Aquatic Resource Functional Assessment
in support of the
Harris Advanced Reactor 404(b)(1) Alternatives Analysis

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Prepared for:

Progress Energy
Raleigh, North Carolina

US Army Corps of Engineers®
Wilmington District

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1.0 INTRODUCTION

1.1 Purpose of Evaluation

The purpose of this aquatic resource functional assessment is to provide supporting documentation for changes to aquatic resource functions that may result from two project alternatives evaluated by Progress Energy Carolinas (PEC) for the proposed construction of two additional reactor units. This functional assessment has been prepared in response to comments and request for additional information submitted to the U.S. Nuclear Regulatory Commission (NRC) by the U.S. Army Corps of Engineers (USACE) Wilmington District via letter dated April 15, 2010, based on review of a document entitled "Harris Advanced Reactor (HAR) Section 404(b)(1) Alternatives Analysis (Revision 1)", dated September 2009, which was prepared by Environmental Services, Inc. (ESI) on behalf of PEC. In addition to specific comments requesting additional information on functional changes resulting from flooding streams and wetlands, the USACE indicated that:

> "...in order to fully satisfy our requirements relative to the 404(b)(1) Guidelines, we must describe and compare the loss of aquatic function(s) associated with the flooding of existing streams and wetlands (Harris alternative) vs. the loss of aquatic function, including habitat loss associated with the removal of mature trees (Brunswick alternative) within an existing wetland. We acknowledge that the magnitude of loss between the two alternatives is different; however, we believe that the flooding of existing wetlands and streams could result in greater functional loss than the removal of trees from an existing forested wetland. Accordingly the EIS must adequately describe both the magnitude of loss associated with each of the alternatives (in acres and feet) as well as the expected loss (or changes) of aquatic function associated with each."

The results of the present functional assessment will be incorporated into a revised alternatives analysis document to provide support for compliance with Section 404(b)(1) Alternatives Analysis Guidelines [404(b)(1) Guidelines].

1.2 Alternatives Evaluated

This functional assessment provides information on the expected changes in aquatic resource function associated with the Harris alternative and the Brunswick alternative. General descriptions are provided below for these two alternatives.

1.2.1 Harris Alternative

The Harris alternative involves expansion at the existing Shearon Harris Nuclear Plant (HNP) site, which is located in the southwestern part of Wake County, North Carolina. The existing nuclear facility contains one 900-megawatt electric (MWe) unit with closed-cycle cooling. PEC owns 10,744 acres at the site. The existing facility and associated infrastructure occupies approximately 440 acres of developed land. Cooling water is obtained from the existing Harris Reservoir (also referred to as the Main Reservoir), which is an approximately 3,610-acre reservoir constructed and filled between 1978 and 1983 for the purpose of providing cooling water storage for use by HNP. A second, smaller impoundment, the 360-acre Auxiliary Reservoir, occurs on the Tom Jack Creek arm above Harris Reservoir and serves as a source of water for the emergency service water system for the HNP (COLA ER 1.1.2). Seven transmission lines presently connect the HNP to the PEC electrical grid through an existing switchyard. The transmission lines generally run through 100-foot wide corridors consisting of maintained right-of-way (ROW). Five lines share a short section of corridor immediately south of the switchyard, resulting in a maintained ROW width of approximately 350 feet for this shared section.

The Harris alternative generally consists of three major components: power block and support facilities, cooling water system, and transmission system:

- **Power Block and Support Facilities** - The proposed construction of two new AP1000 reactors will require an additional development footprint of approximately 400 acres for the reactors and associated support infrastructure (power block and support facilities) at the plant site.

- **Cooling Water** - Cooling towers are included in the 400-acre development area, but additional cooling water requirements will include expansion of the existing Harris Reservoir from 220 feet NGVD29 to 240 feet NGVD29 and construction of a makeup water system pipeline from the Cape Fear River to Harris Reservoir. The makeup water system pipeline will extend along approximately 4 miles primarily within an existing ROW. Harris Reservoir will be expanded by approximately 3,570 acres (COLA ER 4.1.2) to provide the water storage determined necessary to meet reliability considerations. The shoreline of Harris Reservoir will change from its current perimeter length of approximately 457,000 feet (86.6 miles) to approximately 784,000 feet (148.5 miles) following inundation (COLA ER 4.1.2). No change will occur to the Auxiliary Reservoir.

