.07
BRAIDWOOD 1,2	6	71	428	3,484	0.12	6,811.4	0.06
INDIAN POINT 2	3	73	219	1,847	0.12	2,815.5	0.08
MCGUIRE 1,2	6	74	441	3,358	0.13	6,225.8	0.07
COMANCHE PEAK 1,2	6	74	444	2,868	0.16	6,289.7	0.07
THREE MILE ISLAND 1	3	75	224	2,290	0.10	2,303.5	0.10
COOK 1,2	6	76	457	3,275	0.14	5,455.8	0.08
WATERFORD 3	3	78	234	1,672	0.14	2,968.0	0.08
TURKEY POINT 3,4	6	79	474	3,667	0.13	3,627.2	0.13
CRYSTAL RIVER 3	3	84	253	2,031	0.13	2,303.4	0.11
OCONEE 1,2,3	9	85	762	5,991	0.13	6,652.4	0.12
SOUTH TEXAS 1,2	6	85	511	3,019	0.17	6,491.9	0.08
BEAVER VALLEY 1,2	6	85	513	3,871	0.13	4,620.5	0.11
SALEM 1,2	6	86	513	5,959	0.09	5,893.8	0.09
DIABLO CANYON 1,2	6	86	514	3,189	0.16	5,729.4	0.09

Table 5.4-15 (Sheet 3 of 3)
Three-Year Totals and Averages Listed in Ascending Order of Collective TEDE per PWR (2003 – 2005)

Site Name	Reactor Years	Collective TEDE per Reactor	Collective TEDE per Site	Number of Workers with Measurable TEDE	Average TEDE per Worker	Total MW-Years	Average TEDE per MW-Year
SURRY 1,2	6	89	533	3,533	0.15	4,300.5	0.12
DAVIS-BESSE	3	93	278	1,785	0.16	1,474.9	0.19
CALVERT CLIFFS 1,2	6	96	577	3,818	0.15	4,890.2	0.12
SAN ONOFRE 2,3	6	97	582	3,341	0.17	5,892.8	0.10
SEQUOYAH 1,2	6	102	612	4,770	0.13	6,074.5	0.10
WATTS BAR 1	3	105	315	2,856	0.11	3,099.1	0.10
MILLSTONE 2,3	6	110	662	3,407	0.19	5,499.2	0.12
ARKANSAS 1,2	6	113	681	4,535	0.15	4,995.3	0.14
CALLAWAY 1	3	117	352	2,976	0.12	2,910.3	0.12
ST. LUCIE 1,2	6	118	707	4,356	0.16	4,425.1	0.16
FORT CALHOUN	3	169	507	2,198	0.23	1,195.5	0.42
PALISADES	3	195	584	1,952	0.30	2,066.3	0.28
Totals and Averages	207		16,673	124,538	0.13	178,110.2	0.09
Averages per Reactor-Yr		81		602		860.4	

Notes:
Sites where not all reactors had completed 3 full years of commercial operation as of December 31, 2005, are not included.

PWR = pressurized water reactor

Table 5.4-16
Identified Important Species and Analytical Surrogates

Species	Remarks	Surrogate Species
Southeastern Myotis	Bat that migrates through HAR site to spend winters or summer in vicinity of site. Federal and state species of concern.	N/A
Red-cockaded Woodpecker	Last observed near HAR site in 1987. Habitat in vicinity of site is not preferred. Federal and state endangered species.	N/A
Lemmer's Pinion Moth	Observed near Harris Reservoir. Preferred habitat is cedar and pine trees. State-listed rare species.	N/A
Bald Eagle	Occasionally observed around Harris Reservoir. Active nest discovered 600 m (0.37 mi.) from the White Oak arm of the reservoir. Species to be removed from federal threatened list in August 2007.	Heron
Cape Fear Shiner	Endemic to several tributaries of the Cape Fear River. Not observed in Harris Reservoir. Federal and state endangered species.	Freshwater invertebrate or fish
Dwarf Wedgemussel	Habitat for mussel and its host darter species is in streams flowing to Cape Fear River. Considered unlikely to occur in Harris Reservoir. Federal and state endangered species.	Freshwater invertebrate
Black crappie, bluegill, largemouth bass	Recreationally fished in Harris Reservoir.	Freshwater fish
Small game, turkey, waterfowl	Recreationally hunted in Shearon Harris game lands located in site vicinity.	Duck
White-tailed deer	Recreationally hunted in Shearon Harris game lands located in site vicinity.	N/A
Michaux's Sumac	Experimental shrub population transplanted in vicinity of site. Federal and state endangered species.	N/A

Notes:

Surrogate species are for biota doses from liquid effluents used in LADTAP II.

Table 5.4-17
Terrestrial Biota Parameters

Terrestrial Biota	Food Intake (g/d)	Body Mass (g)	Effective Body Radius (cm)	Food Organism
Surrogate Biota				
Muskrat	100	1,000	6	Aquatic plants
Raccoon	200	12,000	14	Invertebrates
Heron	600	4,600	11	Fish
Duck	100	1,000	5	Aquatic plants
Important Biota				
Southeastern Myotis	2.5	7.5	~1	Insects
Red-cockaded Woodpecker	45	45	~1	Insects
White-tailed Deer	1,740	57,000	14	Vegetation
Pinion Moth[a]	1	0.076	<1	Conifer leaf

Notes:
a) Food intake and body mass conservatively based on full grown caterpillar stage.

Table 5.4-18
Shoreline (Sediment) and Swimming Exposures

Biota	Shoreline Exposure (hr/yr)	Swimming Exposure (hr/yr)
Fish	4,380	8,760
Invertebrates	8,760	8,760
Algae	N/A	8,760
Muskrat	2,922	2,922
Raccoon	2,191	N/A
Heron	2,922	2,920
Duck	4,383	4,383

Table 5.4-19
Total Body Dose to Surrogate Biota from Liquid and Gaseous Effluents

	Doses from Liquid Effluents in Harris Reservoir			
	Units 2 and 3		Unit 1	
Biota	**Internal Dose (mrem/yr)**	**External Dose (mrem/yr)**	**Internal Dose (mrem/yr)**	**External Dose (mrem/yr)**
Fish	13	18	1.8	1.8
Invertebrate	8	36	0.8	3.5
Algae	8	0	0.9	0
Muskrat	76	12	9.5	1.2
Raccoon	27	9	0.5	0.9
Heron	407	12	55	1.2
Duck	70	18	8.4	1.8

	Doses from Gaseous Effluents		
	Units 2 and 3		Unit 1
Contributor	**Reservoir (mrad/yr)**	**Site Vicinity (mrad/yr)**	**Site (mrad/yr)**
Air Immersion	14	0.8	0.9
Deposition	0.5	0.02	0.05

Notes:
HNP site boundary was 2.09 km (1.3 mi.) north-northeast of plant.

HNP liquid and gaseous effluent doses are from SHNPP Environmental Report, Chapters 5.2.3 and 5.2.4

Immersion dose is from beta and gamma air doses.

Table 5.4-20
Doses to Important Biota Other Than Man

Biota Species	Internal Dose[c], mrad/yr	External Dose[c], mrad/yr	Total Dose[c], mrad/yr
Cape Fear Shiner[a]	15	20	35
Dwarf Wedgemussel[a]	9	40	48
Black crappie, largemouth bass, bluegill[a]	15	20	35
Bald Eagle[a]	462	13	482
Small game, turkey, and waterfowl[a]	78	20	106
Southeastern Myotis[b]	36	5	56
Red-cockaded Woodpecker[b]	32	2	34
White-tailed Deer [b]	2	2	4
Lemmer's Pinion Moth[b]	51	2	53
Michaux's Sumac[b]	1	2	3

Notes:
a) Doses determined from surrogate biota

b) Terrestrial doses from gaseous effluents to vegetation pathways

c) Doses include contributions from Units 1, 2, and 3.

Table 5.4-21
Comparison of Doses to Surrogate and Important Biota from Plant Effluents to ORNL 1995 Evaluated Daily Limits

Biota – Daily Limits	Total Dose, mrad/day
Aquatic biota – 1000 mrad/day	
Freshwater fish	0.10
Freshwater invertebrate	0.13
Algae	0.02
Cape Fear Shiner	0.10
Dwarf Wedgemussel	0.13
Black crappie, largemouth bass, bluegill	0.10
Terrestrial biota – 100 mrad/day	
Muskrat	0.31
Raccoon	0.15
Heron	1.32
Duck	0.29
Bald Eagle	1.32
Small game, turkey, and waterfowl	0.29
Southeastern Myotis	0.15
Red-cockaded Woodpecker	0.09
White-tailed Deer	0.01
Lemmer's Pinion Moth	0.14

Notes:
Includes contributions from Units 1, 2, and 3.

Table 5.4-22 (Sheet 1 of 4)
Sector Average Atmospheric Dispersion Factors Input to GASPAR

	Downwind Distance (miles)									
	1.0	**2.0**	**3.0**	**4.0**	**5.0**	**10.0**	**20.0**	**30.0**	**40.0**	**50.0**
	Sector Average Annual χ/Q (m^3/sec)									
N	2.54E-06	8.97E-07	4.25E-07	2.63E-07	1.85E-07	9.31E-08	3.6E-08	1.82E-08	1.17E-08	8.40E-09
NNE	3.09E-06	1.10E-06	5.24E-07	3.26E-07	2.29E-07	1.16E-07	4.57E-08	2.30E-08	1.48E-08	1.07E-08
NE	2.87E-06	1.02E-06	4.88E-07	3.05E-07	2.16E-07	1.10E-07	4.35E-08	2.20E-08	1.42E-08	1.03E-08
ENE	3.09E-06	1.09E-06	5.25E-07	3.29E-07	2.34E-07	1.20E-07	4.79E-08	2.45E-08	1.59E-08	1.15E-08
E	2.35E-06	8.34E-07	4.11E-07	2.61E-07	1.86E-07	9.66E-08	3.94E-08	2.04E-08	1.33E-08	9.73E-09
ESE	2.96E-06	1.05E-06	5.23E-07	3.34E-07	2.40E-07	1.26E-07	5.19E-08	2.71E-08	1.78E-08	1.31E-08
SE	3.16E-06	1.11E-06	5.53E-07	3.53E-07	2.53E-07	1.32E-07	5.47E-08	2.86E-08	1.88E-08	1.38E-08
SSE	4.94E-06	1.74E-06	8.74E-07	5.61E-07	4.04E-07	2.13E-07	8.85E-08	4.65E-08	3.07E-08	2.26E-08
S	9.20E-06	3.25E-06	1.65E-06	1.07E-06	7.71E-07	4.08E-07	1.71E-07	9.04E-08	5.98E-08	4.41E-08
SSW	1.02E-05	3.58E-06	1.84E-06	1.19E-06	8.64E-07	4.59E-07	1.94E-07	1.03E-07	6.85E-08	5.06E-08
SW	6.91E-06	2.43E-06	1.24E-06	8.03E-07	5.82E-07	3.08E-07	1.30E-07	6.87E-08	4.56E-08	3.36E-08
WSW	3.83E-06	1.35E-06	6.77E-07	4.33E-07	3.11E-07	1.63E-07	6.75E-08	3.53E-08	2.32E-08	1.71E-08
W	2.50E-06	8.84E-07	4.41E-07	2.81E-07	2.02E-07	1.06E-07	4.35E-08	2.27E-08	1.49E-08	1.09E-08
WNW	1.86E-06	6.61E-07	3.25E-07	2.06E-07	1.47E-07	7.63E-08	3.11E-08	1.60E-08	1.05E-08	7.66E-09
NW	1.68E-06	5.96E-07	2.88E-07	1.81E-07	1.28E-07	6.57E-08	2.63E-08	1.34E-08	8.69E-09	6.31E-09
NNW	1.87E-06	6.63E-07	3.17E-07	1.97E-07	1.39E-07	7.05E-08	2.78E-08	1.40E-08	9.00E-09	6.50E-09

Table 5.4-22 (Sheet 2 of 4)
Sector Average Atmospheric Dispersion Factors Input to GASPAR

	Downwind Distance (miles)									
	1.0	**2.0**	**3.0**	**4.0**	**5.0**	**10.0**	**20.0**	**30.0**	**40.0**	**50.0**
	Sector Average Annual χ/Q (m^3/sec)									
N	6.58E-09	2.00E-09	7.94E-10	4.34E-10	2.76E-10	1.19E-10	3.68E-11	1.46E-11	7.78E-12	4.81E-12
NNE	7.14E-09	2.16E-09	8.61E-10	4.70E-10	2.99E-10	1.28E-10	3.98E-11	1.58E-11	8.43E-12	5.22E-12
NE	6.80E-09	2.06E-09	8.20E-10	4.48E-10	2.85E-10	1.22E-10	3.79E-11	1.50E-11	8.03E-12	4.97E-12
ENE	8.25E-09	2.50E-09	9.96E-10	5.44E-10	3.46E-10	1.49E-10	4.61E-11	1.83E-11	9.75E-12	6.04E-12
E	4.28E-09	1.30E-09	5.17E-10	2.82E-10	1.80E-10	7.71E-11	2.39E-11	9.48E-12	5.06E-12	3.13E-12
ESE	5.17E-09	1.57E-09	6.24E-10	3.41E-10	2.17E-10	9.31E-11	2.89E-11	1.14E-11	6.11E-12	3.78E-12
SE	6.31E-09	1.91E-09	7.62E-10	4.16E-10	2.64E-10	1.14E-10	3.52E-11	1.40E-11	7.46E-12	4.61E-12
SSE	7.99E-09	2.42E-09	9.65E-10	5.27E-10	3.35E-10	1.44E-10	4.46E-11	1.77E-11	9.44E-12	5.85E-12
S	1.25E-08	3.80E-09	1.51E-09	8.26E-10	5.25E-10	2.25E-10	6.99E-11	2.77E-11	1.48E-11	9.16E-12
SSW	1.23E-08	3.74E-09	1.49E-09	8.13E-10	5.17E-10	2.22E-10	6.88E-11	2.73E-11	1.46E-11	9.02E-12
SW	8.71E-09	2.64E-09	1.05E-09	5.74E-10	3.65E-10	1.57E-10	4.86E-11	1.93E-11	1.03E-11	6.37E-12
WSW	5.82E-09	1.76E-09	7.02E-10	3.84E-10	2.44E-10	1.05E-10	3.25E-11	1.29E-11	6.87E-12	4.25E-12
W	3.74E-09	1.13E-09	4.51E-10	2.47E-10	1.57E-10	6.73E-11	2.09E-11	8.28E-12	4.42E-12	2.73E-12
WNW	3.11E-09	9.43E-10	3.75E-10	2.05E-10	1.30E-10	5.60E-11	1.74E-11	6.88E-12	3.68E-12	2.27E-12
NW	3.34E-09	1.01E-09	4.03E-10	2.20E-10	1.40E-10	6.02E-11	1.87E-11	7.39E-12	3.95E-12	2.44E-12
NNW	4.32E-09	1.31E-09	5.22E-10	2.85E-10	1.81E-10	7.78E-11	2.41E-11	9.57E-12	5.11E-12	3.16E-12

Table 5.4-22 (Sheet 3 of 4)
Sector Average Atmospheric Dispersion Factors Input to GASPAR

Downwind Distance (miles)

	1.0	2.0	3.0	4.0	5.0	10.0	20.0	30.0	40.0	50.0
					Sector Average χ/Q 2.26 day decay (m^3/sec)					
N	2.52E-06	8.86E-07	4.16E-07	2.55E-07	1.78E-07	8.74E-08	3.21E-08	1.48E-08	8.78E-09	5.89E-09
NNE	3.07E-06	1.08E-06	5.12E-07	3.15E-07	2.20E-07	1.09E-07	4.01E-08	1.85E-08	1.10E-08	7.35E-09
NE	2.85E-06	1.00E-06	4.77E-07	2.95E-07	2.06E-07	1.02E-07	3.78E-08	1.75E-08	1.04E-08	6.96E-09
ENE	3.07E-06	1.07E-06	5.13E-07	3.18E-07	2.23E-07	1.11E-07	4.14E-08	1.93E-08	1.15E-08	7.71E-09
E	2.33E-06	8.21E-07	4.00E-07	2.51E-07	1.77E-07	8.89E-08	3.35E-08	1.56E-08	9.26E-09	6.20E-09
ESE	2.94E-06	1.03E-06	5.08E-07	3.20E-07	2.27E-07	1.15E-07	4.36E-08	2.04E-08	1.21E-08	8.13E-09
SE	3.14E-06	1.09E-06	5.37E-07	3.38E-07	2.40E-07	1.21E-07	4.60E-08	2.15E-08	1.28E-08	8.59E-09
SSE	4.89E-06	1.71E-06	8.48E-07	5.37E-07	3.82E-07	1.94E-07	7.40E-08	3.47E-08	2.07E-08	1.39E-08
S	9.12E-06	3.19E-06	1.60E-06	1.02E-06	7.27E-07	3.71E-07	1.42E-07	6.69E-08	3.99E-08	2.67E-08
SSW	1.01E-05	3.51E-06	1.78E-06	1.14E-06	8.12E-07	4.16E-07	1.60E-07	7.54E-08	4.49E-08	3.01E-08
SW	6.85E-06	2.39E-06	1.20E-06	7.66E-07	5.47E-07	2.80E-07	1.07E-07	5.05E-08	3.01E-08	2.01E-08
WSW	3.80E-06	1.33E-06	6.57E-07	4.15E-07	2.94E-07	1.49E-07	5.65E-08	2.64E-08	1.57E-08	1.05E-08
W	2.48E-06	8.68E-07	4.28E-07	2.70E-07	1.91E-07	9.66E-08	3.65E-08	1.71E-08	1.01E-08	6.78E-09
WNW	1.85E-06	6.50E-07	3.16E-07	1.98E-07	1.40E-07	7.02E-08	2.64E-08	1.23E-08	7.29E-09	4.87E-09
NW	1.67E-06	5.87E-07	2.81E-07	1.75E-07	1.23E-07	6.09E-08	2.26E-08	1.05E-08	6.22E-09	4.16E-09
NNW	1.85E-06	6.54E-07	3.10E-07	1.91E-07	1.33E-07	6.59E-08	2.43E-08	1.12E-08	6.67E-09	4.46E-09

Table 5.4-22 (Sheet 4 of 4)
Sector Average Atmospheric Dispersion Factors Input to GASPAR

	Downwind Distance (miles)									
	1.0	**2.0**	**3.0**	**4.0**	**5.0**	**10.0**	**20.0**	**30.0**	**40.0**	**50.0**
Sector Average χ/Q depleted and 8 day decay (m^3/sec)										
N	2.27E-06	7.63E-07	3.43E-07	2.04E-07	1.38E-07	6.50E-08	2.21E-08	9.50E-09	5.40E-09	3.50E-09
NNE	2.77E-06	9.33E-07	4.22E-07	2.52E-07	1.72E-07	8.10E-08	2.77E-08	1.20E-08	6.82E-09	4.43E-09
NE	2.57E-06	8.64E-07	3.94E-07	2.36E-07	1.61E-07	7.64E-08	2.63E-08	1.14E-08	6.52E-09	4.24E-09
ENE	2.77E-06	9.24E-07	4.24E-07	2.55E-07	1.74E-07	8.31E-08	2.89E-08	1.26E-08	7.25E-09	4.73E-09
E	2.11E-06	7.08E-07	3.31E-07	2.02E-07	1.39E-07	6.70E-08	2.36E-08	1.04E-08	6.00E-09	3.92E-09
ESE	2.65E-06	8.88E-07	4.21E-07	2.58E-07	1.79E-07	8.69E-08	3.10E-08	1.38E-08	7.98E-09	5.23E-09
SE	2.84E-06	9.42E-07	4.45E-07	2.72E-07	1.89E-07	9.17E-08	3.26E-08	1.45E-08	8.41E-09	5.51E-09
SSE	4.42E-06	1.47E-06	7.03E-07	4.33E-07	3.01E-07	1.47E-07	5.27E-08	2.36E-08	1.37E-08	8.98E-09
S	8.25E-06	2.75E-06	1.33E-06	8.21E-07	5.73E-07	2.82E-07	1.02E-07	4.57E-08	2.66E-08	1.75E-08
SSW	9.12E-06	3.04E-06	1.48E-06	9.17E-07	6.42E-07	3.17E-07	1.15E-07	5.20E-08	3.03E-08	1.99E-08
SW	6.19E-06	2.06E-06	9.98E-07	6.19E-07	4.32E-07	2.13E-07	7.70E-08	3.47E-08	2.02E-08	1.33E-08
WSW	3.43E-06	1.15E-06	5.45E-07	3.34E-07	2.32E-07	1.13E-07	4.02E-08	1.79E-08	1.04E-08	6.80E-09
W	2.24E-06	7.50E-07	3.55E-07	2.17E-07	1.50E-07	7.30E-08	2.60E-08	1.16E-08	6.67E-09	4.37E-09
WNW	1.67E-06	5.61E-07	2.62E-07	1.59E-07	1.10E-07	5.29E-08	1.86E-08	8.21E-09	4.73E-09	3.09E-09
NW	1.51E-06	5.06E-07	2.32E-07	1.40E-07	9.58E-08	4.57E-08	1.58E-08	6.91E-09	3.95E-09	2.57E-09
NNW	1.67E-06	5.63E-07	2.55E-07	1.53E-07	1.04E-07	4.91E-08	1.68E-08	7.27E-09	4.14E-09	2.69E-09

5.5 ENVIRONMENTAL IMPACTS OF WASTE

Construction and operation of the HAR will result in the generation of several identifiable waste streams. The facility wastes are regulated during generation, storage, and disposal. Plant industrial, nonhazardous wastes are regulated by disposal at a permitted landfill by either the local municipality or state authority; or the wastes are recycled. Construction/demolition and industrial wastes generated at the HAR site may be disposed of at the permitted landfill that currently services the Raleigh-Durham area or a similarly permitted facility.

Used oil, hazardous, and mixed wastes are regulated under the Resource Conservation and Recovery Act (RCRA) both for managed storage and disposal. A facility generating these wastes is required to obtain a USEPA RCRA identification number that is site-specific. Wastes generated at the HAR that fall under RCRA regulations are either recycled or disposed of at RCRA-permitted treatment, storage, and disposal (TSD) facilities. No hazardous waste will be disposed of on-site.

Aqueous discharges are regulated through the NPDES program both for stormwater and wastewater. The NCDENR is authorized to oversee the NPDES program in North Carolina, and incorporates chemical monitoring requirements for wastewater and stormwater in NPDES discharge permits. The HNP site has a current NPDES permit, Permit Number NC0039586, covering both process water and stormwater discharges (Reference 5.5-001). Within the permit, point-source discharge outfalls are assigned a discharge serial number (DSN), constituents to be monitored or sampled, and associated limits. This permit is amended as new wastewater streams are identified.

Air emissions are regulated through the Clean Air Act (CAA) by USEPA or an authorized state agency.

Descriptions of some typical nonradioactive and mixed waste streams generated and subject to regulations noted above are discussed in the following sections.

5.5.1 NONRADIOACTIVE WASTE SYSTEM IMPACTS

This subsection describes the potential environmental impacts of nonradioactive solid, liquid, and gaseous waste streams associated with the construction and operation of the HAR. Information provided within this subsection was obtained from a review of historic site documents and experiences from currently operating plants. A description of possible chemical discharges and effluents is provided, based on DCD. A description of the nonradioactive waste systems is provided in Section 3.6. In addition, Table 3.3-4 presents the chemicals added to each system, the amount used per year (not by season), the frequency of use, and the concentration in the waste stream discharged from each unit to Harris Reservoir. Section 2.3 provides a discussion regarding past and present water quality conditions in Harris Reservoir that may potentially affect or be affected by the construction or operation of the HAR facility, specifically temperature, dissolved oxygen, specific conductance, pH, total alkalinity, water clarity, nitrogen, phosphorus, ions/hardness, and metals.

5.5.1.1 Impacts of Discharges to Water

Nonradioactive liquid wastewater from nuclear power plants may include cooling tower blowdown, auxiliary boiler blowdown, water treatment waste, floor and equipment drains, stormwater runoff, and laboratory waste. Many of these wastewater streams have their own NPDES-designated outfall number for monitoring purposes. The NPDES permit establishes criteria that are protective of water quality for the receiving stream. In this case, the criteria are established to protect Harris Reservoir water quality for its designated uses as a drinking water source and for recreation, and industrial use such as cooling.

Subsection 5.5.3 presents a discussion of the pollution prevention and waste minimization program that will be established at the HAR.

Discharges to outfalls will typically consist of cooling tower blowdown, condensate demineralizer regeneration wastes, sanitary waste, metal cleaning wastes, and low volume wastes. These streams are monitored for multiple constituents, typically temperature, flow, pH, fecal coliform, free available chlorine, total residual chlorine, total suspended solids (TSS), hydrazine, oil and grease, total nickel, total manganese, total chromium, total zinc, total copper, total nitrogen, total phosphorus, and total iron.

The current HNP site-specific NPDES permit (Permit Number NC0039586) became effective on March 1, 2007, and expires on July 31, 2011 (Reference 5.5-001). Typically, the approved NPDES permit for a facility will list the systems to be sampled, location of sampling stations (outfall DSNs), constituents to be monitored or sampled, frequency of sampling, type of sample (e.g., surface grab or depth composite), method of sample collection, and time period for required monitoring under the permit. The current HNP site-specific NPDES permit is used in this subsection to provide examples of streams that may require monitoring. Specific DSN locations will change due to discharge configuration or site grading modifications that may alter discharge point locations or site stormwater runoff patterns.

The dominant component of all discharges is the cooling tower blowdown with the contribution of other streams typically amounting to less than 10 percent of the flow. Cooling tower blowdown and other wastewater resulting from electric power generation will typically be monitored for flow, pH, total residual chlorine, free available chlorine, total chromium, total zinc, priority pollutants, temperature, and 7-day chronic toxicity, but monitoring requirements will be stipulated in the new NPDES permit for the HAR or the revised combined permit for the HNP and the HAR.

Currently, the HNP has the following discharges to the following permitted outfalls (Reference 5.5-001):

- Cooling tower blowdown through outfall DSN001.
- Extended aeration wastewater treatment plant discharges of 0.095 mld (0.025 mgd) through outfall DSN002.
- Metal cleaning waste treatment system basin discharges through outfall DSN003.
- Low volume waste treatment system basin discharges through outfall DSN004.
- Radwaste treatment system discharges through outfall DSN005.
- Wastewater discharges from outfalls DSN001 through DSN005 through the combined outfall DSN006.
- Wastewater treatment facility discharges of 0.076 mld (0.02 mgd) through outfall DSN007.
- Discharges of stormwater, normal service water, emergency service water, circulating water, potable water, demineralizer water, hydrostatic flushing of system piping, and wash water from outfalls SW-001 through SW-009, SW-A and SW-B.

It is anticipated that the existing number of permitted DSNs will be reduced because the AP1000 design consolidates several facility liquid-waste streams from facility operations into a single discharge point that will discharge to Harris Reservoir through one NPDES permitted outfall. Chemicals that are added to cooling water for treatment are effective at low concentrations and are mostly consumed or broken down in application.

5.5.1.1.1 Liquid Effluents Containing Biocides or Chemicals

Description of the anticipated nonradioactive, liquid-waste chemical and biocide discharge concentrations are provided in ER Section 3.6 and also in Table 3.3-4.

Table 3.3-4 presents the types of chemicals added to plant systems; amount used per year; frequency of use; and anticipated discharge concentrations. The amount presented would be the maximum amount expected at the point of discharge to Harris Reservoir from the HAR units. However it should be noted that these bounding concentrations at the point of discharge are highly dependant on the consumption rate of the particular chemical in the process system and the dilution flow rates of the discharge stream. These chemicals are usually added in parts per million concentrations and are normally consumed leaving very small concentrations by the time they are discharged.

Typically, the chemicals presented in Table 3.3-4 which are added to cooling water for treatment are effective at low concentrations and are mostly consumed or broken down in application leaving very small concentrations by the time they are discharged. With the assumed dilution flow rates at the point of discharge and the natural dilution flow through Harris Reservoir, it is expected that only deminimus ambient concentrations levels would be present.

The NPDES permit that will be issued by NCDENR for the HAR will impose monitoring and concentration limits for the main outfall (cooling tower blowdown) for free available chlorine, total residual chlorine, time of chlorine addition, total chromium, total zinc, and priority pollutants (typical for cooling tower blowdown, but actual constituents monitored for monitoring protocols and concentrations will be stipulated in the new or revised NPDES permit).

The environmental impacts from discharges of liquid effluents containing biocides or chemicals from the HAR to Harris Reservoir are SMALL.

5.5.1.1.2 Demineralized Water Treatment Wastes

The system to demineralize water prior to its use in various applications at the HAR will typically consist of a reverse osmosis (RO) system. During demineralization or regeneration, chemicals such as sulfuric acid and caustic soda are typically used to adjust the pH to between 6 and 9 standard units (SU) for release to the wastewater stream outfall that discharges to Harris Reservoir.

Discharges to outfalls from processing of demineralized and potable water will typically include coagulation, filtration, disinfection, and ion exchange. Wastes from treatment may include filter backwash and demineralizer regeneration wastes. The spent RO system filters are disposed of in accordance with applicable industrial solid waste regulations.

Impacts from the discharge of this waste stream to Harris Reservoir are SMALL.

5.5.1.1.3 Waste Treatment Facility Sanitary Wastes

Discharges to outfalls from sanitary waste treatment facilities are typically monitored for flow, 5-day biochemical oxygen demand (BOD_5), TSS, fecal coliform, and total residual chlorine.

Impacts from the discharge of this waste stream to Harris Reservoir are SMALL.

5.5.1.1.4 Metal Cleaning Waste Discharges

Discharges from metal cleaning waste operations are usually monitored for flow, total copper, and total iron.

Impacts from the discharge of this waste stream to Harris Reservoir are SMALL.

5.5.1.1.5 Treated Wastewater (Low Volume Wastes and Radwaste)

Discharges from treated wastewater or low-volume wastewater (including membrane backwash water) are usually monitored for flow, TSS, and oil/grease.

Impacts from the discharge of this waste stream to Harris Reservoir are SMALL.

5.5.1.1.6 Floor Drain Systems

Discharges from floor drains are components of wastewater that will also be discharged through the main outfall, and are directed to a sump where they are typically monitored for flow, pH, TSS, and oil and grease. The discharge through the main outfall is composed of sump collection ponds consisting of boiler blowdown, building sumps and floor drains, and other miscellaneous low-volume wastewaters. Floor drain discharges will also discharge through the main outfall and typically consist of sanitary, equipment room floor drains, and laboratory wastewaters. Discharges through the main outfall will typically be monitored for flow, pH, TSS, BOD_5, and fecal coliform, but monitoring requirements will be stipulated in the approved NPDES permit for the HAR.

Impacts from the discharge of this waste stream to Harris Reservoir are SMALL.

5.5.1.1.7 Surface Drainage and Roof Drains

During and after precipitation events, water from roof drains and impervious surfaces, such as parking lots and sidewalks, sheet-flows over land to drainage ways to a sediment retention pond. The sediment retention pond discharge is monitored under the NPDES permit in accordance with the facility's stormwater pollution prevention plan (SWPPP) and is discharged to Harris Reservoir. Further detail on the NPDES Outfall locations is provided in Figures 3.6-1 and 3.6-2. Discharges are composed of the impoundment pond discharge (consisting of main plant area stormwater runoff, and fire and supply test water) and are typically monitored for flow, pH, color, odor, clarity, floating solids, TSS, foam, oil and grease, and other obvious indications of stormwater pollution.

Impacts from the discharge of this waste stream to Harris Reservoir are SMALL.

5.5.1.2 Impacts of Discharges to Land

5.5.1.2.1 Nonradioactive Solid Waste

Solid nonradioactive and non-hazardous waste may include office waste, aluminum cans, laboratory waste, glass, metals, and paper, and will be collected from several on-site locations and deposited in dumpsters located throughout the site. These solid wastes are not burned or disposed of on-site. Solid nonradioactive and non-hazardous waste generated at the HAR site would be disposed of off-site at a permitted disposal landfill.

It is presently difficult to quantify the amount of these waste types that will be generated for the two new HAR facilities. However, according to a study performed by the California Integrated Waste Management Board, employees typically generate approximately 4.8 kg (10.5 lb.) of cold waste per employee per day or conversely, 5.9 kg (13 lb.) of waste per 92 m^2 (1,000 ft^2) of working area per day, in a commercial environment such as the HAR.

Segregation and recycling of waste will be practiced to the greatest extent practical. It is expected that PEC will contract with an outside vendor who will perform weekly collections and disposal at area landfills. It is not expected that the amount of solid waste generated will significantly contribute to the total amount of household waste disposed of weekly by area residents. The waste is not expected to affect site terrestrial ecology, soil, or groundwater.

Water treatment and purification waste are containerized and disposed of at a permitted industrial waste landfill. Construction/demolition and industrial wastes generated at the HAR site would also be disposed of at a similarly permitted facility.

HAR demolition wastes, such as concrete and scrap steel, will be disposed of off-site in a properly permitted industrial waste landfill.

Impacts from the disposition of solid nonradioactive and non-hazardous waste are SMALL.

5.5.1.2.2 Hazardous Wastes

Solid hazardous waste is managed and disposed of in accordance with federal and state regulations under RCRA regulations and permits. The generation of hazardous waste at the HAR will be small, and the facility will be considered a Conditionally Exempt Small Quantity Generator (CESQG) or a Small Quantity Generator (SQG) under RCRA.

RCRA wastes generated through HAR operations, and hazardous chemical wastes from laboratories and other sources at the facility, will be collected and disposed of off-site at RCRA-permitted TSD facilities, using a site-specific assigned USEPA RCRA Identification Number. Transportation of the hazardous waste will be performed by specifically licensed and permitted haulers in accordance with USEPA RCRA regulations. These wastes will not be released to the environment and will not present an impact potential to the environment. Impacts from the shipment and disposal of this waste stream are SMALL.

5.5.1.2.3 Petroleum Waste

Petroleum wastes may include fuels, such as gasoline and diesel oil, and used oil and grease. These materials will be collected and stored on-site in accordance with federal, state, and local regulations. These materials will either be recycled or disposed of at RCRA-permitted TSD facilities and recyclers.

Impacts from this waste stream are SMALL.

5.5.1.3 Impacts of Discharges to Air

Nonradioactive gaseous effluents are generated by the operation of auxiliary boilers, and testing and operation of the diesel-driven fire pumps. Constituents of the gaseous effluents from these systems are typical of releases from the combustion of the fuel. Projected annual emissions and constituents/quantities are discussed in ER Section 3.6.

Minor emissions are expected to be generated from diesel storage tanks used to supply diesel fuel to this equipment. The emissions are expected to comply with applicable federal, state, and local regulations and emissions are also discussed in detail in ER Section 3.6.

Impacts from nonradioactive gaseous effluent emissions to the air are SMALL.

5.5.1.4 Sanitary Waste

Sanitary waste will be treated at the on-site municipal sewage treatment plant. Discharges to surface waters are in compliance with the NPDES permit and impacts are SMALL.

5.5.2 MIXED WASTE IMPACTS

The management of mixed waste at nuclear power plants is jointly regulated by the NRC under the Atomic Energy Act (AEA), and USEPA or authorized states under RCRA. Nuclear power plants managing mixed waste must meet NRC requirements for general radiation protection (10 CFR 20), emission control requirements for low-level waste (LLW) specified in 10 CFR 61, and USEPA requirements for hazardous waste 40 CFR 261, 264, and 265 before final transfer off-site for disposal.

Mixed waste generation is highly variable, but is projected to be approximately 5 cubic meters per year (m^3/year) (177 cubic feet per year [ft^3/year]), which is less than 3 percent of typical LLW volumes (Section 2.3.7.3 of NUREG-1437). Management of this waste is in accordance with NRC and USEPA regulations, and is subject to maintenance and containment criteria described in the RCRA regulations that require containers to be free of corrosion and stored in a bermed catchment area to contain leaks and spills.

Nuclear power plants are not expected to generate significant volumes of mixed waste because of continued progress in reducing mixed waste generation. Mixed waste storage ensures that chemical and radiological exposures are minimized both by the ALARA process and chemical awareness training programs. Regular inspections are conducted and documented, and preventive maintenance measures are taken, when needed. An inventory of the mixed waste is maintained, and a material safety data sheet (MSDS) for the chemicals present is readily available to ensure proper protection is taken. The storage area is placarded with appropriate hazard warning signs, and access is restricted.

Mixed waste, if generated at the HAR site, will be containerized, segregated, and usually stored on-site in a remote, monitored structure to minimize the potential of chemical and radiological exposure to employees and the public. Only authorized individuals will be given access to the storage area to inspect for container integrity and leakage.

It should be noted, however, that based on present mixed waste generation practices employed at the HNP, HAR is not expected to generate much mixed waste during its operational lifetime. HNP has not generated an appreciable quantity nor shipped mixed waste from the site in over 5 years. HAR will be required to comply with an approved mixed waste minimization plan to ensure that mixed waste generation is minimized. HAR workers that handle mixed waste will be trained appropriately and knowledgeable of the chemical and radiological hazards associated with the waste being handled.

The controls that will be employed at the HAR if mixed waste is generated to control exposures to employees and releases to the environment from handling, storage, and transportation of mixed waste are presented in the following subsections.

5.5.2.1 Chemical Hazards Impacts

It is not possible, presently, to predict the exact types, generation rates, and quantities of mixed hazardous waste that may be generated prior to HAR facility operations. As discussed previously, mixed waste generation is highly variable, but is projected to be approximately 5 m^3/yr (177 ft^3/yr). If PEC expects to generate, store, and offer to transport mixed waste, PEC must apply for and receive a USEPA identification number (ID#) in accordance with the requirements of 40 CFR 262.12 prior to performing these activities. If mixed wastes are generated, PEC will maintain a tracking mechanism that can be used to identify wastes, such as RCRA waste codes, source of the hazardous constituents, discussion of how and why the mixed waste was generated, generation rates and volumes, such that waste minimization techniques can be employed to reduce or eliminate the unnecessary generation of mixed waste.

Generation and storage of mixed waste on-site has the potential to expose workers to hazards associated with the chemical component of the mixed waste matrix from leaks and spills. Mixed waste can, and usually does, exhibit one of the following hazardous characteristics: ignitability, corrosivity, reactivity, or toxicity, as well as exhibiting the characteristics of a radiological hazard (i.e., contamination and radiation). Even though personnel may be properly trained, handling and storage accidents do occur where acids are inadvertently stored with bases and may become reactive during a spill. Another example might include the improper storage of oxidizers (nitric acid, nitrates, peroxides, and chlorates) and organics with inorganic reducing agents (metals). Workers and emergency response personnel can be potentially exposed during subsequent cleanup efforts both from the standpoint of the chemical hazard, but also based on the radiological hazards that may be present.

5.5.2.1.1 Mixed Waste Handling and Storage Practices

In order to minimize or eliminate any adverse environmental impacts from the movement and storage of mixed waste on-site, HAR Environmental Health and Safety management should implement and enforce the following suggested guides:

- Use the area only for storage of mixed waste and not for storing unrelated materials or equipment, or for other functions.
- Ensure that liquid mixed wastes that are generated, if any, are stored in secondary containment.
- Segregate mixed wastes from non-hazardous wastes.
- Segregate incompatible wastes (e.g., flammable and corrosive wastes). Follow proper storage protocols for different kinds of mixed waste.
- Aggregate wastes of the same matrix, contamination, and the same source to facilitate storage and disposal. Mixed wastes shall only be aggregated if from the same source and if carrying the same hazardous waste codes.
- Label the containers properly and in accordance with regulatory requirements.
- Follow the container label requirements.
- Post or provide applicable material safety data sheets, emergency spill response procedures, and a spill kit in the area.
- Install fire detection and suppression equipment (if required), alternate water supply, telephone, and alarm at the area.
- Make an emergency shower/eyewash station immediately available and test weekly to ensure it is functioning.
- Fence and lock the gate to the accumulation area or long-term storage area when authorized personnel are not present.
- Post “MIXED HAZARDOUS WASTE AREA” and “DANGER—UNAUTHORIZED PERSONNEL—KEEP OUT” signs at the entrance.

- Conduct weekly inspections.
- Post “NO SMOKING OR OPEN FLAME” signs.

Drums/Containers

- Berm and line container storage areas with a polyethylene liner.
- Transport drums or containers of hazardous waste to the temporary accumulation areas on wood pallets and secure together with non-metallic bonding.
- Inspect and inventory drums or containers prior to movement for signs of contamination or deterioration.
- Provide adequate aisle space (e.g., 30 inches) for containers such as 55-gallon drums to allow the unobstructed movement of personnel and equipment. A row of drums should be no more than two drums wide.
- Provide a label for each container.
- Keep drums or containers covered except when removing or adding waste to the drum. Covers shall be properly secured at the end of each workday.
- Dispose of drums or containers with the contents. If the contents are removed from drums for off-site transportation and treatment or disposal, the drums shall be decontaminated prior to reuse or before leaving the site.

Portable Tanks

- Inspect tanks that will be used to store mixed waste for signs of deterioration and contamination.
- Provide tanks with covers.
- Label each tank.
- Provide secondary containment for tanks containing hazardous waste or incompatible liquids.

If mixed waste is stored at the HAR facility, USEPA 40 CRF 264 mandates that waste storage containers must be inspected on a weekly basis; and certain aboveground portions of waste storage tanks must be inspected on a daily basis. The purpose of these inspections is to detect leakage from, or deterioration of, containers. The methods used for these inspections may include direct visual monitoring or the use of remote monitoring devices for detecting leakage or deterioration. The remote methods would reduce exposures due to direct visual inspections. Additionally, measures will be provided to promptly locate and segregate or remediate leaking containers.

5.5.2.1.2 Contingency Plans, Emergency Preparedness, and Prevention Procedures

HAR facility management will be required to develop and implement contingency plans, emergency preparedness, and prevention procedures that will be utilized in the event of a mixed waste spill. Such contingency plans, emergency preparedness, and prevention procedures, when implemented properly, will virtually eliminate any adverse environmental impacts or personnel exposures from spills. HAR personnel who are designated to handle mixed waste or whose job function it is to provide emergency response for mixed waste spills will receive appropriate training in order to perform their work properly and safely.

Mixed waste storage areas shall contain emergency equipment sufficient to respond to the hazard posed by waste. Typical items in a mixed waste storage area include fire extinguishers, decontamination equipment, and an alarm system (*if radio equipment is not available to all staff working in the storage area)*. Spill control equipment (e.g., sorbent pads) shall be available in the mixed waste storage areas, and where liquids are transferred from one vessel to another.

5.5.2.1.3 Off-Site Treatment and Disposal

If mixed waste is generated and shipped for treatment and disposal rather than stored on-site, HAR facility management will identify potential disposal facilities considering the following selection criteria:

- The desired method of treatment or disposal (e.g., incineration versus land disposal).
- The disposal facility’s permit (e.g., determine whether polychlorinated biphenyls [PCBs], hazardous waste, or radioactive waste can be accepted).
- The disposal facility’s turnaround time on approvals.
- The form of waste (e.g., determine whether it is soil, debris, semi-solid, or liquid).
- The mass or volume of waste.
- The cost of transportation and disposal.

HAR facility management will also identify one disposal facility as the primary facility, and a second facility will be identified as an alternate in the event that laboratory testing or other observations prove the waste to be different than initially determined.

Impacts from the generation and storage of mixed waste are SMALL.

5.5.2.2 Radiological Hazards Impacts

If mixed waste is generated, it must either be stored on-site or shipped off-site for treatment and subsequent disposal. Off-site shipment, treatment, and disposal will depend on the toxicity levels and radiological characteristics of the mixed waste. Personnel performing packaging and shipping operations have the potential to be exposed to increased ambient radiation levels from the containers. Radiological exposures from mixed waste generation, treatment, storage, and off-site transportation activities will be in full compliance with the requirements stipulated in 10 CFR 20 for both radiological and non-radiological workers. PEC's radiological safety program and procedures will ensure compliance.

Impacts to workers from the handling and storage of mixed waste are SMALL.

5.5.3 POLLUTION PREVENTION AND WASTE MINIMIZATION PROGRAM

Under RCRA 42 USC 6901, Congress declared it to be the national policy of the United States that, whenever feasible, the generation of hazardous waste is to be reduced or eliminated as expeditiously as possible. Waste that is nevertheless generated should be treated, stored, or disposed of as soon as possible to minimize the present and future threat to human health and the environment. In order to comply with this requirement, PEC is required to implement a pollution prevention and waste minimization program prior to generating any hazardous waste at the HAR facilities.

Pursuant to the regulations regarding hazardous waste management and the issuance of a license to operate HAR, a hazardous waste minimization plan will be developed and implemented to address storage and management oversight requirements. Elements of the waste minimization plan include the following:

- Schedule for implementation.
- Projection of volume reductions to be achieved.
- Inventory identification and control.
- Work planning to reduce mixed waste generation.
- Hazardous waste reduction methods and processes.
- Key assumptions critical to successful implementation of waste management.

These requirements are part of the USEPA RCRA hazardous waste regulations codified in 40 CFR 260 to 265 implementing the RCRA 42 USC 6901.

The hazardous waste minimization plan will be followed to ensure that activities are conducted in a manner intended to reduce the potential for generation. The storage area is monitored for radiation level and inspected for container integrity. Occupational exposures from on-site storage have been shown to be reduced by the application of waste minimization technologies and procedures. Radiological exposures from hazardous waste generation, treatment, storage, and off-site transportation activities will be in full compliance with the requirements stipulated in 10 CFR 20 for both radiological and non-radiological workers. PEC's radiological safety program and procedures will ensure compliance.

As noted previously in Subsection 5.5.2, the volume of hazardous waste is projected to be about 3 percent or less of the total LLW volume. Due to this projected small volume of hazardous waste and because no significant emissions or releases of hazardous materials are expected as a result of control and containment requirements, the NRC concluded that the findings for LLW remain valid when both LLW and mixed-LLW impacts are considered.

The environmental impacts from the generation, handling, storage, shipment and disposal of waste are SMALL.

The following ten subsections outline components of a typical Pollution Prevention and Waste Management Program. A specific program for HAR will developed for the operating phase.

5.5.3.1 Inventory Management

Inventory management or control techniques will be used to reduce the possibility of generating mixed waste resulting from excess or out-of-date chemicals and hazardous substances. Where necessary, techniques will be implemented to reduce inventory size of hazardous chemicals, size of containers, and amount of chemicals, while increasing inventory turnover.

A chemical management system, if required, will be established prior to initial operation, and acquisition of new chemical supplies will be documented in a controlled process that addresses, as appropriate, the following:

- Need for the chemical.
- Availability of non-hazardous or less hazardous substitutes or alternatives.
- Amount of chemical required and the on-site inventory of the chemical.

Excess chemicals will be managed in accordance with the facility’s chemical management procedures. Excess chemicals that are deemed usable will be handled through an excess chemical program. Material control operations will be revised or expanded to reduce raw material and finished product loss, waste material, and damage during handling, production, and storage.

The inventory management procedures will be periodically assessed and updated, as appropriate, using criteria that include the following considerations:

- Management techniques in accordance with existing pollution prevention and waste minimization guidelines, and regulatory guidelines.
- Existing inventory management procedures and how they are applied more effectively.
- New techniques to be added to or substituted for current procedures.
- Revision of review and evaluation approval procedures for the purchase of materials.
- Additional employee training in the principles of inventory management is needed.
- Specifications for the review and revision of procurement that limit the purchase of environmentally sound products.
- Increase in the purchasing of recycled products.

5.5.3.2 Maintenance Program

Equipment maintenance programs will be periodically reviewed to determine whether improvements in corrective and preventive maintenance can reduce equipment failures that generate mixed waste. The methods for maintenance cost tracking and preventive maintenance scheduling and monitoring will be examined. Maintenance procedures will be reviewed in order to determine which are contributing to the production of waste in the form of process materials, scrap, and cleanup residue. In addition, the need for revising operational procedures, modifying equipment, and source segregation and recovery will be determined.

5.5.3.3 Recycling and Reuse

Recycling of waste types will be considered. Opportunities for reclamation and reuse of waste materials will be explored whenever feasible. Decontamination of tools, equipment, and materials for reuse or recycle will be used to minimize the amount of waste for disposal. Impediments to recycling, whether regulatory or procedural, will be challenged to encourage generators to recycle.

5.5.3.4 Segregation

When radiological or hazardous waste is generated, proper handling, containerization, and separation techniques will be employed, as applicable. This will be done to minimize cross contamination resulting in the generation of unnecessary mixed waste.

5.5.3.5 Decay-In-Storage of Mixed Waste

Some portion of the generated mixed waste will, most probably, contain radionuclides with relatively short half-lives. The NRC generally allows facilities to store waste containing radionuclides with half-lives of less than 65 days until 10 half-lives have elapsed and the radiation emitted from the unshielded surface of the waste, as measured with an appropriate survey instrument, is indistinguishable from background levels. The waste can then be disposed of as a nonradioactive waste. For mixed waste, storage for decay is particularly advantageous, since the waste can be managed solely as a hazardous waste after the radionuclides decay to background levels. Thus, the management and regulation of these mixed wastes are greatly simplified by the availability of storage for decay.

5.5.3.6 Work Planning

Planning will be completed to determine what materials and equipment are needed to perform the anticipated work. One objective of this planning is to prevent pollution, minimize the amount of mixed waste that may be generated, and use only what is absolutely necessary to accomplish the work. Planning will also be completed to prevent mixing of materials or waste types.

5.5.3.7 Pollution Prevention Tracking Systems

A tracking system will be developed, if required, to identify waste generation data and Pollution Prevention and Waste Minimization Programs (PPWMP) opportunities. This will provide essential feedback to successfully guide future efforts. The data collected by the system will be used for internal reporting. The tracking system will provide feedback on the progress of the PPWMP including the results of the implementation of pollution prevention technologies. In addition, it will facilitate reporting pollution prevention data and accomplishments to the NRC and NCDENR.

The system will track waste from point of generation to point of final disposition (cradle to grave). The system will also permit the tracking of hazardous substances from the point of site entry to the final disposition in order to comply with environmental regulations and reporting requirements. The system will collect data on input material, material usage, type of waste, volume, hazardous constituents, generating system, generation date, waste management costs, and other relevant information.

5.5.3.8 Implement Pollution Prevention and Waste Minimization Awareness Programs

A successful PPWMP requires employee commitment. By educating employees in the principles and benefits of a PPWMP, solutions to current and potential environmental management problems can be found. The broad objective of the PPWMP is to educate employees in the environmental aspects of activities occurring at the HAR, in their community, and in their homes. A PPWMP will be developed and implemented, as required, that incorporates the following:

- Review, revise, and implement a waste minimization plan during the phases of HAR facility construction and operation.
- Educate employees of general environmental activities and hazards at the HAR and pollution prevention program and waste minimization requirements, goals, and accomplishments.
- Inform employees of specific environmental issues.
- Train employees on their responsibilities in pollution prevention and waste minimization.
- Recognize employees for efforts to improve environmental conditions through pollution prevention and waste minimization.
- Encourage employees to participate in pollution prevention and waste minimization.

5.5.3.9 Implement Environmentally Sound Pollution Prevention Procurement Practices

Management at the HAR will implement procurement practices that comply with regulatory guidance, and other requirements for the purchase of products with recovered materials. This includes the elimination of the purchase of ozone depleting substances and the minimization of the purchase of hazardous substances.

5.5.3.10 Ensure Consistent Policies, Orders, and Procedures

Policies and procedures will be developed, as applicable, to reflect a focus on integrating PPWMP objectives into HAR activities. The respective environmental, health, and safety departments will review new procedures for HAR activities. The procedures will determine whether the elimination or revision of procedures can contribute to the reduction of waste (hazardous, radiological, or mixed). This will include incorporating PPWMP into the appropriate on-site work procedures. Changes to procurement procedures to require affirmative procurement of NCDENR designated recycled products, and reduction of procurement of ozone-depleting substances will also be completed.

5.5.4 REFERENCES

5.5-001 Progress Energy Carolinas, Inc., "Carolina Power & Light Company, Harris Nuclear Plant and Harris Energy & Environmental Center National Pollutant Discharge Elimination System Permit (NPDES) Number NC0039586," January 30, 2006.

5.6 TRANSMISSION SYSTEM IMPACTS

This section describes the impacts of transmission system operation of the HAR. The HAR facility is located in the service territory of PEC, the regional electrical transmission system owner/operator.

Seven 230-kV transmission lines currently connect the HNP to the transmission system (Reference 5.6-001). Subsection 2.2.2 of this ER describes the locations of existing corridor routes. Section 3.7 describes the proposed 30.5-m (100–ft.) expansion of three existing corridors for new lines to support HAR 3, and associated switchyard and substations that will be developed to transmit the additional power generated by the two new units. Subsection 4.1.2 of the ER presents detailed information regarding the impacts from construction of the electric transmission system.

HAR 2 will be connected to the existing 230-kV switchyard that serves HNP. This switchyard will be modified to provide the required connections to HAR 2. HAR 3 will be connected to a new 230-kV switchyard. Three existing transmission corridors will be expanded no more than 30.5 m (100 ft.) to accommodate new lines to connect the 230-kV HAR 3 switchyard to the PEC electrical grid. These transmission lines will be connected to Fort Bragg (Woodruff St.), Erwin, and Wake (Reference 5.6-002). Land use in areas impacted by the corridor expansion is primarily agricultural and undeveloped land and is further discussed in Section 4.1.

In total, for the specific purpose of connecting the HAR site to the transmission system, PEC has approximately 166 km (103 mi.) of corridors that occupy approximately 5.1 km^2 (1250.2 ac. or 2.0 $mi.^2$ The corridors pass through land that is primarily agriculture and forest. The areas are mostly remote, with low population densities. The longer lines cross numerous state and United States highways (Reference 5.6-001).

Carolina Power & Light Company (CP&L) designed and constructed all HNP transmission lines in accordance with industry guidance that was current when the lines were built. Ongoing surveillance and maintenance of HNP-related transmission facilities ensure continued conformance to design standards (Reference 5.6-001). The transmission system and any proposed changes to it are more fully described in ER Chapters 3, 4, and 10.

Corridor maintenance activities in compliance with applicable federal, state, and local laws, regulations, and permit requirements are routinely performed by PEC. Maintenance activities on the proposed expansions of the transmission lines will also be the responsibility of PEC and will be in compliance with all requirements. Subsections 5.6.1 and 5.6.2 of this ER discuss potential impacts of routine maintenance to terrestrial and aquatic ecosystems, respectively. ER Subsection 5.6.3 addresses impacts of proposed transmission lines to the public.

5.6.1 TERRESTRIAL ECOSYSTEMS

Routine vegetation maintenance inspection and clearing activities in the ROW will be conducted. These activities would be carried out in consultation with affected landowners and appropriate measures will be taken to minimize any disturbances. PEC employs economical vegetation management techniques through communication, continuous learning, and assessment of BMPs throughout the industry. The PEC Transmission Vegetation Management Program includes visual inspection and appropriate maintenance of transmission line ROWs. Inspections will be conducted by aircraft and ground patrols, as needed. Maintenance and repair inspections required by cause, such as storms that may down timber on or near the lines, will be conducted by air, road, or foot, as required by the circumstances. These occurrences are expected to be few, and will have limited impact on the land.

Transmission corridors are managed to prevent woody growth from encroaching on the transmission lines and potentially disrupting service or becoming a general safety hazard. PEC clears ROWs by mowing or hand-cutting the entire ROW every 3 years. Trees in residential areas and near streets are trimmed every 2 years. Herbicide is applied approximately every 5 years (Reference 5.6-003).

PEC uses an integrated vegetation management (IVM) approach including mechanical and chemical control methods. Mechanical methods include pruning, felling, mowing, and hand-clearing. Chemical methods include the use of herbicides, which control woody vegetation that reseeds or re-sprouts after mowing. The consistent use of herbicides results in the growth of low growing, non-woody plants, such as grasses and other native plants. This, in turn, leads to a reduced need for future mowing and herbicide applications. PEC uses only herbicides approved by the USEPA for use on power-line ROWs. In addition, herbicides are only applied under the supervision of a licensed applicator with a radiarc or backpack sprayer (Reference 5.6-004). In the event that herbicides are used, low-volume foliar application occurs from May through October, dormant-stem application from October through April, and cut stump/vine application throughout the year (Reference 5.6-004).

The transmission corridors are beneficial to the terrestrial ecosystem in several ways. The transmission corridors act as valuable edge habitat and wildlife corridors, providing long stretches of uninhabited corridor for wildlife to pass through. The maintenance of the corridors encourages vegetation diversity of native plants.

5.6.1.1 Natural Ecosystems and Rare, Threatened, and Endangered Species

PEC works with federal, state, local governmental agencies, and environmental organizations to identify and protect natural ecosystems and rare plants within ROWs. These are protected via selective management. PEC strives to conserve native plants valuable to wildlife within ROWs and minimize invasive exotic plants.

In addition, PEC signed a Memorandum of Understanding (MOU) with NCDENR to preserve and protect rare, threatened, and endangered species and sensitive natural areas within transmission ROWs (Reference 5.6-001). PEC follows BMPs for managing rare plants along transmission ROWs. PEC currently works with the NCNHP to manage sections of ROWs to protect species of rare plants (Reference 5.6-005).

No areas are designated by the U.S. Fish and Wildlife Service (USFWS) as “critical habitat” for endangered or threatened species on or adjacent to HNP transmission lines. PEC contacted the USFWS, NCWRC, and NCNHP requesting information on listed species and important habitats within the HAR site (Reference 5.6-006). USFWS and NCWRC responses were consistent with the information presented in this section of the ER. Correspondence from the NCWRC identified a bald eagle nest located across the Cape Fear River from Buckhorn Dam, with a secondary management zone with a radius of 457 m (1500 ft.) surrounding the nest (Reference 5.6-007). The existing Fort Bragg transmission corridor crosses through this management zone as well as through the Buckhorn bluffs and levees, a North Carolina significant natural area (Reference 5.6-007). The preferential location of the proposed lines within existing corridors will prevent further disturbance to this nest and the significant natural area. The appropriate precautions will be taken to prevent any adverse impacts to the bald eagle nest and Buckhorn bluffs and levees. Per communication with the USFWS, PEC will conduct surveys for federally listed species along the proposed transmission lines (Reference 5.6-008). In the event any listed species are identified, PEC will cooperate with the appropriate agencies to protect that species.

Red-cockaded woodpeckers are known to occur in mature longleaf pine forests crossed by the Harris-Fayetteville transmission corridor. Any activities involving removal of mature longleaf pine in this area require surveys for this species to ensure that no red-cockaded woodpeckers or cavity trees are impacted (Reference 5.6-001).

The eastern tiger salamander (*Ambystoma tigrinum*), which is state-listed as threatened, is known to occur about 91.4 m (300 ft.) from the Harris-Wake transmission corridor. The eastern tiger salamander inhabits burrows in sandy pinewoods near semi-permanent ponds in which it breeds (Reference 5.6-001). PEC will use appropriate precautions when conducting operational maintenance in this area.

Carolina grass-of-parnassus (*Parnassia caroliniana*), a state-listed endangered species, occurs in wet savannahs on the Harris-Fayetteville transmission corridor (Reference 5.6-001). PEC will use appropriate precautions when conducting operational maintenance in this area.

The transmission corridors pass through the Shearon Harris Game Lands. These areas will be operated and maintained in a manner consistent with protecting these game lands.

Given the current measures taken and commitments made by PEC to avoid affecting terrestrial habitat during operation and maintenance, any impacts associated with routine maintenance and operation of the transmission corridors, substations and switchyards will be SMALL.

5.6.1.2 Agricultural Lands

The preferential use of existing transmission corridors will avoid long-term changes to agricultural resources. Where maintenance exposes soil, appropriate erosion control and re-vegetation methods will be applied. PEC will adhere to all applicable federal, state, and local BMPs in the maintenance and operation of the transmission system. In the event that a customer (e.g., organic farmer) has a concern about IVM, other options are provided.

The effects to agricultural lands from maintenance and operation of the transmission system will be SMALL.

5.6.1.3 Electrical Fields

According to the NRC, electric field effects to terrestrial biota are not relevant at less than 765 kV.

The effects to terrestrial ecosystems from electrical fields will be SMALL.

5.6.1.4 Avian Collisions

The potential for avian mortalities from collisions with transmission lines at nuclear plants is insignificant and makes up only a small fraction of total collision mortalities associated with all transmission and distribution lines.

The effects to avian wildlife from collision with transmission lines and their associated infrastructure will be SMALL.

5.6.2 AQUATIC IMPACTS

Corridor maintenance work may have minor effects on smaller streams and intermittent streams along the transmission corridor and the Harris Reservoir makeup water pipeline corridor. Activities with the potential to affect aquatic habitats may include mowing and the removal of woody vegetation. Streamside management zones (SMZs) and BMPs are implemented by PEC in transmission corridors to minimize adverse effects to aquatic ecosystems. SMZs and BMPs are discussed in detail in ER Sections 2.4 and 4.3.

Some minor wetland areas have been identified within the vicinity. When maintaining the transmission corridors, these floodplains and wetlands will be carefully considered. Adverse effects to water courses, wetlands, and floodplains within a transmission ROW will be avoided to the greatest extent possible. BMPs are observed in all potential wetland areas to avoid and minimize potential impacts. All actions performed in wetland areas are in accordance with the USACE.

Routine maintenance activities on existing transmission line ROWs are performed on a 2- to 3-year cycle by PEC. The transmission lines within the vicinity of the HNP cross aquatic habitats including reservoirs, streams, and the Cape Fear River. PEC has procedures in place for ROW maintenance to protect them.

SMZ widths are defined depending on the slope of the surrounding area, the type of stream, and the particular resource that may be present in the stream. SMZ practices include avoiding disturbance and the use of chemicals in areas adjacent to water bodies. Leaving natural vegetation in areas next to water bodies minimizes the potential for runoff and siltation during maintenance activities. IVM to minimize the potential for aquatic wildlife exposure is discussed in the previous Subsection 5.6.1. If impact avoidance is not possible, heritage specialists will consult, as appropriate, with the USFWS.

No areas designated by the USFWS as “critical habitat” for endangered or threatened species exists on or adjacent to HNP transmission lines. Per communication with the USFWS, PEC will conduct surveys for federally listed species along the proposed transmission lines, as necessary (Reference 5.6-008). In the event any listed species are identified, PEC will cooperate with the appropriate agencies to protect that species.

PEC contacted the USFWS, NCWRC, and NCNHP requesting information on listed species and important habitats within the HAR site (Reference 5.6-006). PEC received responses from the USFWS and NCWRC that are consistent with the information presented within this section of the ER. As discussed in ER Section 4.3, the federally and state-listed endangered Cape Fear Shiner (*Notropis mekistocholas*) and dwarf wedgemussel (*Alasmidonta heterodon*) are not expected to occur in the area of the Cape Fear River that will be crossed by the transmission corridors. The Sandhills chub (*Semotilus lumbee*), a state special concern species, is known to occur in a stream crossing the Harris-Fayetteville corridor. Habitat for this species consists of slow-flowing headwaters, creeks, and small rivers with sand and gravel bottoms and sparse vegetation (Reference 5.6-001). Several federally and state-listed mussels have the potential to exist in the area; PEC will use appropriate precautions when conducting operational maintenance in this area.

Given the measures taken by PEC to avoid affecting aquatic habitat, any impacts associated with routine maintenance and operation of the transmission corridors will be SMALL.

5.6.3 IMPACTS TO MEMBERS OF THE PUBLIC

This subsection is included to analyze the impacts of the current and proposed transmission system to the public. Existing transmission lines currently connect the HNP to the energy distribution grid. The expansion of three existing transmission corridors will accommodate new lines to connect the 230-kV switchyard to the PEC electrical grid. The highest voltage associated with the existing and proposed transmission lines at the HNP and HAR is 230 kV (Reference 5.6-001). Transmission lines designed for voltage levels less than 765 kV reduce adverse impacts from ozone formation. Transmission lines will be clearly marked to prevent impacts to aircraft. Other potential impacts include electric shock, electromagnetic field (EMF) effects, corona discharges, and visual impacts.

5.6.3.1 Electric Shock

Objects located near transmission lines can become electrically charged because of their immersion in the lines' electric field. The charge results in a current that flows through the object to the ground. The current is called induced because there is no direct connection between the line and the object. The induced currents can also flow to the ground through the body of a person who touches an object. An object that is insulated from the ground can actually store an electrical charge becoming what is called "capacitively charged." A person standing on the ground touching a vehicle or a fence receives an electric shock from the sudden discharge of the capacitive change through the person's body to the ground. After the initial surge, a steady-n current can develop. The magnitude of this depends on several factors, including the following:

- The strength of the electric field, which in turn, depends on the voltage of the transmission line as well as its height and geometry.
- The size of the object on the ground.
- The extent to which the object is grounded.

Minimum vertical clearances have been established by the National Electrical Safety Code (NESC) for electric lines exceeding 98 kV. Clearance must limit induced current to 5 milliamperes.

Induced current can also be prevented by grounding metal objects that are in the transmission line ROWs. Grounding chains can be installed on tractors. Metal fences can be connected to a simple ground rod with an insulated lead and wire clamp. Grounding objects within the ROWs is expected to be in accordance with Institute of Electrical and Electronics Engineers (IEEE)-142, IEEE Recommended Practices for Grounding of Industrial and Commercial Power Systems. Impacts due to electric shock from induced current are SMALL.

5.6.3.2 Electromagnetic Field Exposure

EMFs are produced by electrical devices, including transmission lines. Some epidemiological studies have suggested a link between power-frequency EMF and some types of cancer, while others have not. Although there is no scientific consensus on the topic, the presence of EMF, especially from transmission lines, has become a greater public concern in recent years. Because of the lack of evidence supporting a health risk from EMF, there are no federal health standards for EMF. The parameters having the greatest effect on EMF levels near the transmission line are operating voltage, current, conductor height, electrical phasing, and distance from the source. EMF reduction measures will be incorporated into the line and station designs to minimize the EMF strengths.

PEC is committed to providing safe electric service for their customers and a safe working environmental for their employees. PEC recognizes that there is public concern about whether any adverse health effects are caused by EMFs that result from generation, transmission, distribution, and use of electricity. Many scientific research efforts and other studies examining the potential health and other effects of EMFs have been and are being done. Studies, interpretations, and research to date are not conclusive about potential associations between electric or magnetic field and possible health impacts. PEC has provided both financial and technical support for EMF research, and continues to monitor ongoing study. (Reference 5.6-009)

Because EMF diminishes quickly with distance, the routing of transmission lines using constraint buffers effectively reduces potential public exposure to EMF. Impacts resulting from public exposure to EMF are SMALL.

5.6.3.3 Noise

When an electric transmission line is energized, an electric field is created in the air surrounding the conductors. If this field is sufficiently intense, it may cause the breakdown of the air in the immediate area surrounding the conductor (corona). Corona can result in audible noise. Audible noise levels are usually very low and not heard, except possibly directly below the line on a quiet day. Design practices to minimize noise for the proposed transmission lines include the use of extra high voltage (EHV) conductors, corona-resistant line hardware, and grading rings at insulators.

According to a study conducted by the NRC, coronas are generally not a problem at voltages below 345 kV. All of the transmission lines associated with HNP are 230 kV (Reference 5.6-001).

Because of the low voltage of the transmission lines and precautionary design measures, impacts to the public from noise will be SMALL.

5.6.3.4 Radio and Television Interference

Radio interference (RI) and television interference (TVI) can occur from corona, electrical sparking, and arcing between two pieces of loosely fitting hardware or burrs or edges on hardware. This noise occurs at discrete points and can be minimized with good design and maintenance practices. Design practices for the proposed transmission lines include the use of EHV conductors, corona-resistant line hardware, and grading rings at insulators. The effect of corona on radio and television reception depends on the radio/television signal strength, the distance from the transmission line, and the transmission line noise level.

Because of the low voltage of the transmission lines and precautionary design measures impacts to the public from RI and TVI will be SMALL.

5.6.3.5 Visual Impacts

The operation and maintenance of transmission lines along existing ROWs will have minimal effects on visual aesthetics. The locations of the three proposed transmission lines will be preferentially located in existing ROWs, thereby minimizing visual impacts to the public. Refer to Section 3.7 of this ER for further information on the locations of the transmission lines.

Visual impacts to the public resulting from operational maintenance of the transmission lines will be SMALL.

5.6.4 REFERENCES

5.6-001 Progress Energy Carolinas, Inc., “Applicant’s Environmental Report - License Renewal Operating Stage Shearon Harris Nuclear Plant, Unit 1,” Docket No. 50-400, License No. NPF-63, November 2006.

5.6-002 Sargent & Lundy, LLC “230-kV Switchyard Conceptual Design Report, Harris Advanced Reactors Units 2 and 3, HAR-ZBS-GER-001 Rev. 2,” June 22, 2007.

5.6-003 Progress Energy Carolinas, Inc., “FAQs,” Website, www.progress-energy.com/aboutenergy/transmission/carolinas/faq.asp, accessed July 9, 2007.

5.6-004 Progress Energy Carolinas, Inc., “Herbicide Usage – Progress Energy Carolinas, Inc.,” Website, www.progress-energy.com/environment/vegetation/herbicide.asp, accessed July 9, 2007.

5.6-005 Progress Energy Carolinas, Inc., “Environmental Management,” Website, www.progress-energy.com/aboutenergy/transmission/carolinas/envmgmt.asp, accessed July 11, 2007.

5.6-006 Progress Energy Carolinas, Inc., “Request of Information on Listed Species and Important Habitats,” January 10, 2007.

5.6-007 North Carolina Wildlife Resources Commission, “Response to Information Request,” February 27, 2007.

5.6-008 U.S. Fish and Wildlife Service, “Response to Information Request,” January 29, 2007.

5.6-009 Progress Energy Carolinas, Inc., “Electromagnetic Fields,” Website, www.progress-energy.com/environment/programs/fields/index.asp, accessed July 9, 2007.

5.7 URANIUM FUEL CYCLE IMPACTS

This section addresses the uranium fuel cycle environmental impacts. This section addresses the light-water-cooled reactor (LWR) design presently being considered (i.e., Westinghouse Electric Company, LLC's [Westinghouse's] AP1000 Reactor [AP1000]).

5.7.1 REGULATORY REQUIREMENTS

The environmental standard review plan (ESRP) requires compliance with 10 CFR 51.51(a) which states that:

> Every environmental report prepared for the construction permit stage of a light-water-cooled nuclear power reactor, and submitted on or after September 4, 1979, shall take Table S-3, *Table of Uranium Fuel Cycle Environmental Data*, as the basis for evaluating the contribution of the environmental effects of 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 waste and high-level wastes related to uranium fuel cycle activities to the environmental costs of licensing the nuclear power plant. Table S-3 shall be included in the environmental report and may be supplemented by a discussion of the environmental significance of the data set forth in the table as weighed in the analysis for the proposed facility.

Specific categories of natural resource use included in Table S-3 relate to land use, water consumption and thermal effluents, radioactive releases, burial of transuranic (TRU) and high-level waste (HLW) and low-level wastes (LLW), and radiation doses from transportation and occupational exposures. The contributions in the table for reprocessing, waste management, and transportation of wastes are maximized for either of the two fuel cycles (uranium only and no recycle); that is, the cycle that results in the greater impact is used.

The effects (those presented in Table S-3 and reproduced as Table 5.7-1 in this subsection) are calculated for a Reference 1000-megawatt electric (MWe) light water reactor (LWR) operating at an annual capacity factor of 80 percent for an effective electric output of 800 MWe. In developing the Reference Reactor (RR) data, the NRC staff considered two Uranium Fuel Cycle (UFC) options. The first, no recycle, and the second, uranium-only recycle, that differ only in the treatment of spent fuel removed from a reactor. No recycle treats all spent fuel as waste to be stored at a federal waste repository. Uranium-only recycle involves reprocessing spent fuel to recover unused uranium and return it to the UFC. The RR values provided for reprocessing, waste management, and transportation are from the UFC option resulting in the larger environmental effect.

5.7.2 URANIUM FUEL CYCLE

The stages of UFC include the following:

- Mining.
- Conversion.
- Enrichment of uranium.
- Fabrication of nuclear fuel.
- Use of this fuel.
- Disposal of the used (spent) fuel.

Natural uranium is mined in either open-pit, underground mines, or by an in-place leaching process. Leaching involves injecting a solvent solution into the underground uranium ore to dissolve uranium, and then pumping the solution to the surface for further processing. The ore or leaching solution is moved to mills where it is processed to produce uranium oxide (U_3O_8). The uranium oxide is then converted to uranium hexafluoride (UF_6) in preparation for the enrichment process.

The UF_6 is then transported to an enrichment facility. The process of enrichment increases the percentage of the more fissile isotope uranium-235 (U-235) and decreases the percentage of the isotope uranium-238 (U-238). Natural uranium is approximately 0.7 percent U-235.

All production methods of enrichment exploit the slight differences in atomic weights of the two isotopes. A feature common to all large-scale enrichment schemes is that they employ a number of identical stages, which produce successively higher concentrations of U-235. Each stage concentrates the product of the previous stage further before being sent to the next stage.

Similarly, the tailings from each stage are returned to the previous stage for further processing. This sequential enriching system is called a cascade.

At a fuel-fabrication facility, the enriched uranium is then converted from UF_6 to uranium dioxide (UO_2). The UO_2 is formed into pellets, inserted into tubes, and loaded into fuel assemblies. The fuel assemblies are placed in the reactor to produce power. After most of the U-235 has fissioned, the concentration reaches a point where the nuclear fission process becomes inefficient. The fuel assemblies are then withdrawn from the reactor. After on-site storage for sufficient time to allow for short-lived fission product decay and to reduce the heat generation rate, the fuel assemblies are transferred to a waste repository for interment. Storing the spent fuel elements in a repository constitutes the final step in the no-recycle option.

5.7.3 PROPOSED PLANT AND REACTOR CHARACTERISTICS

The LWR technology being considered in this ER is the AP1000 (Advanced Passive PWR). Two units will be constructed at the HAR. The DCD for the AP1000 reports the following reactor characteristics:

- A single unit is rated at 3400 megawatts thermal (MWt), nominal 1000 megawatt electric (MWe) PWR.
- The AP1000 reactor fuel:
    - Fuel pellets = UO_2 sintered.
    - Clad Material = ZIRLO™ – NRC 10 CFR 50.46 allows the use of ZIRLO™. The ZIRLO™ cladding material combines neutron economy (low absorption cross section); high corrosion resistance to coolant, fuel, and fission products; and high strength and ductility at operating temperatures. ZIRLO™ is an advanced zirconium-based alloy that has the same or similar properties and advantages as Zircaloy-4 and was developed to support extended fuel burnup.
    - U-235 enrichment = Region 1 (2.35), Region 2 (3.4), and Region 3 (4.45).
- The center-line temperature limit has been applied to reload cores with a lead rod average burnup of up to 60,000 megawatt days per metric ton of Uranium (MWd/MTU)

Section 3.8 of this ER provides a point-by-point comparison of the above reactor characteristics to those stipulated in 10 CFR 51.52. It is reasonable to assume that if the bounding requirements presented in 10 CFR 51.52 (i.e., reactor core thermal power, fuel form, fuel enrichment, fuel encapsulation, average fuel irradiation, and transportation) are met that the environmental effects from the UFC for the proposed reactors would be adequately bounded with no further analysis required. However, to be complete, in the subsections that follow, a comparative analysis has been performed and the environmental effects from the UFC for one AP1000 was evaluated against those presented in Table S-3 of 10 CFR 51.51. In order to compare them, only one AP1000 reactor was evaluated against the values calculated by the NRC for the RR. Even though PEC is planning on constructing two AP1000 units at the site it would not be appropriate to double the scaling factor and compare the results to the bounding values presented for the Reference Reactor, unless you also doubled the values presented for the Reference Reactor.

Table S-3 of 10 CFR 51.51 provides estimates of the environmental effects due to the UFC. The effects are calculated for a Reference 1000 MWe light water reactor (LWR) operating at an annual capacity factor of 80 percent for an effective electric output of 800 MWe. Data are calculated and presented in tables for land use, water consumption, thermal effluents, radioactive releases, waste burial, and radiation doses.

As presented above, the DCD states that, “the plant's net electrical power to the grid is at least 1000 MWe.” An assumed capacity factor of 93 percent is applied for conservatism. One AP1000 reactor operating at 1000 MWe, with an annual capacity factor of 93 percent, yields an effective electric output of 930 MWe. A ratio of the generation values of 930 MWe and 800 MWe provides a scaling factor of 1.16 to convert the RR values to one AP1000 reactor specific value (Table 5.7-1). Applying the AP1000 scaling factor to the values presented in Table S-3, the environmental effects (including the effects from Radon-222 [Rn-222] and Technetium-99 [Tc-99]) of the UFC due to the operation of one AP1000 reactor can be basically assessed.

5.7.4 NUREG-1437

NUREG-1437, Generic Environmental Impact Statement for License Renewal of Nuclear Plants, the NRC staff provides a detailed analysis of the environmental effects from the UFC. Although NUREG-1437 is specific to license renewal, the information is relevant because the LWR design considered here uses the same type of fuel. Section 6.2 of NUREG-1437 discusses the sensitivity to recent changes in the UFC on the environmental effects in detail.

Where relevant in discussions below, a single significance level of the potential effect (i.e., SMALL, MODERATE, or LARGE) is assigned to each analysis. This is consistent with the criteria that the NRC established in 10 CFR 51, Appendix B, Table B 1, Footnote 3, as follows:

- **SMALL**—Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource.
- **MODERATE**—Environmental effects are sufficient to alter noticeably, but not to destabilize, any important attribute of the resource.
- **LARGE**—Environmental effects are clearly noticeable and are sufficient to destabilize any important attributes of the resource.

5.7.4.1 Land Use

The total annual land requirement for the UFC supporting one operating AP1000 reactor is presented in Table 5.7-1. This includes values for both permanently and temporarily committed land. NUREG-1555, states that, a “temporary” land commitment is a commitment for the life of the specific UFC plant (e.g., a mill, enrichment plant, or succeeding plants). Following completion of decommissioning, such land can be released for unrestricted use. “Permanent” commitments represent land that may not be released for use after plant shutdown or decommissioning. This is because decommissioning activities on the pertinent land cannot remove sufficient radioactive material to meet the limits in 10 CFR 20, Subpart E, for release of land for unrestricted use.

As stated in NUREG-1437, the LWR fuel cycle requires only 10 percent of the temporarily committed land and 9.5 percent of the permanently committed land that would be required by replacement with coal-fired capacity. If the quality and opportunity cost of the land were equivalent, then it would be reasonable to say that land requirements for the uranium fuel cycle (at 20 to 30 percent of those for the coal fuel cycle) are relatively small.

The division of temporarily committed land into undisturbed and disturbed land is presented in Table 5.7-1, and compared to the land disturbed to provide fuel for a coal-fired power plant using strip-mined coal with power generation is equivalent to the AP1000 value. The effects on land use to support one or two AP1000 reactors from the UFC would be SMALL.

5.7.4.2 Water Use

Power stations supply electrical energy to the enrichment stage of the UFC. The primary water requirement of the UFC is waste heat removal from these power stations. For the UFC supporting the proposed project, over 97 percent of the annual water requirement is used in this manner. Values for the various water uses required are presented in Table 5.7-1.

Water requirements for the uranium fuel cycle are compared to the annual requirements for an LWR. The amount of water withdrawn from surface and ground water and discharged to air by activities within the fuel cycle represents only 2 percent of the annual discharges to air of an LWR with cooling towers. The fuel cycle discharges are spread among facilities involved in the various stages of the fuel cycle; thus, the water discharge to air from any one of these facilities will be less than the 2 percent. The environmental impacts of water withdrawal, use, and discharge from LWRs with cooling towers is found to have only small, or in special but unusual circumstances, moderate environmental impacts. Given that the water discharged to the air from other fuel cycle facilities for a Reference Reactor Year (RRY) is only a small fraction of the discharge from an LWR, the environmental consequences will be even smaller.

The expected thermal effluent values for one AP1000 are presented in Table 5.7-1. It is concluded that the effects on water use for these combinations of thermal loadings and water consumption would be SMALL relative to the water use and thermal discharges of the proposed project (i.e., two AP1000 units).

5.7.4.3 Fossil Fuel Effects

Electrical energy and process heat are required during various phases of the UFC process. The electrical energy is usually produced by combustion of fossil fuels at power plants. Electrical energy needs associated with the UFC represents about 5 percent of the annual electrical power production of the RR. Process heat is primarily generated by the combustion of natural gas. This gas consumption, if used to generate electricity, would be less than 0.4 percent of the electrical output from the RR.

The fossil fuel (coal and natural gas) consumed to produce electrical energy and process heat during the various phases of the uranium fuel cycle results in a considerable net savings in the use of resources and chemical effluents over the use that would occur if the electrical output from the LWR were supplied by a coal-fired plant. The use of coal and natural gas in the uranium fuel cycle allows the production of electricity with nuclear fuel, which results in a substantial reduction in the requirements for coal and natural gas as fuels to produce electricity. Not only are the fossil fuel requirements small per RRY; there is a net savings in the use of fossil fuel compared to replacing the nuclear-generating capacity with coal-fired capacity.

Electrical energy needs for one operating AP1000 associated with the UFC are presented in Table 5.7-1. The fossil fuel effects from the consumption of electrical energy for UFC operations would be SMALL relative to the net power production of one or two AP1000 reactors.

5.7.4.4 Chemical Effluents

The quantities of chemical, gaseous, and particulate effluents due to UFC processes to support one AP1000 are presented in Table 5.7-1. The principal effluents are sulfur oxides (SO_x), nitrogen oxides (NO_x), and particulates.

The gaseous effluents SO_x, NO_x, hydrocarbons, CO, and particulates listed in Table S-3 are the consequence of the coal-fired electrical energy used in the uranium fuel cycle. The volume of effluent is equivalent to that of a quite small (45 MWe) coal-fired plant; thus, the contribution to the degradation of air quality is small. The generation of electricity with nuclear rather than coal-fired power will result in a net improvement in air quality. For these reasons, the impact of these effluents is considered SMALL.

According to information presented in NUREG-1555, these emissions constitute a SMALL additional atmospheric loading in comparison with these emissions from the stationary fuel combustion and transportation sectors in the United States (i.e., about 0.02 percent of the annual national releases for each of these species).

Liquid chemical effluents produced in the UFC processes are related to fuel enrichment and fabrication, and may be released to receiving waters. These effluents are usually present in such small concentrations that only small amounts of dilution water are required to reach levels of concentration that are within established standards. Table 5.7-1 presents the amount of dilution water required for specific constituents. Additionally, any liquid discharges into the navigable waters of the United States from plants associated with UFC operations are subject to requirements and limitations set in an NPDES permit issued by an appropriate federal, state, regional, local, or affected Native American tribal regulatory agency. The effects of these liquid chemical effluents from the UFC would be SMALL for the HAR (i.e., two operating AP1000 units).

Tailings solutions and solids are generated during the milling process. These materials are not released in quantities sufficient to have a significant effect on the environment. The effects of these chemical effluents would be SMALL for the HAR (i.e., two operating AP1000 units).

5.7.4.5 Radioactive Effluents

The estimates of radioactive effluent releases to the environment are presented in Table 5.7-1. These are from waste management activities and certain other phases of the UFC process. The 100-year involuntary environmental dose commitment to the United States population is calculated in several parts.

The portion of dose commitment from radioactive gaseous effluents during reactor operation per year of operation of the proposed project is presented in Table 5.7-2. This estimate excludes reactor releases and any dose commitment from Rn-222.

The portion of dose commitment from radioactive liquid effluents due to all UFC operations other than reactor operation per year of operation of the proposed project is presented in Table 5.7-2. Thus, the total 100-year environmental dose commitment to the United States population from radioactive gaseous and liquid releases resulting from these portions of the UFC per year of operation of the proposed project is presented in Table 5.7-2.

Currently, the radiological effects associated with Rn-222 and Tc-99 release are not addressed in the RR data presented in Table S-3. Principal Rn-222 releases occur during mining and milling operations and as emissions from mill tailings, whereas principal Tc-99 releases occur from gaseous diffusion enrichment facilities. Based on information contained in NUREG-1437, an assessment was performed to determine the effects from Rn-222 and Tc-99. In Section 6.2.2.1 of NUREG-1437, the NRC staff estimated the Rn-222 releases from the mining and milling operation and from mill tailings required to support each year of operations of the RR. Of this total, about 78 percent would be from mining, 15 percent from milling operations, and 7 percent from inactive tailings prior to stabilization.

The major risks from Rn-222 are bone and lung exposure; although, there is a small risk from whole body exposure. The organ-specific dose weighting factors from 10 CFR 20 were applied to the bone and lung doses to estimate the 100-year dose commitment from Rn-222 to the whole body in Table 6.2 of NUREG-1437. The estimated population dose commitment from mining, milling, and tailings before stabilization for each year of operation for one AP1000 at the

HAR is presented in Table 5.7-3. From stabilized tailings piles, the estimated 100-year environmental dose commitment is presented in Table 5.7-3. Additional insights regarding routine Rn-222 exposure and risk, and long-term releases from stabilized tailings piles, are discussed in NUREG-1437.

As shown in NUREG-1437, the NRC staff also considered the potential health effects associated with the release of Tc-99. Using that evaluation method, the releases of Tc-99 per year for one AP1000 are chemical reprocessing of recycled UF_6 before it enters the isotope enrichment cascade, and released into the groundwater from a federal repository. These values are presented in Table 5.7-3.

The major risks from Tc-99 are from gastrointestinal tract and kidney exposure, although there is a small risk from whole-body exposure. Using organ-specific risk estimators, these individual organ risks were converted to a whole-body 100-year dose commitment per year for one operating AP1000. This value is presented in Table 5.7-3.

Although radiation may cause cancers at high doses and high dose rates, currently, there are no data that unequivocally establish the occurrence of cancer following exposure to low doses and dose rates. However, radiation protection experts conservatively assume that any amount of radiation may pose some risk of causing cancer or a severe hereditary effect and that the risk is higher for higher radiation exposures. Therefore, a linear, no-threshold dose response model is typically accepted and used to describe the relationship between radiation dose and risk such as cancer induction. A report by the National Academies' National Research Council (NANRC) supports the linear, no-threshold dose response model. Simply stated, any increase in dose, no matter how small, results in an incremental increase in health risk. This theory is accepted by the NRC (NUREG-1437 Vol. 1) as a conservative model for estimating health risks from radiation exposure, recognizing that the model probably overestimates those risks.

Based on this model, the NRC staff estimated the risk to the public from radiation exposure. The sum of the estimated whole body population doses from gaseous effluents, liquid effluents, Rn-222, and Tc-99 discussed above can be used to estimate the number of fatal cancers, nonfatal cancers, and severe hereditary effects that the United States population would incur annually. This risk is quite small compared to the number of fatal cancers, nonfatal cancers, and severe hereditary effects that would be estimated to occur in the United States population annually from exposure to natural sources of radiation using the same risk estimation method. As presented in Subsection 5.7.4.8 that follows, for comparative purposes, it is estimated that the average annual dose from man-made and natural background radiation is approximately 350 mrem/yr. The estimated population living within an 80-km (50-mi.) radius of the HAR is approximately 2,400,000. The estimated collective dose from man-made and natural background radiation to the population within 80 km (50 mi.) of the HAR can be estimated at approximately 840,000-person-rem per year (rem/yr).

Typically, the radiation levels from Rn-222 released from tailings piles are indistinguishable from background radiation levels at a few kilometers from the tailings. The public dose limit specified by USEPA regulation in 40 CFR 190, is 25 mrem/yr to the whole body from the entire UFC, but most NRC licensees have airborne effluents resulting in doses of less than 1 mrem/yr .

Based on the analyses presented above, the environmental effects of radioactive effluents from the UFC are SMALL even when the effects to account for two operating AP1000 units are doubled.

5.7.4.6 Radioactive Wastes

The quantities of buried radioactive waste material (LLW, HLW, and TRU waste) are specified in Table 5.7-1.

For low-level waste disposal at land burial facilities, the NRC notes in the RR data presented in Table S-3, that there will be no significant radioactive releases to the environment

For HLW and TRU waste, the NRC notes that in Table S-3 that these wastes are expected to be buried at a repository and that no release to the environment is expected to be associated with such disposal. The gaseous and volatile radionuclides contained in the spent fuel would have been released and monitored before disposal.

The NRC is one of three federal agencies under the Act with a role in the disposal of spent nuclear fuel and other high-level radioactive waste.

- The U.S. Department of Energy (USDOE) has the responsibility for developing permanent disposal capacity for spent fuel and other high-level radioactive waste.
- The USEPA has responsibility for developing environmental standards to evaluate the safety of a geologic repository.
- The NRC has responsibility for developing regulations to implement the USEPA safety standards and for licensing the repository.

The NRC regulations for geologic disposal of high-level radioactive waste in 10 CFR 60 limits the releases of radioactive material to the accessible environment. In addition to satisfying an overall performance objective to be established by USEPA, the basic requirements are that containment of HLW within the waste packages will be substantially complete for a period between 300 and 1000 years (to be determined by the NRC), and that the annual releases from the engineered barrier system thereafter should not exceed one part in 100,000 of the total inventory of each radionuclide calculated to be present 1000 years following permanent source of the repository. For HLW, 10 CFR 60.111 requires compliance with 10 CFR 20 and with USEPA general environmental standards in 40 CFR 191.

For the HLW and spent-fuel disposal component of the fuel cycle, there are no current regulatory limits for off-site releases of radionuclides for the candidate repository at Yucca Mountain. If it is assumed that limits are developed along the lines of the 1995 National Academy of Sciences (NAS) report, *Technical Bases for Yucca Mountain Standards*, and that in accordance with the Commission's Waste Confidence Decision, 10 CFR 51.23, a repository can and likely will be developed at some site that will comply with such limits, peak doses to virtually all individuals will be 100 mrem/yr or less.

Based on the discussion presented above, it is concluded that the environmental effects of radioactive waste disposal from the UFC are SMALL.

5.7.4.7 Occupational Dose

In the review and evaluation of the environmental effects of the UFC, the annual occupational dose attributable to all phases of the UFC for one operating AP1000 is presented in Table 5.7-2. Occupational doses would be maintained to meet the dose limits in 10 CFR 20, which is 5 rem/yr. On this basis, it is concluded that environmental effects from this occupational dose would be SMALL even if the doses were doubled for two units.

5.7.4.8 Transportation

The transportation dose to workers and the public is presented in Table 5.7-1 for one operating AP1000. For comparative purposes, it is estimated that the average annual dose from man-made and natural background radiation is approximately 350 mrem/yr. The estimated population living within an 80-km (50-mi.) radius of the HAR is approximately 2,400,000 as shown in Table 2.5-4 of this ER. The estimated collective dose from man-made and natural background radiation to the population within 80 km (50 mi.) of the HAR is 840,000-person-rem/yr. Doses from natural and man-made radioactive sources would greatly exceed any doses from transportation activities associated with radioactive wastes.

On this basis, it is concluded that environmental effects of transportation would be SMALL.

5.7.4.9 Conclusion

Using an evaluation process as provided by NUREG-1437, considering the environmental effects of the UFC, the effects of Rn-222 and Tc-99, and the effects of the scaled data for the proposed AP1000 reactor, it is concluded that the environmental effects of the UFC would be SMALL, and mitigation is not warranted.

Table 5.7-1 (Sheet 1 of 5)
10 CFR 51.51 Table S-3 of Uranium Fuel Cycle Environmental Data[a]
Normalized to Model LWR Annual Fuel Requirement (WASH-1248) or Reference Reactor Year (NUREG-0116)

Environmental Considerations	Total	Maximum Effect per Annual Fuel Requirement or Reference Reactor Year of Model 1000 MWe LWR	AP1000 Data (Reference Reactor data scaled to proposed plant, i.e., RRV*Scaling Factor of 1.16)
NATURAL RESOURCE USE			
Land (hectares [acres]):			
Temporarily committed [b]	40.5 (100)		47 (116)
Undisturbed area	32 (79)		37 (92)
Disturbed area	9 (22)	Equivalent to a 110 MWe coal-fired power plant.	10 (26)
Permanently committed	5 (13)		6 (15)
Overburden moved in millions of Metric Tons (MT)	2.8 (3.1)	Equivalent to 95 MWe coal-fired power plant.	3.3 (3.6)
Water (millions of liters [millions of gallons]):			
Discharged to air	606 (160)	=2 percent of model 1000 MWe LWR with cooling tower.	703 (186)
Discharged to water bodies	41,980 (11,090)		48,697 (12,864)
Discharged to ground	481 (127)		558 (147)
Total	**43,067 (11,377)**	<4 percent of model 1000 MWe LWR with once through cooling.	**49,958 (13,197)**
Fossil Fuel:			
Electrical energy (thousands of MW-hour)	323	<5 percent of model 1000 MWe output.	375
Equivalent coal in thousands of MT (tons)	118 (130)	Equivalent to the consumption of a 45 MWe coal-fired power plant.	137 (151)
Natural gas in millions of cubic meters (cubic feet)	3.8 (135)	<0.4 percent of model 1000 MWe energy output.	4.4 (157)

Table 5.7-1 (Sheet 2 of 5)
10 CFR 51.51 Table S-3 of Uranium Fuel Cycle Environmental Data[(a)]
Normalized to Model LWR Annual Fuel Requirement (WASH-1248) or Reference Reactor Year (NUREG-0116)

Environmental Considerations	Total	Maximum Effect per Annual Fuel Requirement or Reference Reactor Year of Model 1000 MWe LWR	AP1000 Data (Reference Reactor data scaled to proposed plant, i.e., RRV*Scaling Factor of 1.16)
EFFLUENTS—CHEMICAL (MT [ton])			
Gases (including entrainment) [(c)]			
SO_x	4400 (4850)		5104 (5626)
NO_x [d]	1190 (1312)	Equivalent to emissions from 45 MWe coal-fired plant for a year.	1380 (1522)
Hydrocarbons	14 (15)		16 (17)
CO	29.6 (32.6)		34.3 (37.8)
Particulates	1154 (1272)		1339 (1476)
Other gases:			
F	0.67 (0.74)	Principally from UF_6, production, enrichment, and reprocessing. Concentration within range of state standards-below level that has effects on human health.	0.78 (0.86)
HCl	0.014 (.015)		0.016 (0.017)
Liquids:			
$SO\text{-}_4$	9.9 (10.9)	From enrichment, fuel fabrication, and reprocessing steps.	11.5 (12.6)
$NO\text{-}_3$	25.8 (28.4)	Components that constitute a potential for adverse environmental effect are present in dilute concentration levels below permissible standards. The constituents that require dilution and the flow of dilution water are as follows: NH_3 – 17 cubic meters per second (m^3/s) (600 ft^3/s), NO_3 – 0.56 m^3/s (20 ft^3/s), and Fluoride – 2 m^3/s (70 ft^3/s).	29.9 (32.9)
Fluoride	12.9 (14.2)		15 (32.9)
CA^{++}	5.4 (5.9)		6.3 (6.8)
$C1^-$	8.5 (9.4)		9.9 (10.9)
Na^+	12.1 (13.3)		14 (15.4)
NH_3	10 (11)		12 (13)
Fe	0.4 (0.44)		0.5 (0.51)
Tailings Solutions (thousands of MT [tons])	240 (264.5)	From mills only— no significant effluents to environment.	278 (306.8)
Solids	91,000 (100,310)	Principally from mills— no significant effluents to environment.	105,560 (116,360)

Table 5.7-1 (Sheet 3 of 5)
10 CFR 51.51 Table S-3 of Uranium Fuel Cycle Environmental Data(a) Normalized to Model LWR Annual Fuel Requirement (WASH-1248) or Reference Reactor Year (NUREG-0116)]

Environmental Considerations	Total	Maximum Effect per Annual Fuel Requirement or Reference Reactor Year of Model 1000 MWe LWR	AP1000 Data (Reference Reactor data scaled to proposed plant, i.e., RRV*Scaling Factor of 1.16)
EFFLUENTS —RADIOLOGICAL - CURIES			
Gases (including entrainment):			
Rn-222		Presently under reconsideration by the Commission.	
Ra-226	0.02		0.023
Th-230	0.02		0.023
Uranium	0.034		0.039
Tritium (thousands)	18.1		21
C-14	24		28
Kr-85(thousands)	400		464
Ru-106	0.14	Principally from fuel reprocessing plants.	0.16
I-129	1.3		1.5
I-131	0.83		0.96
Tc-99		Presently under consideration by the Commission.	
Fission products and transuranics	0.203		0.235
Liquids:			
Uranium and daughters	2.1	Principally from milling—included tailings liquor and returned to ground—no effluents; therefore, no effect on the environment.	2.4
Ra-226	0.0034	From UF_6 production.	0.0039
Th-230	0.0015		0.0017
Th-234	0.01	From fuel fabrication plants—concentration 10 percent of 10 CFR 20 for total processing 26 annual fuel requirements for model LWR.	0.012
Fission and activation products	5.9E-06		6.8E-06

Table 5.7-1 (Sheet 4 of 5)
10 CFR 51.51 Table S-3 of Uranium Fuel Cycle Environmental Data[(a)]
Normalized to Model LWR Annual Fuel Requirement (WASH-1248) or Reference Reactor Year (NUREG-0116)

Environmental Considerations	Total	Maximum Effect per Annual Fuel Requirement or Reference Reactor Year of Model 1000 MWe LWR	AP1000 Data (Reference Reactor data scaled to proposed plant, i.e., RRV*Scaling Factor of 1.16)
Solids (buried on-site):			
Other than high level (shallow)	11,300	The 9100 Ci comes from low-level reactor wastes and 1500 Ci comes from reactor decontamination and decommissioning buried at land burial facilities. The 600 Ci comes from mills included in tailing returned to ground. Approximately 60 Ci comes from conversion and spent fuel storage. No significant effluent to the environment.	13,108
Transuranic (TRU) and High-Level Waste (HLW) (deep)	1.1E+07	Buried at Federal Repository	1.3E+07
Effluents—thermal (billions of British thermal units)	4063	<5 percent of model 1000 MWe LWR.	4713
Transportation (person-rem):			
Exposure of workers and general public	2.5		2.9
Occupational exposure	22.6	From reprocessing and waste management.	26.2

Table 5.7-1 (Sheet 5 of 5)
10 CFR 51.51 Table S-3 of Uranium Fuel Cycle Environmental Data[a]
Normalized to Model LWR Annual Fuel Requirement (WASH-1248) or Reference Reactor Year (NUREG-0116)

Notes:

a) In some cases where no entry appears, it is clear from the background documents that the matter was addressed and that, in effect, the Table should be read as if a specific zero entry had been made. However, there are other areas that are not addressed at all in the Table. Table S–3 does not include health effects from the effluents described in the Table, or estimates of releases of Radon-222 from the uranium fuel cycle or estimates of Technetium-99 released from waste management or reprocessing activities. These issues may be the subject of litigation in the individual licensing proceedings. Data supporting this table are given in the ‘‘Environmental Survey of the Uranium Fuel Cycle,’’ WASH–1248, April 1974; the ‘‘Environmental Survey of the Reprocessing and Waste Management Portion of the LWR Fuel Cycle,’’ NUREG–0116 (Supp.1 to WASH–1248); the ‘‘Public Comments and Task Force Responses Regarding the Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle,’’ NUREG–0216 (Supp. 2 to WASH–1248); and in the record of the final rulemaking pertaining to Uranium Fuel Cycle Impacts from Spent Fuel Reprocessing and Radioactive Waste Management, Docket RM–50–3. The contributions from reprocessing, waste management, and transportation of wastes are maximized for either of the two fuel cycles (uranium only and no recycle). The contribution from transportation excludes transportation of cold fuel to a reactor and of irradiated fuel and radioactive wastes from a reactor which are considered in Table S–4 of § 51.20(g). The contributions from the other steps of the fuel cycle are given in columns A–E of Table S–3A of WASH–1248.

b) The contributions to temporarily committed land from reprocessing are not prorated over 30 years, since the complete temporary impact accrues regardless of whether the plant services 1 reactor for 1 year or 57 reactors for 30 years.

c) Estimated effluents based upon combustion of equivalent coal for power generation.

d) About 1.2 percent from natural gas use and process.

Table 5.7-2
Whole Body 100-Year Committed Dose Estimate

100-yr Overall Involuntary Whole-Body Dose Commitment to the U.S. Population from the Uranium Fuel Cycle, Excluding Rn-22 or Tc-99	RR/RRY (person-rem)	Person-rem/per AP1000 Operating Year (RRY*1.16 scaling factor)
From radioactive gaseous releases (this excludes reactor releases and the dose commitment from Rn-222)	400	464
From radioactive liquid releases (all fuel-cycle operations excluding reactor operations)	200	232
Subtotal	**600**	**696**
Rn-222 Total from Table 5.7-3	140	162
Tc-99 Total from Table 5.7-3	100	116
Total including contributions from Rn-222 and Tc-99	**840**	**974**

Table 5.7-3
Whole Body 100-Year Committed Dose Estimate from Rn-222 and Tc-99

Rn-222 values	**Release, Ci per RRY**	**Release, Ci/AP1000 operating yr (RRY*1.16 scaling factor)**	**Whole Body 100-yr committed dose (100-yr person-rem/RRY)**	**Whole Body dose commitment (100-yr person-rem/AP1000 operating yr) (RRY*1.16 scaling factor)**
Mining	4060 (78% of total)	4710	110 (~78% of total)	128
Milling	780 (15% of total)	905	21 (~15% of total)	24
Tailings	350 (7% of total)	406	9 (~7 % of total)	10
Stabilized Tailings	1 (<1% of total)	1.16	0.027 (<1% of total)	0.031
Total-Rn-222	**5191**	**6022**	**140**	**162**
Tc-99 Values				
Chemical Processes	0.007 (58% of total)	0.008	58 (58% of total)	67
Groundwater	0.005 (42% of total)	0.006	42 (42% of total)	49
Tc-99 Totals	**0.012**	**0.014**	**100**	**116**

5.8 SOCIOECONOMIC IMPACTS

This section evaluates the socioeconomic impacts related to operation of the HAR and appurtenant facilities as described in Section 5.0. For this discussion, the HAR and appurtenant facilities will be collectively referred to as operation of the new facilities. It is assumed that these appurtenant facilities are support infrastructure and will not require daily operations personnel. It is further assumed that requirements for periodic maintenance of these facilities will be conducted by existing maintenance personnel. The operational impacts of the appurtenant facilities will have no socioeconomic impact. Therefore, the primary emphasis of this analysis will be the operational impacts of the HAR.

The socioeconomic impacts to the vicinity and the region are anticipated to be SMALL and are described below. The operations personnel for HAR 2 will include approximately 515 employees, with approximately 258 additional operations personnel at HAR 3. These additional 773 employees, combined with the 754 operations personnel at the HNP, bring the total operations personnel for all three units to 1527 as shown in Table 5.8-1.

The proposed project is near the City of Raleigh, which functions as a major employment and economic hub for the region. According to the 2000 Census, the population within an 80-km (50-mi.) radius of the project location is 1,973,427 (Reference 5.8-001). Raleigh is part of the Research Triangle area, which is nationally known for its research and development initiatives; therefore, there is a widely skilled and trained workforce in the region (Reference 5.8-002).

Because the region has a highly skilled workforce and an existing nuclear power facility, it is assumed that the majority (75 percent or approximately 580) of the new operations workforce for the HAR will already live in the region. It is further assumed that the remaining 25 percent (approximately 193) of operation workers would be highly specialized and would relocate to the region. It is assumed that these new in-migrants (25 percent of the operations workforce) will follow the same residential patterns as the existing HNP workforce. Currently, approximately 91.3 percent of the existing HNP workforce lives in Wake (61.6 percent), Chatham (6.3 percent), Lee (16.2 percent), and Harnett (7.2 percent) counties. The remaining 8.7 percent of workers live within the surrounding counties.

5.8.1 PHYSICAL IMPACTS OF STATION OPERATION

This subsection assesses the potential impacts on the nearby communities that could result from the operation of the HAR. Physical impacts are defined as noise, odors, exhausts, thermal emissions, and visual intrusion. Potential physical impacts have been assessed and alternative locations, designs, and procedures utilized where appropriate. Physical impacts will be mitigated where necessary and the project will meet the criteria and standards set forth in applicable local, regional, state and federal regulations.

5.8.1.1 Site and Vicinity

There are approximately 55,219 people within 16 km (10 mi.) of the HAR site The largest cities in the area include Holly Springs (population 9192) located approximately 11.1 km (6.9 mi.) east, Apex (population 20,212) located approximately 13.9 km (8.6 mi.) northeast, and Fuquay-Varina (population 7898) located approximately 15.7 km (9.8 mi.) east-southeast of the HAR site (References 5.8-003 and 5.8-004). All are small towns that also serve as bedroom communities to Raleigh. These communities will not experience any physical impacts from operation of the new facilities. There will be no direct physical impacts to structures, including residences near the plant site or in the vicinity. SMALL impacts to hospitals or other institutional facilities are anticipated, as described in more detail in Subsection 2.5.2.7.

The HAR is accessed by the following roads: Shearon Harris Road and New Hill Holleman Road off of Route 1, which are described in Subsection 5.8.2.8. The roads and highways within the immediate vicinity of the HAR site will experience an increase in use, especially during morning and evening peak-hour traffic. Currently, there is one primary access road to the HAR site and an emergency backup road that was used during construction. Efforts are being made to explore ways to improve access to U.S. Highway 1. Subsection 5.8.2.8 provides a more detailed discussion of this information.

There are eight major recreational facilities in the vicinity. These include: Jordan Lake State Recreation Area, Eno River State Park, Falls Lake State Recreation Area, Raven Rock State Park, William B. Umstead Park, Harris Lake County Park, North Carolina Wildlife Resources Commission (NCWRC) Game Lands (which include Shearon Harris Game Lands and Chatham Game Lands). There are three major recreational areas located within the 16-km (10-mi.) radius of the HAR: Jordan Lake State Recreation Area, Wake County-Harris County Park, and the NCWRC Game Lands. Because it is expected that the majority of the new operations workforce will already live in the region, nearby recreational areas will not experience any abnormal influx in use from operation of the new facilities.

There will be no physical impacts (noise, air, and aesthetic disturbances) from the operation of the new facilities outside of the 9.7-km (6-mi.) radius of the vicinity. The surrounding area is heavily wooded and will buffer any potential noise, air, or aesthetic disturbances.

5.8.1.2 Noise

Once the HAR is constructed, there will be a minimal increase in noise from day-to-day operations. This noise impact is expected to be SMALL. Noise from operation of the two new units will be commensurate with the existing plant operations and will result in a small change to overall noise levels in the area. Noise from the operation of appurtenant facilities is anticipated to be negligible. The following pieces of equipment on the HAR are anticipated to generate noise:

turbines, generators, pumps, transformers, cooling towers, and switchyard gear. Noise will also be generated by periodic operations and testing of the emergency diesel generators and periodic testing of sirens used to alert on-site and off-site personnel for plant emergencies. These noises will be episodic and comparable to civil defense siren testing or similar to facility testing currently in place. Noise levels, however, will be controlled in accordance with the following regulations:

- The Occupational Safety and Health Administration (OSHA) has developed noise exposure limits (29 Code of Federal Regulations [CFR] 1910). These acceptable noise levels for offices and control rooms relate to workers' health and annoyance factors .
- Federal noise pollution control regulations (40 CFR 204) identify noise emission standards for construction equipment.
- Wake County Unified Development Ordinance (Article 17. General Site Design and Performance Standards) cites a sound level of 55 decibels adjusted (dBA) as the maximum permitted noise level in areas that are adjacent to any residential district (Reference 5.8-005).

Noise control devices will be used on equipment that exceeds noise abatement criteria. Equipment manufacturers will be required to guarantee that specifications on allowable octave bands will be met. Most equipment will be located inside structures; therefore, building walls will reduce outside noise levels as much as 15 decibels (A-weighted scale) (dBA) (Reference 5.8-006). Further, reduction will be achieved as noise travels to the property line. Figure 5.8-1 presents the sensitive receptors to the HAR. The nearest resident is 1.6 km (1.0 mi.), and the nearest recreation area (Harris Lake County Park) is 3.2 km (2.0 mi.) from the HAR site. The area around the HAR is scattered rural residential land use and recreational facilities. There may be a SMALL increase in traffic noise generated by additional station employees, delivery trucks, and off-site shipments. However, it is anticipated that the majority of these trips will occur during normal weekday business hours. Additional traffic from the operations workforce, to and from the HAR, will increase the level of vehicular noise for those residents living along routes that access the site. However, the low volume roadway, even with the added traffic, is expected to be below the noise criteria for residential areas. The infrequent amounts of train traffic are not expected to increase because of the additional operations at the HNP site. Therefore, noise impacts from increased traffic are anticipated to be SMALL. These noise impacts will be mitigated where necessary, and the project will meet criteria and standards set forth in applicable local, regional, state, and federal regulations.

It was assumed that noise will result from line sources. Natural attenuation of line-source noise occurs over distance, typically decreasing by 3 dBA with each doubling of distance (Reference 5.8-007). The actual noise levels experienced by receptors more than 1.6 km (1.0 mi.) from the construction area would be 18 to 21 dBA lower than the noise level at 15 m (50 ft.). Following the distance attenuation rule, 975.3 m (3200 ft.) would result in six doublings and 1950.7 m (6400 ft.) would result in seven doublings. This would produce a natural attenuation of 18 dBA at six doublings (3 multiplied by 6) and 21 dBA at seven doublings (3 multiplied by 7). Additionally, the area surrounding the HAR is heavily wooded, and therefore, noise generated on-site will quickly dissipate upon reaching these natural sound buffers. The nearest residence is 1.6 km (1.0 mi.) from the HAR site. Noise levels from operations are not expected to exceed 60 dBA, 304.8 m (1000 ft.) from the system; traffic will be limited to normal weekday business hours; and noise control devices will be used when necessary. The nearby recreation areas will not be impacted by noise, because recreational facilities are well beyond 304.8 m (1000 ft.) from the facility. The nearest campground is approximately 3.1 km (1.9 mi.) from the HAR site. Nearby residents or individuals taking part in recreational activities are not expected to experience noise impacts.

5.8.1.3 Air

Air quality impacts to workers and nearby residents from operation of the new facilities are anticipated to be negligible. The average annual exposure at the HAR boundary from gaseous sources will not exceed applicable regulations during normal operation. Additionally, it is anticipated that the impact of air emission levels at the HAR boundary will be SMALL, as defined by the U.S. Environmental Protection Agency (USEPA). Depending on the reactor technology selected, air pollution control devices may be needed, and will be installed if needed to meet applicable regulations. Section 2.7 of this ER provides specific information on cumulative air quality impacts.

Additional air emissions from increased vehicular traffic from the new operations workforce may contribute to deteriorated air quality in Wake County. Wake County is a non-attainment area for ozone and a maintenance area for carbon monoxide (Reference 5.8-008 and Reference 5.8-009). It is anticipated that the operations workforce will increase from 754 employees at the HNP to an additional 773 operations personnel for the HAR, making the cumulative total 1527 personnel. As discussed in Section 5.8, it is assumed that 75 percent of the new operations personnel already live in the region and are accounted for in current air quality data. Assuming that the remaining 25 percent (193) of operations workers will relocate to the region and may bring families who also make daily trips to schools, shopping, or places of employment, the additional trips per day per family is anticipated to be small in comparison to the overall trips per day generated by the current Wake County population. Therefore, the additional vehicle trips per day associated with new employees and their families will result in a small or negligible increase of ozone-producing emissions. Air impacts from increased traffic will be SMALL, and no mitigation measures are warranted.

5.8.1.4 Aesthetic Disturbances

HNP is already industrial in appearance; therefore, the HAR will not substantially alter the already disturbed plant site. The closest residence is approximately 1.6 km (1.0 mi.) from the HAR site, and the closest town is Holly Springs, located approximately 11.0 km (6.9 mi.) east of the HAR site; so there will be no immediate visual impact to nearby residents. Recreational users of the Harris Reservoir will be able to view the operation areas. This view, however, is already industrial in nature and will remain unchanged with the introduction of the two new units.

The cooling towers for the HAR will discharge two additional plumes, which will be visible to the surrounding communities. These plumes will be similar in size and scale to the plume that is currently discharged from the HNP. The height of the current discharge is 158.5 m (520 ft.) above plant grade. After leaving the tower, the plume may rise another 304.8 to 914.4 m (1000 to 3000 ft.), depending on wind speed and atmospheric conditions. The length of the visible plume depends on the temperature and humidity of the atmosphere. Colder and more humid weather is more conducive to longer plumes. Most of the time, the visible plume will extend only a short distance from the tower and then disappear by evaporation. The visual impact of two additional plumes will be minimal because the current facility emits a similar discharge plume. Because the surrounding land is primarily undeveloped and heavily wooded, the plume is blocked from view by dense trees and is not visible from nearby roads in many areas. Any visual impacts from the two additional visible plumes will be similar to those associated with the HNP site.

The proposed project will have similar visual impacts to those of the existing facility. The HAR will have a SMALL impact on aesthetic quality for nearby residences and recreational users of Jordan Lake State Recreation Area, Wake County-Harris Lake County Park, and the NCWRC Game Lands. However, in the area surrounding the cooling towers, vapors may be visible to people boating on in the Harris Reservoir or fishing near the shoreline. The area surrounding the HAR site is heavily undeveloped forested timber and game lands. The current plume is buffered by existing trees and is only visible from the shoreline of the lake or in areas that have been heavily cleared. Therefore, no mitigation will be required.

During severe drought conditions, the operation of the new facilities could have an impact on water levels by slightly adding to the duration and extent of shoreline mud flats that could be exposed. These visual aesthetic impacts would be temporary in duration and therefore SMALL. Mitigation is not warranted because of the temporary and infrequent nature of the impacts.

5.8.2 SOCIAL AND ECONOMIC IMPACTS OF STATION OPERATION

Social and economic impacts associated with operation include impacts to the economy, tax and social structure, housing, educational, recreational, public services and facilities, transportation facilities, distinctive communities, and agriculture.

5.8.2.1 Economic Characteristics

This subsection on economic impacts of operations of the HAR first considers the total (i.e., direct, indirect, and induced) contribution to regional employment and income (i.e., wages and salaries, proprietors' [business owners'] income and all other income). Second, the operations activity is placed in the context of the larger economy in order to evaluate the likely significance of the net contribution to employment and earnings in the region.

The Erickson and Associates 2005 economic impact study uses the 2002 IMPLAN data and multipliers for counties that comprise the North Carolina Planning Region J (Chatham, Durham, Johnston, Lee, Moore, Orange, and Wake counties) plus Harnett County, which is outside of but adjacent to Region J. These multiplier effects include "indirect" and "induced" effects, which are added to the direct changes in output, income, and employment due to operations to capture the total economic impacts on the region (Reference 5.8-010).

According to the Erickson and Associates 2005 study, the existing unit at the HNP has approximately a 920 MW capacity. The study estimates a contribution of $448 million in the value of output in the utility sector (Reference 5.8-010). In turn, this increase in expenditures in the utility sector leads to an increase in output in other sectors that supply materials and services to the utility industry or to the households who receive income from the utility industry. For the existing unit the addition of these indirect and induced contributions to output leads to a total output value of approximately $697 million in 2005 dollars (Reference 5.8-010). The proposed new units combined would contribute an estimated minimum additional 2000 MW capacity (1000 MW for each unit). The capacity ratio as the estimate of the increased value of output for the operation of the two new units would be 2.2 (2000 divided by 920). This is based on if the existing unit contributes $697 million in output, then the two units would add $1533 million ($697 multiplied by 2.2). The cumulative impacts of operating all three units are $2230 million in 2005 dollars. Based on the U.S. Department of Labor (DOL) Bureau of Labor Statistics (BLS) consumer price index for all urban consumers, the ratio of the 2007 to the 2005 consumer price index is 1.06 (Reference 5.8-011). When converted to 2007 dollars the total for operating the three units would be $2364 million (2230 multiplied by 1.06).

The current operations workforce consists of 754 people at the HNP and it is projected that there will be an additional 773 people for the HAR with the addition of both units. Additionally, the contractor workforce increases during outages, which are planned to occur every 18 months and last for approximately 45 to 90 days. Due to the temporary addition of these workers and because it is assumed that much of their income is spent at their primary residence, the outage workforce is not included in the economic impact calculations. The Erickson and

Associates study estimates an employment multiplier of 1.84 for the utilities sector in this region (Reference 5.8-010). This means that by expanding the workforce by an additional 773 employees to operate the HAR, the total new employment impact in the region would increase by approximately 1422 people (773 multiplied by 1.84), including the indirect and induced employment of 646 full time equivalents (1422 minus 773 operations personnel) due to the multiplier effect. The current employment impact in the region is 1,387 people (754 multiplied by 1.84). Therefore, the cumulative impact in the region from the new and existing units is 2809 full time equivalents.

The corresponding impacts on income in the region associated with these employment figures are found by adjusting Erickson and Associates' estimate of operations income ($47 million) for differences in the sizes of the operations workforce (773 new personnel for the HAR versus 1150 utilities jobs cited in the analysis, or a 67.2 percent difference). This gives an estimate of $31.6 million in direct income ($47 million multiplied by 67.2 percent). The income multiplier for the utilities sector implied by the Erickson and Associates study calculations is 2.62. Thus, the total income impact is calculated by multiplying $31.6 million by 2.62, which is $82.8 million (Reference 5.8-010). Because this figure was calculated using 2005 dollars, the DOL BLS consumer price index for all urban consumers is used to convert this figure from 2005 dollars to 2007 dollars. The adjustment factor is 1.06 (Reference 5.8-011). Thus, the total incremental impact on income in the region is approximately $86.9 million per year in 2007 dollars. The cumulative impact on regional income is approximately twice this figure because the addition of two new units doubles the existing operations workforce at the HNP.

Therefore, operation of the new facilities will result in a noticeable MODERATE beneficial impact to the local economy.

Subsection 2.5.2.1 describes the regional employment by industry. In 2000, the total regional labor force was approximately 1,896,380 (Reference 5.8-012). Wake, Chatham, and Harnett counties experienced a job increase between 21 and 24 percent from 1995 to 2005. Lee County experienced a slight job decrease by less than 1 percent during the same period. Between 1995 and 2005, unemployment rates increased from 2.4 percent to 4.0 percent for Wake County, 2.8 percent to 3.8 percent for Chatham County, 4.8 percent to 5.5 percent for Lee County, and 3.8 percent to 5.2 percent for Harnett County (Reference 5.8-013).

As stated in Section 5.8, it is assumed that a majority the new operations workers will already live within the region and the remaining workforce will relocate to the region. The overall population increase from operations workers is expected to be small in relation to the existing population in the area.

Operations workforce salaries and spending by their families will have a multiplier effect where money is spent and re-spent within the region. Workers may patronize local retail and service sector businesses, thereby increasing sales in these areas. The additional operations personnel expected to move into the region may help to sustain existing businesses throughout the region, as well as provide opportunities for some new businesses. The proposed project may result in a slight decrease in unemployment levels in the area. The unemployment rate in 2005 was 4.0 percent in Wake County and 5.1 percent nationwide (Reference 5.8-013 and Reference 5.8-014). Overall, the economic impact from employment of operations workers to operate the HAR will be SMALL.

During refueling outages (typically every 18 months per unit) there will be increases above the permanent workforce by as many as 800 temporary workers brought on-site to perform maintenance work. The total temporary workforce was approximated using historical tracked staffing levels during refueling outages plus approximated non-tracked staff. The duration of the outage usually runs between 45 and 90 days per outage. These refueling outages are considered periodic maintenance activities and are currently conducted at the existing facility. Because the facility is located within the larger Raleigh metropolitan area, temporary worker housing such as hotels, apartments, and campgrounds, are available in the area, as discussed in further detail in Subsection 5.8.2.4. Impacts to the housing market and infrastructure from increased workforce during periodic refueling maintenance are anticipated to be SMALL. The temporary increase in operational workforce will result in a SMALL, beneficial economic impact to the local economy, as workers may spend some of their earnings at local retail and service sector establishments.

5.8.2.2 Tax Impacts

The proposed project will be subject to North Carolina State and Wake County property taxes. Therefore, the proposed project will result in an increase in the overall tax revenue for both the State and Wake County. The Wake County Public School System (WCPSS) will also benefit from this project as described in Subsection 2.5.2.2. A 2006 WCPSS school bond passed in 2006 that includes a 2.7 cent increase in taxes per $100 assessed property value. Hence, in 2008, the owner of a $150,000 home would pay $54 more a year in property taxes, or a little less than 15 cents a day (Reference 5.8-015). Any local property taxes paid in connection with the proposed project are expected to be a benefit to the local community.

Other potential tax impacts include an increase in state income tax revenue generated from the additional operations jobs and indirect salaries created by operation of the new facility. A small increase in state income tax revenue will be generated from the salaries paid to new operations workers employed at the new facilities.

Sales taxes will be levied on materials purchased during operation of the new facilities, as well as on goods and services purchased by new workers. Sales taxes on such purchases are expected to be a SMALL but beneficial impact to the local economy. Similarly, there may be SMALL direct and indirect beneficial economic impacts from sales tax revenue generated from goods and services purchased by operations workers who do not currently work in the region.

Because HNP is located in Wake County, PEC pays the majority of its annual property tax to Wake County. Chatham County receives the remaining portion of the annual property tax. The average amount of taxes paid between 2001 and 2004 ranged from $50,000 to $60,000 annually. From 2001 and 2004, PEC paid between $7,061,685 and $8,396,063 annually in total real and personal property tax revenues to Wake County. This averages out to 2.3 percent of Wake County's total tax annual revenues. A portion of these funds is retained for county operations and the remainder is disbursed to the Wake County's 12 cities or municipalities to fund their respective operating budgets. Approximately 58 percent of Wake County's General Fund is generated by real and personal property tax generated by the HNP. Dispersal of General Fund revenues are as follows: Education: 32.2 percent, Human services: 26.6 percent, Capital and debt: 20.2 percent, General administration: 6.6 percent, Sheriff: 5.7 percent, Public safety: 2.7 percent, Community services: 2.7 percent, Environmental services: 1.0 percent, and Other: 1.3 percent. The cumulative impact of property taxes contributes to the overall beneficial economic impact described above in Subsection 5.8.2.1.

5.8.2.3 Social Structure

The social structure for the region is described in Subsection 2.5.2.3. No impacts to the social structure of the region are anticipated as a result of the operation of the new facilities. The operations workforce will largely be from the region (Section 5.8). Therefore, the social structure and patterns observed in the surrounding communities will not experience the effects of a rapid population increase. It is expected that the social structure will remain unchanged during operation and impacts will be SMALL.

5.8.2.4 Housing

The total population of the 80-km (50-mi.) region surrounding the HAR site was 1,973,427 in 2000. The majority of this population was concentrated in the City of Raleigh and Wake County.

As stated in Section 5.8, it is assumed that a majority of the new operations workers will already live within the region and the remaining workforce will relocate to the region.

The 2000 Census indicated that the region has a robust housing market, as shown in the following housing status data (Reference 5.8-016):

- Wake County had 258,953 total housing units. Of this number, 242,040 (93.5 percent) were occupied and 16,913 (6.5 percent) were vacant. Of the occupied housing units, 159,456 (65.9 percent) were occupied by owners and 82,584 (34.1 percent) were occupied by renters.

- Chatham County had 21,358 total housing units. Of this number, approximately 19,741 (92.4 percent) were occupied and 1617 (7.6 percent) were vacant. Of the occupied housing units, 15,239 (77.2 percent) were occupied by owners and 4502 (22.8 percent) were occupied by renters.

- Lee County had 19,909 total housing units. Of this number, approximately 18,466 (92.8 percent) were occupied and 1443 (7.2 percent) were vacant. Of the occupied housing units, 13,235 (66.5 percent) were occupied by owners, and 5231 (26.3 percent) were occupied by renters.

- Harnett County had 38,605 total housing units. Of this number, approximately 33,800 (87.6 percent) were occupied and 4805 (12.4 percent) were vacant. Of the occupied housing units, 23,752 (70.3 percent) were occupied by owners, and 10,048 (29.7 percent) were occupied by renters.

Based on the available housing and the expected commuting, no housing shortages are anticipated as a result of operation of the new facilities, as shown on Table 5.8-3. The abundance of existing housing within the surrounding area will mitigate against effects on rents or prices produced by the operation. Impacts to the local housing market are not anticipated as result of the slight increase in operations workforce and impacts will be SMALL.

5.8.2.5 Education System

It is assumed that the operation of the HAR will not result in an increase in school-age population in the surrounding area. The WCPSS has prepared the “Blueprint for Excellence 2006” to address recent school system expansion plans. The Wake County voters passed a $970-million bond referendum in November 2006 to finance school renovations and new construction. This program will include new school construction and the renovation of existing facilities through the year 2011 (Reference 5.8-015). This plan indicates that there is sufficient capacity for the small increase in population anticipated as a result of the proposed project. SMALL impacts to the educational system are anticipated as a result of increased operations workforce.

5.8.2.6 Recreation

Recreation facilities within the region are described in Subsection 2.5.2.6. Assuming that the majority of the new operations workforce will already live in the region, no additional increase in recreational activities or nearby park visitors is expected as a result of the operation of the HAR and appurtenant facilities.

Park facilities impacted by construction activities and the increase in lake level will be relocated as part of construction process and therefore, will be available for use once the new facility is operational. The increase in lake level required to support the operation of the HAR will result in increased lake area and therefore, will provide additional recreational area for boaters and other water-related activities. The increase in lake area would be more than doubled, resulting in a MODERATE long-term beneficial impact due to the additional recreational opportunities created by the noticeable increase in the surface area of Harris Reservoir.

5.8.2.7 Public Services and Facilities

In general, public facilities are not anticipated to be overcrowded because the majority of the new operations workforce is expected to already live in the region (see Section 5.8). The HAR site is near the larger Raleigh metropolitan area, and therefore, community services are not expected to be directly affected.

It is anticipated that existing public facilities will be able to absorb the small increase in load due to the small influx of people expected. A survey of local water and wastewater supply facilities in the area indicates that there is sufficient capacity to accommodate a potential increase in population in the region. No impacts to public services and facilities are anticipated as a result of the additional operations workforce.

5.8.2.7.1 Security Services

The current facility is heavily secured in accordance with Homeland Security and Nuclear Regulatory Commission (NRC) regulations, and it is assumed that PEC will continue to provide this level of security. Security for the HAR will be integrated into the existing system and the appropriate security training will be conducted. This security service will be expanded to the HAR site.

The Apex Fire Department is comprised of three fire stations (Reference 5.8-017). Apex Fire Station 2 is the closest fire station to the HAR site and is located approximately 4.8 km (3.0 mi.) from the site in New Hill, NC. The Apex Fire Department is staffed by 27 full-time and 4 part-time operations staff, and 40 volunteer fire fighters (Reference 5.8-018). The closest police station is the Holly Springs Police Station, located approximately 11.0 km (6.9 mi.) from the HAR site (Reference 5.8-004). Therefore, existing public facilities will be capable of absorbing any small increase in demand from increased security needs related to operating the HAR.

The closest hospital to the HAR site is WakeMed Cary Hospital. Other hospitals in the region include WakeMed Raleigh, WakeMed North HealthPlex, Duke Raleigh Hospital, and Rex Hospital (Reference 5.8-019). In 2009, WakeMed Cary Hospital will expand to include an additional 42 acute beds (Reference 5.8-020). Wake County Emergency Management Service conducts emergency management drills at WakeMed Raleigh, WakeMed North HealthPlex, and WakeMed Cary Hospitals (Reference 5.8-019).

PEC has consulted with emergency management services (EMS) for Wake, Lee, Chatham, and Harnett counties regarding the proposed expansion of the Harris facility in early 2007. The four county EMS organizations are able to support the emergency plan for the proposed expansion of HAR. Current public services and facilities are sufficient to absorb any incremental growth associated with a small workforce in-migration. Because there is an existing facility, local emergency management agencies have emergency response plans in place for responding to emergency situations. Therefore, operation of the new facilities will have negligible impacts on the public and security services.

5.8.2.7.2 Water and Wastewater Services

The HAR site is located within the Cape Fear River basin. Five water treatment plants (WTPs) and intakes utilize this river basin as described below. Each WTP is permitted on a maximum day demand (MDD) basis.

The average household size is 2.47 people for the State of North Carolina (Reference 5.8-021). The average wastewater flow rate for a 2-person urban residential household is 287.7 liters per capita per day (lpcd) (76 gallons per capita per day [gpcd]), while a 3-person urban residential household is 249.8 lpcd (66 gpcd) (Reference 5.8-022). Based on these data, the average household in North Carolina would generate 672 liters per day (lpd) (177.5 gallons per day [gpd]) of wastewater. It is assumed that 25 percent (193) of the operations workers will move to the region. This additional operations workforce and their families would generate 129,681 mld (34,258 mgd) of wastewater. Based on the current settlement patterns for existing HNP operations workers, the majority of the additional generated wastewater from operation workers and their families would be distributed amongst Wake, Chatham, Lee, and Harnett counties. Therefore, the overall impacts to water and wastewater infrastructure would be SMALL.

Current and projected capacity of water treatment facilities in the area are described below:

- Cary/Apex, Wake County WTP has a permitted capacity of 151 million liters per day (mld) (40 million gallons per day [mgd]) and serves Cary, Apex, Morrisville, Research Triangle Park (RTP) south. The plant is six miles from Jordan Lake, in western Wake County, near US Highway 64. (Reference 5.8-023).

- Chatham County WTP (11 mld [3 mgd]) serves northern Chatham County. The plant is located on the eastern shore of Jordan Lake off US Highway 64. (Reference 5.8-024).

- City of Sanford, Lee County WTP, located above the Buckhorn Dam (45 mld [12 mgd]), serves the City of Sanford, Chatham County East, Lee County WAS District 1, Town of Broadway, and Utilities, Inc. (Carolina Trace) (Reference 5.8-025 and Reference 5.8-026).

- Harnett County Regional WTP (68 mld [18 mgd]) serves unincorporated Harnett County as well as the Harnett County towns of Angier, Coats, Lillington, Linden, and contracts water sales to the Wake County communities of Holly Springs and Fuquay-Varina (Reference 5.8-025 and Reference 5.8-027). The plant is located along the Cape Fear River in the Town of Lillington.

- HNP WTP is located within the exclusion area boundary (EAB).

The North Carolina Department of Environment and Natural Resources (NCDENR), Division of Water Resources, has established water supply allocations from the Cape Fear River Basin, specifically the Cape Fear River upstream of Buckhorn Dam and Jordan Lake. In 2001, the Division of Water Resources reviewed the water demands of the communities utilizing Jordan Lake and downstream to Buckhorn Dam, and concluded the capacity of the watershed was sufficient for projected population demands through at least 2030 (Reference 5.8-025). Water demands for the area and water allocation based on average day demand (ADD) basis are described below:

- Cary, Wake County WTP anticipates an increase in ADD from 15.8 mgd in 2005 (for a population of approximately 130,500) to 18.5 mgd in 2010 (for a projected population of nearly 152,000) and 25.0 mgd in 2020 (for a projected population of nearly 197,000) (Reference 5.8-025).

- Apex, Wake County WTP anticipates an increase in ADD from 11.7 mld (3.1 mgd) in 2005 (for a population of approximately 36,000) to 15.9 mld (4.2 mgd) in 2010 (for a projected population of nearly 49,000) and 23.8 mld (6.3 mgd) in 2020 (for a projected population of nearly 75,000) (Reference 5.8-025).

  This growth will require expansion of the Cary-Apex WTP. An expansion of the plant's treatment capacity to 212 mld (56 mgd) is planned to be completed by 2015 (Reference 5.8-028).

- Chatham County WTP: Chatham County anticipates consolidation of its water system to serve customers county-wide in unincorporated areas. Additionally, the county plans future sales to the Towns of Siler City and Pittsboro, after 2030. In addition to an allocation from Jordan Lake, utilized by the Chatham County WTP, the county receives water for its customers from Pittsboro, Siler City, Sanford, and the Goldston-Gulf Sanitary District. As adjusted by the Division of Water Resources, the anticipated ADD for the county-wide system are expected to increase from 11 mld (2.9 mgd) in 2005 (for a population of approximately 16,000) to 23.5 mld (6.2 mgd) in 2010 (for a projected population of just over 20,500) and 30.7 mld (8.1 mgd) in 2020 (for a projected population of nearly 27,000) (Reference 5.8-025).

This growth will require expansion of the Chatham County WTP. The water treatment plant is anticipated to be expanded to 22.7 mld (6 mgd) in 2008. The expanded WTP will have the ability to expand to 30.3 mld (8 mgd), should it be needed to meet system demand, which should be sufficient for demands through 2020 (Reference 5.8-029).

- City of Sanford, Lee County WTP: Sanford's water system anticipates an increase in ADD from 30.3 mld (8.0 mgd) in 2005 (for a population of approximately 35,000 and substantial commercial demand) to 35.6 mld (9.4 mgd) in 2010 (for a projected population of nearly 41,000 and substantial commercial demand) and 52.0 mld (13.7 mgd) in 2020 (for a projected population of nearly 57,000 and substantial commercial demand) (Reference 5.8-025).

  This growth is expected to require expansion of the City of Sanford WTP by 2010 to 2020 based on a comparison of the MDD to the permitted capacity. The MDD is calculated by multiplying the ADD by the peaking ration. The peaking ration is calculated by dividing the maximum day withdrawal of 36.7 mld (9.7 mgd) by the average day withdrawal of 26.5 mld (7.0 mgd). Using the 2010 ADD (35.6 mld [9.4 mgd]) and the calculated peaking ration (5.3 mld [1.4 mgd]) the 2010 MDD is 51.7 mld (13.7 mgd). As stated above the City of Sanford WTP permitted capacity is 45.4 mld (12 mgd), based on the projected 2010 MDD of 51.7 mld (13.7 mgd), the City of Sanford WTP would need to expand to meet the projected demand in 2010 (Reference 5.8-026).

  The 2020 ADD for the City of Sanford WTP is 51.5 mld (13.6 mgd) and the MDD is 72.0 mld (19.0 mgd) (Reference 5.8-025). Based on the projected 2020 MDD of 72.0 mld (19.0 mgd), the capacity would have to be expanded to meet the projected demand in 2020.

- Harnett County Regional WTP: Harnett County's water system anticipates an increase in ADD from 25.0 mld (6.6 mgd) in 2005 (for a population of approximately 75,000) to 29.1 mld (7.7 mgd) in 2010 (for a projected population of nearly 85,000) and 37.5 mld (9.9 mgd) in 2020 (for a projected population of nearly 110,000) (Reference 5.8-025).

  This growth is expected to require expansion of the Harnett County WTP by 2012. The water treatment plant site has capability of expansion from its current 68.1 mld (18 mgd) capacity to a maximum-day capacity of approximately 90.8 mld (24 mgd) (Reference 5.8-027).

Wastewater treatment facilities in the area include:

- Utley Creek WWTP (23 mld [6 mgd]), the municipal wastewater plant for the Town of Holly Springs, Wake County (Reference 5.8-030).

- Proposed Western Wake Regional Water Reclamation Facility (WRF), which will serve Cary, Apex, Morrisville, and Holly Springs, will have a treatment capacity of 68 mld (18 mgd) on a maximum month average day basis when it begins operation, which is estimated to occur in 2012. The plant will eventually have a treatment capacity of 114 mld (30 mgd) when it is expanded after 2020 (Reference 5.8-031). The plant is anticipated to be constructed west of Apex, near the intersection of US Highway 1 and Shearon Harris Road (Reference 5.8-032).

- Chatham County Bynum WWTP (0.1 mld [0.03 mgd]) serves a total of 26 customers and does not have any plans to expand their wastewater treatment facility. The county has 3130 water service connections with septic systems (Reference 5.8-029).

- City of Sanford, Lee County WWTP (26.1 mld [6.8 mgd]) is the municipal wastewater plant for the City of Sanford that serves 7714 customers and does not have any plans to expand their wastewater treatment facility. The City of Sanford has 5610 water service connections with septic systems (Reference 5.8-026).

- Harnett County’s North Harnett Regional WWTP (21.2 mld [5.6 mgd]), the municipal wastewater plant for Lillington, Angier, and other areas of unincorporated Harnett County, serves 3475 customers and has 26,000 septic systems. This wastewater treatment facility does have plans to expand by 2012 (Reference 5.8-025, Reference 5.8-027, and Reference 5.8-033).

Based on the current and projected water and wastewater infrastructure for Wake, Chatham, Lee, and Harnett counties, there is sufficient capacity to absorb the increase in population from operation activities. Impacts to water and wastewater infrastructure would be SMALL as a result of additional operation workers and their families.

5.8.2.8 Transportation Facilities

A large increase in operations-related traffic is anticipated. Because it is expected that most of the operations workers already live within the 80-km (50-mi.) radius of the plant site, traffic would be divided over the two primary access routes:

- U.S. Highway 1 to New Hill Holleman Road.

- Old U.S Highway 1 to Shearon Harris Road.

U.S. Highway 1 is a four-lane divided (six lanes near Raleigh) limited-access highway from Raleigh past the HNP, and Old U.S. Highway 1 is a two-lane highway that should be able to handle an increase in operations worker-related vehicular traffic. The current operations workforce consists of 754 people at the

HNP and it is projected that there will be an additional 773 operations personnel for the HAR.

To determine the potential impact of additional workers on traffic, average daily traffic counts for the two major transportation corridors near the plant site were obtained from the NCDOT. U.S. Highway 1 and Old U.S. Highway 1 are the most direct routes to the plant site from nearby population centers and are described below:

- **U.S. Highway 1:** At its nearest point, U.S. Highway 1 is 2.1 km (1.3 mi.) from the center of the plant site. The average annual daily traffic (AADT) near the plant site is 18,000 vehicles (Reference 5.8-034).
- **Old U.S. Highway 1:** At its nearest point, Old U.S. Highway 1 is 3.2 km (2.0 mi.) from the center of the plant site. The AADT for Old U.S. Highway 1 near the plant site is 1800 vehicles (Reference 5.8-035).

It is expected that the 1527 operations personnel working at the facility will work in two 12-hour shifts during a 24-hour period. Table 5.8-3 presents a detailed analysis of the estimated daily one-way vehicle trips made to the HAR site per shift. Based on the current shift structure for the operations personnel at the HNP, it is expected that the majority (95 percent) of additional operations workers for the HAR will work during the first shift from 6 am to 6 pm. The remaining 5 percent of workers are expected to work during the second shift from 6 pm to 6 am.

New operations personnel are expected to generate a peak number of 773 vehicles a day during shift change. This shift change would include 39 vehicles leaving the HAR site from the first shift and 734 vehicles entering for the second shift. These trips are anticipated to be distributed over the two primary access routes to and from the HAR site as employees are expected to live in the surrounding areas. Some limited congestion problems may occur as vehicles enter and exit the HAR site when work shifts begin and end. It is assumed that this congestion will last approximately 10 to 15 minutes. U.S. Highway 1 and Old U.S. Highway 1 have sufficient capacity to accommodate the increase in traffic volume from additional operations workers and therefore the impact from traffic will be SMALL.

The transportation impacts will be mitigated where necessary with alternate access routes that may be available in the future, as discussed below. Additionally, it is assumed that some of the operations workforce would carpool to the HAR site.

The proposed Western Wake Parkway will provide additional transportation mobility and capacity when complete. It will be located approximately 14.7 km (9.1 mi.) from the HAR site (Reference 5.8-004). This project (No. R-2635) will provide a new six-lane, controlled access parkway in western Wake County. The roadway will be approximately 20.0 km (12.6 mi.) long and extend the Raleigh

Outer Loop from NC 55 near RTP south to the NC 55 Holly Springs Bypass. The estimated cost of the project is between $435 million and $780 million (Reference 5.8-036 and Reference 5.8-037).

The project is divided into three segments: R-2635A, R-2635B, and R-2635C. Segment R-2635A extends from North of SR1172 (Old Smithfield Road) between Apex and Holly Springs at NC 55 to south of U.S. Highway 1; segment R-2635B begins south of U.S. Highway 1 and extends to south of U.S. Highway 64; and segment R-2635C travels from south of U.S. Highway 64 to NC55, which is north of Cary, NC (Reference 5.8-038). Segments R-2635A and R-2635B are scheduled for construction in 2010 and are projected to be open to traffic in 2012. Segment R-2635C is scheduled for construction at the beginning of 2008 and is projected to be open in 2011 (Reference 5.8-039).

Progress Energy has initiated discussion with the DOT regarding county and state roadway impacts due to increased lake levels in the Harris Reservoir required for operations of the HAR. A Transportation Impact Analysis (TIA) will be completed by Progress Energy to evaluate construction and operational road impacts. As part of this process, a temporary access road at the intersection of U.S. Highway 1 and Shearon Harris Road will be evaluated. This access road would be used during construction of the HAR.

Some roads in the Harris Reservoir area will have to be reconstructed or relocated to accommodate the increased water level of Harris Reservoir, as discussed in more detail in Subsection 5.1.1.2.2.4.

5.8.2.9 Distinctive Communities

As stated in Subsection 2.5.2.9, there are no distinctive populations in the area and impacts will be SMALL. The population is fairly homogeneous, largely white, and not dominated by a particular ethnic group.

5.8.2.10 Agriculture

Wake County government shows the HAR site as zoned industrial and light residential (Reference 5.8-040). Some nearby areas, however, are used for silviculture or timber management (Reference 5.8-041). The Chatham County zoning code identifies the area surrounding U.S. Highway 1 and Old U.S. Highway 1 as low density/agricultural use (Reference 5.8-042). Also, the 64.5-km (40.1-mi.) shoreline of Harris Reservoir is mostly wooded and the 1820.7 ha (44,992 ac. or 70.3 mi.^{2}) drainage area is mostly rolling hills with land used primarily for forestry and agriculture. The conversion of areas from forestry or agricultural purposes to residential uses continues in many areas of the drainage. Because the land impacted by operation of the new facilities will be limited to the HAR and preferentially the existing transmission ROW, SMALL impacts to agricultural lands are anticipated.

5.8.3 ENVIRONMENTAL JUSTICE

This subsection evaluates the potential for disproportionate impacts to low-income and minority populations that could result from the operation of the new facilities. Environmental Justice involves evaluating whether there is a disproportionate impact to low-income or minority populations as a result of the project. A disproportionate impact to these existing populations exists when they endure more than their “fair share” of industrial facilities (Reference 5.8-043).

Environmental justice issues also include the environmental health effects of air and noise pollution on low-income and minority populations. Some low-income populations augment their existing incomes with subsistence fishing or farming. Such activities, if impacted by operation of the new facilities, may result in disproportionate impacts to low-income populations. Subsistence fishing and farming takes place in primarily rural areas. While the majority of the immediate area surrounding the HAR is undeveloped game lands or recreational areas, subsistence fishing is not expected to occur in the area because of the steep slopes of the bank, forested shoreline, and limited accessibility unless traveling by boat. Subsistence agriculture may include growing small vegetable gardens or growing and collecting agricultural products for resale. Collection of pine straw for resale as landscaping material could be considered subsistence farming in this area. Because of the heavily wooded steep slopes of the shoreline, collection of pine straw as a method of subsistence farming, however, is not expected to occur in this area.

Operation of the new facilities will meet the criteria and standards set forth in applicable local, regional, state, and federal regulations. Therefore, no disproportionately high or adverse impacts on minority and low-income populations are anticipated as a result of operation of the facility.

Analysis of census data indicates that no disproportionate impacts to low-income populations or minority populations in the region (as defined by the U.S. Department of Health and Human Services) will occur as a result of operation of the proposed facility (Reference 5.8-043).

5.8.3.1 Racial, Ethnic, and Special Groups

The detailed analysis of the region shows no disproportionate impacts to minority populations. Baseline data for racial, ethnic, and special groups is defined in ER Section 2.5.

Based on the information given in Subsections 2.5.2.3 and 2.5.4.1, there are no special groups located within the region. No impacts to minority, ethnic, or special groups are anticipated as a result of operation of the new facilities. Furthermore, no pathways were identified that may result in disproportionate environmental impacts on minority populations. Impacts will be SMALL.

5.8.3.2 Income Characteristics

Census block data for household incomes were evaluated to identify low-income populations.(1) The national average for the low-income population is 12.4 percent and the North Carolina average is 12.3 percent (Reference 5.8-044).

No impacts to low-income populations are anticipated as a result of the operation of the HAR or appurtenant facilities. No pathways were identified that may result in disproportionate environmental impacts on low-income populations. Impacts will be SMALL.

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Table 5.8-1
Estimated Daily Operations Personnel

Operation	Personnel
Day-to-Day Employees	483
Day-to-Day Contractors	78
E&E Center	57
Security Personnel	136
Current Total Population	754
Subtotal Two New Reactors	773
Total with existing	1527

Table 5.8-2 [Not Used]

Table 5.8-3
Housing Units Needed for New Operations Personnel

County	Total Housing Units	Occupied Housing Units	Unoccupied Housing Units	Vacancy of Housing Units	Needed Housing Units [(a)]
Wake	258,953	242,040	16,913	6.5%	119
Chatham	21,358	19,741	1617	7.6%	12
Lee	19,909	18,466	1443	7.2%	31
Harnett	38,605	33,800	4805	12.4%	14
Other [(b)]	N/A	N/A	N/A	N/A	17

Notes:
a) Number of needed housing units is based on the assumption that 25 percent (193 out of 773 total new workers) of the new operations workforce will be in-migrants. Out of the 193 in-migrants, the projected residential settlement by county is based on current residential settlement patterns of the HNP workforce.

b) “Other” represents the total distribution among other counties within the region.

N/A = Data not available

Source: Reference 5.8-016

Table 5.8-4
Estimated Daily One-Way Vehicle Trips

Work Shifts	Existing Commuters	Additional Commuters	Total Trips
Total Operations Personnel	754	773	1527
First Shift (a)	716	734	1450
Second Shift (b)	38	39	77

Notes:
a) Assumes 95 percent operations personnel will work for the first shift.

b) Assumes 5 percent operations personnel will work for the second shift.

5.9 DECOMMISSIONING

In accordance with NUREG-1555, Section 5.9, this subsection provides an analysis and evaluation of decommissioning the HAR, which will be co-located with the HNP.

A license to operate a nuclear power plant is issued for a term not to exceed 40 years, from the date of the issuance. At the end of the specified period, the operator of a nuclear power plant must renew the license for another time period, or must decommission the facility. Decommissioning is defined as "permanently removing a nuclear facility from service and reducing radioactive material on the licensed site to levels that would permit termination of the NRC license." Decommissioning must occur because NRC regulations do not permit an operating license holder to abandon a facility after ending operations.

There are specific regulatory actions that the NRC and a licensee must take to decommission a nuclear power facility. In addition, there are radiological criteria that must be met for license termination. One regulatory action that is required is that the NRC prohibits licensees from performing decommissioning activities that result in significant environmental impacts not previously reviewed. Therefore, NRC has indicated in the Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities, NUREG-0586 that licensees for existing reactors can rely on the findings of a generic environmental impact statement (GEIS) to obtain an understanding of the type and magnitude of environmental impacts associated with decommissioning activities for the existing fleet of domestic nuclear power reactors. In addition, the U.S. Department of Energy (USDOE) funded a study that presents estimates of the costs to decommission the advanced reactor designs following a scheduled cessation of plant operations (Reference 5.9-001). These regulatory actions, radiological criteria requirements, and decommissioning activities apply to the existing fleet of power reactors and to advanced reactors such as the reactor(s) for the HAR.

An applicant for a license to operate a nuclear power facility is required to provide a report containing a certification that financial assurance for radiological decommissioning will be provided. The cost estimate amount may be based on a cost estimate for decommissioning the facility that may be more, but not less, than that given in the table 10 CFR 50.75(c)(1). This requirement ensures that a licensee will be financially able to radiologically decommission a facility when it ceases to produce power. Further information relating to the decommissioning process (such as a description of the decommissioning process and schedule) is not required until after permanent cessation of operation and is not expected during the initial licensing or license-renewal phases.

The following subsections summarize the decommissioning GEIS, the USDOE study on decommissioning costs and the cost analysis of decommissioning Westinghouse Electric Company, LLC's (Westinghouse's) AP1000 Reactor (AP1000) at the HAR site.

5.9.1 NRC GENERIC ENVIRONMENTAL IMPACT STATEMENT REGARDING DECOMMISSIONING

The NRC's GEIS on decommissioning of nuclear facilities was written to provide an analysis of environmental impacts from decommissioning activities that can be treated generically so that decommissioning activities for commercial nuclear power reactors conducted at specific sites will be bounded, to the extent practicable, by this and appropriate previously issued environmental impact statements. Activities and impacts that NRC considered to be within the scope of the GEIS include:

- Activities performed to remove the facility from service once the licensee certifies that the facility has permanently ceased operations, including organizational changes and removal of fuel from the reactor.
- Activities performed in support of radiological decommissioning, including decontamination and dismantlement (D&D) of radioactive structures, systems, and components (SSCs), and any activities required to support the decontamination and dismantlement process such as isolating the spent fuel pool to reduce the scope of required safeguards and security systems so D&D can proceed on the balance of the facility without affecting the spent fuel.
- Activities performed in support of dismantlement of nonradiological SSCs, such as diesel generator buildings and cooling towers.
- Activities performed up to license termination and their resulting impacts as provided by the definition of decommissioning, including shipment and processing of radioactive waste.
- Impacts that are nonradiological, occurring after license termination from activities conducted during decommissioning.
- Activities related to release of the facility.
- Impacts to human health from radiological and nonradiological decommissioning activities.

Studies of social and environmental effects of decommissioning large commercial power generating units have not identified any significant impacts beyond those considered in the GEIS on decommissioning and the site-specific final environmental impact statement (FEIS) for the facility. The NRC's GEIS on decommissioning of nuclear facilities evaluates the environmental impact of the following three decommissioning methods:

- **DECON** – The equipment, structures, and portions of the facility and site that contain radioactive contaminants are removed or decontaminated to a level that permits termination of the license shortly after cessation of operations.

- **SAFSTOR** – The facility is placed in a safe stable condition and maintained in that state (safe storage) until it is subsequently decontaminated and dismantled to levels that permit license termination. During SAFSTOR, a facility is left intact, but the fuel is removed from the reactor vessel and radioactive liquids are drained from systems and components and then processed. Radioactive decay occurs during the SAFSTOR period, thus reducing the quantity of contaminated and radioactive material that must be disposed of during the decontamination and dismantlement of the facility at the end of the storage period.

- **ENTOMB** – This alternative involves encasing radioactive structures, systems, and components in a structurally long-lived substance, such as concrete. The entombed structure is appropriately maintained, and continued surveillance is carried out until the radioactivity decays to a level that permits termination of the license.

NRC regulations do not require the applicant to inform the NRC of its plans for decommissioning the facility at either the construction permit or operating license stage; consequently, no definite plan for the decommissioning of the plant has been developed at this time. Decommissioning plans are required (by 10 CFR 50.82) after a licensee has determined to permanently cease operations.

General environmental impacts associated with decommissioning are summarized as follows. According to the NRC, decommissioning a nuclear facility has a positive environmental impact. The major environmental impact, regardless of the specific decommissioning option selected, is the commitment of small amounts of land for waste burial in exchange for the potential reuse of the land where the facility is located. The air quality, water quality, and ecological impacts of decommissioning are expected to be substantially smaller than those of power plant construction or operation because the level of activity and the releases to the environment are expected to be smaller during decommissioning than during construction and operation.

Decommissioning will generate radiological impacts associated with the transportation of radioactive material, which should be no different from those associated with transportation impacts during normal facility operation. Also, studies indicate that occupational radiation doses can be controlled to levels comparable to occupational doses experienced with operating reactors through the use of appropriate work procedures, shielding, and remotely controlled equipment. To date, experience at decommissioned facilities has shown that the occupational exposures during the decommissioning period are comparable to those associated with refueling and routine maintenance of the facility when operational.

5.9.2 USDOE STUDY ON DECOMMISSIONING COSTS

USDOE commissioned a study that presents estimates of the costs to decommission the advanced reactor designs following a scheduled cessation of plant operations. Four reactor types were evaluated in the study: the Toshiba and General Electric Advanced Boiling Water Reactor, the General Electric Economic Simplified Boiling Water Reactor, the AP1000, and the Atomic Energy of Canada, Limited’s Advanced CANDU Reactor. The cost analysis described in the study is based upon the prompt decommissioning alternative, or DECON as defined by the NRC. The DECON alternative is also the basis for the NRC funding regulations and the use of the DECON alternative for the advanced reactor designs facilitates the comparison with NRC’s own estimates and financial provisions (Reference 5.9-001).

The cost estimates prepared for decommissioning the advanced reactor designs consider the unique features of a generic site, including the nuclear steam supply systems, power generation systems, support services, site buildings, and ancillary facilities The cost estimates are based on numerous fundamental assumptions, including regulatory requirements, project contingencies, and low-level radioactive waste disposal practices. The primary cost contributors are either labor-related or associated with the management and disposition of the radioactive waste. (Reference 5.9-001)

The USDOE study concluded that with consistent operating and management assumptions, the total decommissioning costs projected for the advanced reactor designs are comparable to those projected for operating reactors with appropriate reductions in costs due to reduced physical plant inventories (Reference 5.9-001).

5.9.3 DECOMMISSIONING COST ANALYSIS

As stated in NUREG, Section 5.9, applicants are required to submit a report that contains a certification that financial assurance for radiological decommissioning will be provided. To provide this assurance, the regulation requires that two factors be considered: the amount of funds needed for decommissioning; and the method used to provide the financial assurance . At its discretion, a power reactor licensee may submit a certification based either on the formulas provided in 10 CFR 50.75(c)(1) and (2) or, when a higher funding level is desired, on a facility-specific cost estimate that is equal to or greater than that calculated in the formula in 10 CFR 50.75(c)(1) and (2). COLA Part I contains PEC’s report on financial assurance for radiological decommissioning.

The amount of funding stated in the certification may be based on a cost estimate for decommissioning the facility. Minimum certification funding amounts required to demonstrate reasonable assurance of funds are located in 10 CFR 50.75(c)(1)(i). These minimum funding amounts are based on reactor types (pressurized-water reactor vs. boiling-water reactor) and on the power level of the reactor. Adjustment factors are also provided in 10 CFR 50.75(c)(2) based on escalation factors for labor, energy, and waste burial costs. The proposed reactor for use at the HAR is the AP1000, a Westinghouse-designed pressurized water reactor with a core power rating of 3400 MWt.

As stated in the NRC's Regulatory Guide 1.159, the certification amounts in 10 CFR 50.75(c)(1) act as threshold review levels. While not necessarily representing the actual cost of decommissioning for specific reactors, these certification amounts provide assurance that licensees are able to demonstrate adequate financial responsibility in that the bulk of the funds necessary for a safe decommissioning are being considered and planned for early in facility life, thus providing adequate assurance that the facility will not become a risk to public health and safety when it is decommissioned.

The minimum certification funding amount required to demonstrate reasonable assurance of funds was calculated by PEC using the formula delineated in 10 CFR 50.75(c)(1)(i) and the escalation indices provided in 10 CFR 50.75(c)(2) . The funding calculations can be found in COLA Part I, which contains PEC's report on financial assurance for radiological decommissioning.

PEC certifies that they possess the financial wherewithal to perform decommissioning (for direct disposal with vender option) of the HAR. The per unit decommissioning cost is estimated to be $368,569,138 (in March 2007 dollars) PEC and its parent company, Progress Energy, Inc., have sufficient financing capacity to fund this project, either through existing credit facilities or access to the capital markets capable of securing the capital needed to fund this project. Funding of the decommissioning costs will be comprised of one or more of the financial assurance instruments described in 10 CFR 50.75(e)(1).

5.9.4 SUMMARY AND CONCLUSIONS

The NRC has indicated that licensees for existing nuclear power reactors can rely on the findings of a generic environmental impact statement in order to obtain an understanding of the type and magnitude of environmental impacts associated with decommissioning the existing fleet of domestic nuclear power reactors. The major environmental impact associated with decommissioning is the commitment of small amounts of land for waste burial in exchange for the potential reuse of the land where the facility is located. The air quality, water quality, and ecological impacts of decommissioning are expected to be substantially smaller than those of power plant construction or operation because the level of activity and the releases to the environment are expected to be smaller. Decommissioning will generate radiological impacts associated with the transportation of radioactive material, but those should be no different from those associated with transportation impacts during normal facility operation. Overall, decommissioning a nuclear facility has a positive environmental impact.

The USDOE compared activities required to decommission existing reactors to those activities required for decommissioning advanced reactors and presented cost estimates for the decommissioning of the advanced reactor designs. The

USDOE study concluded that with consistent operating and management assumptions, the total decommissioning costs projected for the advanced reactor designs are comparable to those projected for operating reactors with appropriate reductions in costs due to reduced physical plant inventories.

An applicant for a license to operate a nuclear power facility is required to provide a report containing a certification that financial assurance for radiological decommissioning will be provided. The cost estimate amount may be based on a cost estimate for decommissioning the facility that may be more, but not less, than that given in the table 10 CFR 50.75(c)(1). The purpose of this requirement is to ensure that a licensee will be financially able to radiologically decommission a facility when it ceases to produce power.

The minimum certification funding amounts required to demonstrate reasonable assurance of funds were calculated using the formula delineated in 10 CFR 50.75(c)(1)(i) and the escalation indices provided in 10 CFR 50.75(c)(2). PEC certifies that financial assurance for decommissioning HAR will be provided in an amount of $368,569,138 (in March 2007 dollars) for each HAR Unit for the direct disposal with vendor option. PEC and its parent company, Progress Energy, Inc., have sufficient financing capacity to fund this project, either through existing credit facilities or access to the capital markets capable of securing the capital needed to fund this project.

5.9.5 REFERENCES

5.9-001 U.S. Department of Energy, “Study of Construction Technologies and Schedules, O&M Staffing and Cost, and Decommissioning Costs and Funding Requirements for Advanced Reactor Designs,” prepared by Dominion Energy, Inc., Bechtel Power Corporation, TLG, Inc., and MPR Associates for United States Department of Energy Cooperative Agreement DE-FC07-031D14492, Contract DE-AT01-020NE23476, May 27, 2004.

5.10 MEASURES AND CONTROLS TO LIMIT ADVERSE IMPACTS DURING OPERATION

In accordance with NUREG-1555, Section 5.10, this section summarizes potential adverse environmental impacts from the operation of the HAR, along with associated measures and controls to limit those adverse impacts.

5.10.1 ADVERSE ENVIRONMENTAL IMPACTS

PEC is committed to limiting, minimizing, and reducing adverse environmental impacts during operation activities wherever and whenever feasible and practical. The operation of the HAR facilities will result in certain adverse environmental impacts.

The “Potential Impact Significance” columns in Table 5.10-1 list the elements identified in NUREG-1555, Section 5.10 that relate to operation activities. The following list identifies elements with potential adverse environmental impacts that may be encountered during operation of the proposed facilities:

- Noise
- Erosion and Sediment
- Air Quality
- Traffic
- Effluents and Wastes
- Surface Water
- Groundwater
- Land-Use
- Water-Use
- Terrestrial Ecosystem
- Aquatic Ecosystem
- Socioeconomic
- Radiation Exposure to Workers
- Other (Site-Specific)

Table 5.10-1 lists and describes facility operational impacts that require mitigation along with corresponding measures and controls that may be committed to limit potential adverse environmental impacts. The listed measures and controls have been designed to achieve a practical level of mitigation that can be achieved through implementation. Further, the listed measures and controls are reasonable, specific, and unambiguous; and involve methods and techniques that are appropriate, achievable, and can be verified through subsequent field reviews and inspections. Finally, the environmental, economic, and social costs of implementing the measures and controls have been thoughtfully balanced against the expected benefits.

Some of the listed operational impacts do not require mitigation and are identified accordingly within the table. Some of the listed operational impacts for which mitigation is not practical have been identified in the table and are further discussed in Section 10.1 (Unavoidable Adverse Environmental Impacts During Operation) of this ER.

Table 5.10-1 uses the NRC’s three-level standard of significance levels for each element (i.e., [S]MALL, [M]ODERATE, or [L]ARGE). These significance levels were determined by evaluating the potential effects after any controls or mitigation measures had been implemented. The following significance levels used in the evaluation were developed using the Council on Environmental Quality guidelines set forth in the footnotes to Table B-1 of Title 10 of the CFR Part 51, Subpart A, Appendix B:

- **SMALL**. Environmental effects are not detectable or are so minor 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.

The impact categories evaluated in this chapter are the same as those used in the Generic Environmental Impact Statement for License Renewal of Nuclear Plants (GEIS), NUREG-1437, Volumes 1 and 2.

5.10.2 MEASURES AND CONTROLS TO LIMIT ADVERSE IMPACTS DURING OPERATION OF THE PROPOSED FACILITY

The following measures and controls may limit potential adverse environmental impacts related to operation activities for the HAR:

- Compliance with local, regional, state (i.e., North Carolina), tribal, and federal laws, ordinances, and regulations intended to prevent or minimize adverse environmental effects (e.g., solid waste management, erosion and sediment control, air emissions, noise control, stormwater management, spill response and cleanup, and hazardous waste management).

- Compliance with applicable requirements of existing permits and licenses for the operation of the HNP and other permits and licenses required for operation of the HAR.

- Compliance with existing PEC processes or procedures applicable to the operation of environmental compliance activities for the HAR site (e.g., solid waste management, hazardous waste management, and spill prevention and response).

- Identification of environmental resources and potential effects during the development of this ER.

Operation activities at the HAR site will conform to the goals and criteria set forth in the regulatory guidelines and requirements. PEC will adhere to applicable local, regional, state, tribal, and federal requirements during operation activities. Because technology by the time a new facility is constructed, the listed commitments of potential mitigation measures and controls within Table 5.10-1 are subject to change. The mitigation techniques presented herein represent BMPs or standard industrial practices at the time of the HAR COLA submittal.

Table 5.10-1 (Sheet 1 of 13)
Summary of Measures and Controls to Limit Adverse Impacts During Operation

	Potential Impact Significance$^{(a), (b)}$															
Section Reference	**Noise**	**Erosion and Sediment**	**Air Quality**	**Traffic**	**Effluents and Wastes**	**Surface Water**	**Groundwater**	**Land-Use$^{(c)}$**	**Water-Use$^{(d)}$**	**Terrestrial Ecosystem**	**Aquatic Ecosystem**	**Socioeconomic**	**Rad Exp to Wkrs**	**Other (Site-Specific)**	**Impact Description or Activity**	**Measures and Controls to Limit Adverse Impacts**
5.1 Land-Use Impacts																
5.1.1 HAR Site and Vicinity								S							Direct impacts from operation of the proposed facility and appurtenant facilities.	Mitigation measures specific to the HAR site are described in the following sections.
5.1.1.1 Long-Term Restrictions and Physical Changes to Land Use of the Site and Vicinity Resulting from Operation				S				S		S to M	S				1. Increase in pool level of Harris Reservoir. 2. Impacts on transportation system from an increased workforce. 3. Cooling and heat dissipation system. 4. Harris Lake makeup water system. The MODERATE impact noted is discussed specifically in Subsection 5.1.1.1.1.1.	1. Erosion control and stabilization measures; follow permitting requirements; limit vegetation removal; relocate structures or facilities to higher ground. 2. Modifications to existing roads and highways. 3. Compliance with applicable permitting requirements. 4. Appropriate measure will be taken to minimize any disturbances during routine maintenance of structures, ROWs, and access roads; vegetation maintenance; waste generation and transport.
5.1.1.2 Short-Term Physical Changes in Land Use of the Site and Vicinity and Plans for Mitigation of Adverse Impacts								S				S			1. Water Quality 2. Recreational Areas 3. Roads 4. PEC Facilities 5. Municipal Facilities	1. Mitigation and BMPs will limit the potential water quality effects to surface water and groundwater. 2. Relocate recreational areas to higher elevations. 3. Reconstruct roads along with associated infrastructure. 4. Relocate or modify PEC facilities. 5. Relocate and modify firing range.

Table 5.10-1 (Sheet 2 of 13)
Summary of Measures and Controls to Limit Adverse Impacts During Operation

	Potential Impact Significance(a), (b)															
Section Reference	**Noise**	**Erosion and Sediment**	**Air Quality**	**Traffic**	**Effluents and Wastes**	**Surface Water**	**Groundwater**	**Land-Use(c)**	**Water-Use(d)**	**Terrestrial Ecosystem**	**Aquatic Ecosystem**	**Socioeconomic**	**Rad Exp to Wkrs**	**Other (Site-Specific)**	**Impact Description or Activity**	**Measures and Controls to Limit Adverse Impacts**
5.1.2 Transmission Corridors and Off-Site Areas								S							Routine vegetation inspection and clearing activities in the ROW and temporary access road construction for temporary maintenance needs.	An approved soil erosion and sediment control plan will be followed.
5.1.3 Historic Properties														S	Impacts to historic properties and archaeological sites.	Comply with Section 106 of National Historic Preservation Act.
5.2 Water-Related Impacts																
5.2.1 Hydrologic Alterations and Plant Water Supply						S									Adding volume to Harris Reservoir and withdrawing water from the Cape Fear River.	Mitigation measures specific to the hydrologic alterations and plant water supply are described in the following sections.
5.2.1.1 Freshwater Streams		S				S									Adequate water supply from freshwater streams, Harris Reservoir, or groundwater to meet water withdrawal criteria.	Erosion control and stabilization measures; follow permitting requirements during drought conditions.
5.2.1.2 Lakes and Impoundments		S				S			S						Impacts associated with water quality and water use.	Relocate roads and recreational facilities to higher elevations and follow permitting requirements during lake filling activities.
5.2.1.3 Groundwater							S								Lowering of the existing water table around the proposed facilities.	Groundwater will not be used as a source of water and a monitoring program will be initiated to evaluate groundwater resources.
5.2.1.4 Wetlands										S					Inundation of wetlands along the perimeter of the Harris Reservoir.	New wetlands will be created and impacts will be limited by compliance with applicable state and federal laws.

Table 5.10-1 (Sheet 3 of 13)
Summary of Measures and Controls to Limit Adverse Impacts During Operation

	Potential Impact Significance$^{(a), (b)}$															
Section Reference	**Noise**	**Erosion and Sediment**	**Air Quality**	**Traffic**	**Effluents and Wastes**	**Surface Water**	**Groundwater**	**Land-Use$^{(c)}$**	**Water-Use$^{(d)}$**	**Terrestrial Ecosystem**	**Aquatic Ecosystem**	**Socioeconomic**	**Rad Exp to Wkrs**	**Other (Site-Specific)**	**Impact Description or Activity**	**Measures and Controls to Limit Adverse Impacts**
5.2.1.5 Conclusion		S				S			S						See impact description or activities from Subsection 5.2.1 above.	See measures and controls from Subsection 5.2.1 above.
5.2.2.1 Freshwater Streams						S									1. Water availability 2. Water quality	1. Makeup water withdrawals can be decreased or halted temporarily during low-flow conditions. 2. Compliance with applicable state and federal laws.
5.2.2.2 Lakes and Impoundments						S			S						1. Water availability 2. Water quality	1. Makeup water withdrawals can be decreased or halted temporarily during low-flow conditions. 2. Compliance with applicable state and federal laws.
5.2.2.3 Groundwater Use							S								No anticipated impacts.	No specific mitigation measures are required.
5.2.2.4 Conclusions						S			S						See impact description or activities from Subsection 5.2.2 above.	See measures and controls from Subsection 5.2.2 above.
5.2.3 Additional Impact Analysis Methods						S			S						No anticipated impacts.	No specific mitigation measures are required.
5.3 Cooling System Impacts																
5.3.1.1 Hydrodynamic Descriptions and Physical Impacts											S				Creation of velocity flow fields in the vicinity of the raw water pumphouse.	Orientation of the raw water pumphouse and canal; low approach velocities; submerged weir across intake canal.

Table 5.10-1 (Sheet 4 of 13)
Summary of Measures and Controls to Limit Adverse Impacts During Operation

	Potential Impact Significance[(a), (b)]															
Section Reference	Noise	Erosion and Sediment	Air Quality	Traffic	Effluents and Wastes	Surface Water	Groundwater	Land-Use[(c)]	Water-Use[(d)]	Terrestrial Ecosystem	Aquatic Ecosystem	Socioeconomic	Rad Exp to Wkrs	Other (Site-Specific)	Impact Description or Activity	Measures and Controls to Limit Adverse Impacts
5.3.1.2 Aquatic Ecosystems											S				1. Flow capacity-based limits. 2. Impingement. 3. Entrainment. 4. Protected species and enhanced Harris Lake makeup water system pumphouse design features. 5. Impacts due to fluctuations in lake level.	1. Compliance with applicable permitting requirements. 2. Compliance with applicable permitting requirements. 3. Compliance with applicable permitting requirements and location of intake port. 4. Compliance with applicable permitting requirements. 5. No anticipated impacts.
5.3.2 Discharge System		S			S	S					S				Impacts from operation of the discharge system.	Mitigation measures specific to the discharge system are described in the following sections.
5.3.2.1 Thermal Description and Physical Impacts		S			S	S									Impacts from thermal discharge.	Compliance with applicable state permitting requirements and implementation of an operational monitoring program.

Table 5.10-1 (Sheet 5 of 13)
Summary of Measures and Controls to Limit Adverse Impacts During Operation

	Potential Impact Significance(a), (b)															
Section Reference	Noise	Erosion and Sediment	Air Quality	Traffic	Effluents and Wastes	Surface Water	Groundwater	Land-Use(c)	Water-Use(d)	Terrestrial Ecosystem	Aquatic Ecosystem	Socioeconomic	Rad Exp to Wkrs	Other (Site-Specific)	Impact Description or Activity	Measures and Controls to Limit Adverse Impacts
5.3.2.2 Aquatic Ecosystems						S					S				1. Thermal Effects 2. Chemical Impacts 3. Physical Impacts	1. Minimize thermal impact through plant design and compliance with applicable state permitting requirements. 2. Compliance with applicable state permitting requirements and performing toxicity tests on live organisms. 3. Compliance with applicable state permitting requirements.
5.3.3.1 Heat Dissipation to the Atmosphere			S											S	1. Length and frequency of elevated plumes. 2. Ground-level fogging and icing. 3. Solids deposition. 4. Cloud shadowing and additional precipitation. 5. Interaction with existing pollution sources. 6. Ground-level humidity increase.	1. Height of the natural draft cooling tower. 2. No mitigation measures are anticipated. 3. No mitigation measures are anticipated. 4. No mitigation measures are anticipated. 5. No mitigation measures are anticipated. 6. No mitigation measures are anticipated.

Table 5.10-1 (Sheet 6 of 13)

Summary of Measures and Controls to Limit Adverse Impacts During Operation

	Potential Impact Significance[(a), (b)]															
Section Reference	Noise	Erosion and Sediment	Air Quality	Traffic	Effluents and Wastes	Surface Water	Groundwater	Land-Use[(c)]	Water-Use[(d)]	Terrestrial Ecosystem	Aquatic Ecosystem	Socioeconomic	Rad Exp to Wkrs	Other (Site-Specific)	Impact Description or Activity	Measures and Controls to Limit Adverse Impacts
5.3.3.2 Terrestrial Ecosystem										S					1. Salt drift 2. Vapor plumes and icing 3. Precipitation modifications 4. Noise 5. Avian collisions 6. Reservoir expansion	1. No mitigation measures are anticipated. 2. No mitigation measures are anticipated. 3. No mitigation measures are anticipated. 4. No mitigation measures are anticipated. 5. No mitigation measures are anticipated. 6. Shoreline vegetation will develop overtime along the proposed perimeter of the expanded Harris Reservoir.
5.3.4.1 Thermophilic Microorganism Impacts														S	Potential human contact of microorganisms associated with cooling towers and thermal discharges.	Biocide treatment of the cooling tower basin and workers in high risk areas will follow the applicable HAR health and safety plans.
5.3.4.2 Noise Impacts from Cooling Tower Operation	S														Noise impacts from the proposed plant operations.	No mitigation measures are anticipated.
5.4 Radiological Impacts of Normal Operation																
5.4.1.3 Direct Radiation from the HAR													S		Human exposure to direct radiation from normal operation.	Minimize direct radiation impact through plant design.
5.4.3 Impacts to Members of the Public														S	Impacts to members of the public from operation of the new units.	Mitigation measures specific to impacts to members of the public are described in the following section.

Table 5.10-1 (Sheet 7 of 13)

Summary of Measures and Controls to Limit Adverse Impacts During Operation

	Potential Impact Significance$^{(a), (b)}$															
Section Reference	**Noise**	**Erosion and Sediment**	**Air Quality**	**Traffic**	**Effluents and Wastes**	**Surface Water**	**Groundwater**	**Land-Use$^{(c)}$**	**Water-Use$^{(d)}$**	**Terrestrial Ecosystem**	**Aquatic Ecosystem**	**Socioeconomic**	**Rad Exp to Wkrs**	**Other (Site-Specific)**	**Impact Description or Activity**	**Measures and Controls to Limit Adverse Impacts**
5.4.4 Impacts to Biota Other than Members of the Public										S	S				Impacts of radiation exposure to biota other than man or members of the public.	Mitigation measures specific to impacts to biota other than members of the public are described in the following sections.
5.4.5 Occupational Radiation Exposures													S		Impacts of occupational radiation exposure to HAR operating personnel.	Minimize direct radiation impact through plant design.
5.5 Environmental Impacts of Waste																
5.5.1.1 Impacts of Discharges to Water					S										1. Liquid effluents containing biocides or chemicals. 2. Demineralized water treatment wastes. 3. Waste treatment facility sanitary wastes. 4. Metal cleaning waste discharges. 5. Treated wastewater (low volume wastes and radwaste). 6. Floor drain systems. 7. Surface drainage and roof drains.	1. Compliance with regulatory and permitting requirements. 2. Compliance with regulatory and permitting requirements. 3. Compliance with regulatory and permitting requirements. 4. Compliance with regulatory and permitting requirements. 5. Compliance with regulatory and permitting requirements. 6. Compliance with regulatory and permitting requirements. 7. Compliance with regulatory and permitting requirements.

Table 5.10-1 (Sheet 8 of 13)
Summary of Measures and Controls to Limit Adverse Impacts During Operation

	Potential Impact Significance$^{(a), (b)}$															
Section Reference	Noise	Erosion and Sediment	Air Quality	Traffic	Effluents and Wastes	Surface Water	Groundwater	Land-Use$^{(c)}$	Water-Use$^{(d)}$	Terrestrial Ecosystem	Aquatic Ecosystem	Socioeconomic	Rad Exp to Wkrs	Other (Site-Specific)	Impact Description or Activity	Measures and Controls to Limit Adverse Impacts
5.5.1.2 Impacts of Discharges to Land					S										1. Nonradioactive solid waste 2. Hazardous wastes 3. Petroleum waste	1. Solid nonradioactive and non-hazardous waste will be disposed of at an off-site, permitted disposal landfill. 2. Compliance with federal and state regulations and permits 3. Collected, stored, and recycled or disposed of in accordance with federal, state, and local regulations.
5.5.1.3 Impacts of Discharges to Air			S		S										Discharge of nonradioactive gaseous effluents.	Compliance with federal, state, and local regulations and permits.
5.5.1.4 Sanitary Waste					S										Discharge of sanitary waste to surface waters.	Compliance with federal and state regulations and permits.
5.5.2.1 Chemical Hazards Impacts					S										1. Mixed waste handling and storage practices 2. Contingency plans, emergency preparedness, and prevention procedures 3. Off-site treatment and disposal	1. Compliance with federal and state regulations and permits. 2. Compliance with federal and state regulations and permits. 3. Compliance with federal and state regulations and permits.

Table 5.10-1 (Sheet 9 of 13)
Summary of Measures and Controls to Limit Adverse Impacts During Operation

	Potential Impact Significance$^{(a), (b)}$															
Section Reference	Noise	Erosion and Sediment	Air Quality	Traffic	Effluents and Wastes	Surface Water	Groundwater	Land-Use$^{(c)}$	Water-Use$^{(d)}$	Terrestrial Ecosystem	Aquatic Ecosystem	Socioeconomic	Rad Exp to Wkrs	Other (Site-Specific)	Impact Description or Activity	Measures and Controls to Limit Adverse Impacts
5.5.2.2 Radiological Hazards Impacts					S								S		Impacts to workers from the handling and storage of mixed waste.	Compliance with federal and state regulations and permits.
5.5.3 Pollution Prevention and Waste Minimization Program					S										Development of a hazardous waste minimization plan.	Mitigation measures specific to a pollution prevention and waste minimization program are described further in Subsection 5.5.3.
5.6 Transmission System Impacts																
5.6.1.1 Natural Ecosystems and Rare, Threatened and End. Species										S					Impacts on terrestrial ecosystems from expansion of existing transmission corridors.	Follow MOU to preserve and protect rare and listed species, follow BMPs, coordination with regulatory agencies, and compliance with permit and regulatory requirements.
5.6.1.2 Agricultural Lands								S							Impacts of transmission corridor expansion on agricultural lands.	Compliance with federal, state and local regulatory requirements and BMPs.
5.6.1.3 Electrical Fields										S					Impacts associated with electrical fields.	Electrical field effects to terrestrial biota are not relevant at less than 765 kV.
5.6.1.4 Avian Collisions										S					Impacts on avian species with transmission lines.	Measures and controls are not required.

Table 5.10-1 (Sheet 10 of 13)
Summary of Measures and Controls to Limit Adverse Impacts During Operation

	Potential Impact Significance$^{(a), (b)}$															
Section Reference	**Noise**	**Erosion and Sediment**	**Air Quality**	**Traffic**	**Effluents and Wastes**	**Surface Water**	**Groundwater**	**Land-Use$^{(c)}$**	**Water-Use$^{(d)}$**	**Terrestrial Ecosystem**	**Aquatic Ecosystem**	**Socioeconomic**	**Rad Exp to Wkrs**	**Other (Site-Specific)**	**Impact Description or Activity**	**Measures and Controls to Limit Adverse Impacts**
5.6.2 Aquatic Impacts										S					Impacts from maintenance of transmission corridors on aquatic ecology.	Implementation of SMZs and BMPs, coordination with appropriate regulatory agencies, and compliance with permit requirements.
5.6.3.1 Electric Shock														S	Impacts associated with electric shock from transmission lines.	Minimal vertical clearances and appropriate grounding.
5.6.3.2 Electromagnetic Field Exposure														S	Impacts associated with electromagnetic fields from transmission lines.	No specific mitigation measures required.
5.6.3.3 Noise	S														Noise impacts associated with transmission lines.	Implement standard designs to minimize noise.
5.6.3.4 Radio and Television Interference														S	Impacts from transmission lines on radio and television reception.	Implement standard design and maintenance practices to minimize interference.
5.6.3.5 Visual Impacts														S	Visual impacts associated with transmission lines.	Existing corridors will be expanded to accommodate new lines minimizing visual impacts.
5.7 Uranium Fuel Cycle Impacts																
5.7.4.1 Land Use								S							Land use impacts associated with the Uranium Fuel Cycle.	Evaluation of impacts as specified in NUREG-1437.
5.7.4.2 Water Use									S						Water use impacts associated with the uranium fuel cycle.	Evaluation of impacts and limitations as specified in NUREG-1437.

Table 5.10-1 (Sheet 11 of 13)
Summary of Measures and Controls to Limit Adverse Impacts During Operation

	Potential Impact Significance(a), (b)															
Section Reference	Noise	Erosion and Sediment	Air Quality	Traffic	Effluents and Wastes	Surface Water	Groundwater	Land-Use(c)	Water-Use(d)	Terrestrial Ecosystem	Aquatic Ecosystem	Socioeconomic	Rad Exp to Wkrs	Other (Site-Specific)	Impact Description or Activity	Measures and Controls to Limit Adverse Impacts
5.7.4.3 Fossil Fuel Effects														S	Impacts associated with fossil fuel combustion to support the uranium fuel cycle.	Evaluation of impacts and limitations as specified in NUREG-1437.
5.7.4.4 Chemical Effluents			S		S										Impacts associated with chemical effluents to support the uranium fuel cycle.	Evaluation of impacts and limitations as specified in NUREG-1437.
5.7.4.5 Radioactive Effluents					S										Impacts associated with the radioactive effluents associated with the uranium fuel cycle.	Evaluation of impacts and limitations as specified in NUREG-1437.
5.7.4.6 Radioactive Waste					S										Impacts of radioactive wastes associated with the uranium fuel cycle.	Compliance with regulatory requirements and limitations.
5.7.4.7 Occupational Dose													S		Impacts associated with occupational dose associated with the uranium fuel cycle.	Compliance with applicable regulatory limits.
5.7.4.8 Transportation														S	Transportation impacts associated with uranium fuel cycle.	Compliance with applicable regulatory limits.
5.8 Socioeconomics																
5.8.1.1 Site and Vicinity												S			Physical impacts of station operation on the site and vicinity.	Communication with appropriate regulatory and planning agencies.
5.8.1.2 Noise	S														Noise impacts associated with station operation.	Use of standard noise control devices and abatement techniques.

Table 5.10-1 (Sheet 12 of 13)
Summary of Measures and Controls to Limit Adverse Impacts During Operation

	Potential Impact Significance(a), (b)															
Section Reference	**Noise**	**Erosion and Sediment**	**Air Quality**	**Traffic**	**Effluents and Wastes**	**Surface Water**	**Groundwater**	**Land-Use(c)**	**Water-Use(d)**	**Terrestrial Ecosystem**	**Aquatic Ecosystem**	**Socioeconomic**	**Rad Exp to Wkrs**	**Other (Site-Specific)**	**Impact Description or Activity**	**Measures and Controls to Limit Adverse Impacts**
5.8.1.3 Air			S												Air quality impacts associated with station operation.	Compliance with applicable regulatory requirements.
5.8.1.4 Aesthetic Disturbances														S	Aesthetic impacts associated with station operation.	Specific measures and controls are not required.
5.8.2.1 Economic Characteristics												S-M			Beneficial economic impacts associated with station operation.	Specific measures and controls are not required.
5.8.2.2 Tax Impacts												S			Beneficial tax impacts associated with station operation.	Specific measures and controls are not required.
5.8.2.3 Social Structure												S			Impacts of station operation on social structure.	Specific measures and controls are not required.
5.8.2.4 Housing												S			Housing impacts associated with station operation.	Specific measures and controls are not required.
5.8.2.5 Education System												S			Impacts of station operation on educational system.	Coordination with local school districts.
5.8.2.6 Recreation												M			Beneficial impacts of station operation on recreation resources.	Specific measures and controls are not required.

Table 5.10-1 (Sheet 13 of 13)
Summary of Measures and Controls to Limit Adverse Impacts During Operation

	Potential Impact Significance(a), (b)															
Section Reference	**Noise**	**Erosion and Sediment**	**Air Quality**	**Traffic**	**Effluents and Wastes**	**Surface Water**	**Groundwater**	**Land-Use(c)**	**Water-Use(d)**	**Terrestrial Ecosystem**	**Aquatic Ecosystem**	**Socioeconomic**	**Rad Exp to Wkrs**	**Other (Site-Specific)**	**Impact Description or Activity**	**Measures and Controls to Limit Adverse Impacts**
5.8.2.7 Public Services and Facilities												S			1. Impacts of station operation on public services and facilities. 2. Security services. 3. Water and wastewater services.	1. Community services exist in sufficient capacity to support operation. 2. Coordination of emergency services in surrounding counties. 3. Consultation with appropriate utilities in the surrounding counties.
5.8.2.8 Transportation Facilities				S											Impacts of station operation on regional transportation.	Coordination with appropriate planning and regulatory agencies an upgrade of impacted roads around the site as necessary.
5.8.2.9 Distinctive Communities												S			Impacts of station operation on distinctive communities.	Specific measure or controls are not required.
5.8.2.10 Agriculture								S				S			Impacts of station operation on agriculture.	Land impacted by operation of the new facilities will be limited to the HAR site.
5.8.3.1 Racial, Ethnic, and Special Groups												S			Impacts of station operation on racial, ethnic and special groups.	Evaluation of minority populations surrounding the HAR site.
5.8.3.2 Income Characteristics												S			Impacts of station operation on income characteristics.	Specific mitigation measures and controls are not needed.

Notes:

a) The assigned potential impact significance levels of (S)mall, (M)oderate, or (L)arge are based on the assumption that mitigation measures and controls would be implemented.

b) A blank in the elements column denotes “no impact” on that specific element because of the assessed activities.

c) Land-Use Protection/Restoration.

d) Water-Use Protection/Restoration.