- **Transmission System** - The existing seven transmission lines, plus an eighth line planned for 2011 (the new Research Triangle Park Line) will connect HAR 2 to the PEC transmission grid. HAR 2 will connect to the PEC transmission grid utilizing the existing towers, lines, and ROWs that currently support HNP operations (COLA ER 3.7.1.1). Three new lines will be required to connect the 230-kV HAR 3 switchyard to the PEC electrical grid (COLA ER 3.7.1.1). The transmission line upgrade involves three new lines totaling approximately 103 miles in length to connect to the existing Fort Bragg Woodruff Street substation (in northwestern Cumberland County), Erwin substation (in eastern Harnett County), and Wake substation (in eastern Wake County). The proposed routing of the new lines for HAR 3 is being evaluated to be adjacent to or within the existing maintained transmission corridors for the HNP (COLA ER 3.7.1.1).

1.2.2 Brunswick Alternative

The Brunswick alternative involves expansion at the Brunswick Steam Electric Plant (BSEP) site, which is located in the southeastern part of Brunswick County, North Carolina. BSEP currently contains two nuclear units with a once-through cooling system. PEC owns approximately 1,200 acres at the site. The industrial portion of the site comprises approximately 130 acres and consists of generating facilities, office buildings, warehouses, parking lots, and equipment storage areas. Additional land is occupied by intake and outfall canals, dredge disposal sites for maintenance of the intake and outfall canals, stormwater treatment facilities, and transmission corridor. The once-through cooling system includes a 3-mile-long intake canal that is used to withdraw cooling water from the Cape Fear River, and a 6-mile-long discharge canal that conveys heated effluent to the Atlantic Ocean. Eight transmission lines presently connect the BSEP to the PEC electrical grid through an existing switchyard. All eight lines share the first 1.3 miles of corridor exiting the plant site, resulting in a maintained ROW width of approximately 750 feet for this shared section.

The Brunswick alternative generally consists of three major components: power block and support facilities, cooling water system, and transmission system:

- **Power Block and Support Facilities** - The proposed construction of two new AP1000 reactors will require an additional development footprint of approximately 400 acres for the reactors and associated support infrastructure (power block and support facilities) at the plant site.

- **Cooling Water** - Cooling towers will be utilized for the two new units, with cooling water obtained from the intake canal for cooling tower makeup water. Additional considerations for cooling water are also required for the Brunswick alternative. The two new AP1000 units will also require an average-day use of 1.58 million gallons per day (mgd) and maximum-day use of 5.8 mgd of treated freshwater for process and service water needs. The brackish water obtained from the intake canal is unsuitable for this purpose and the freshwater requirements will require a different source, either through additional capacity obtained from the Brunswick County Public Utilities, groundwater, or a combination of both means.

- **Transmission System** - Transmission line upgrades will require a minimum of four new lines totaling approximately 359.7 miles in length to connect to the existing Cumberland substation (in southwestern Cumberland County), Clinton substation (in central Sampson County), Jacksonville substation (in central Onslow County), and Womack substation (in central Lenoir County). The transmission line upgrades evaluated for the Brunswick alternative are based on the initial siting study which only considered transmission upgrades required for addition of an 1100-MWe generating unit. Additional transmission upgrades required for the additional generating capacity (approximately 2,000 MWe) provided by construction of two AP1000 reactors for the Brunswick alternative has not been determined and may result in upgrades for other lines.

2.0 METHODS OF EVALUATION

This aquatic resource functional assessment was developed and prepared in support of the HAR alternatives analysis with the following four objectives:

1) quantify potential physical impacts to aquatic resource types by project component actions (impact types) anticipated for the Harris and Brunswick alternatives;

2) identify relative function provided by existing aquatic resource types potentially impacted by the Harris and Brunswick alternatives;

3) identify functional changes expected to occur to each aquatic resource type by impact types anticipated for the Harris and Brunswick alternatives; and

4) compare overall changes to aquatic resource functions expected to occur for the Harris and Brunswick alternatives.

2.1 Determination of Potential Physical Impacts

One of the primary considerations of the alternatives analysis was to summarize potential impact on the aquatic ecosystem, which included a determination of potential physical impacts. Direct impacts considered included potential siting of the new facility, new or expanded cooling water sources, intake pipes, and related infrastructure improvements including new or relocated roads and transmission lines. The primary sources of information used to determine potential physical impacts are the Combined Operating License Application Environmental Report (COLA ER) and a proprietary siting study (PEC 2006). Information from these sources as well as additional information obtained from other PEC documents and supplemented by additional guidance provided by PEC was used to identify potential physical impact footprints. These potential impacts are based on preliminary or conceptual siting information and are not based on detailed site planning.

Initially, potential aquatic resources within the preliminary or conceptual project impact areas were identified using desktop GIS-based evaluation techniques with limited field evaluations. A field-delineation of aquatic resources has now been completed by CH2M HILL and reviewed by the USACE for the anticipated footprint for Harris alternative project components including 400-acre power block and support facilities area, anticipated roadway improvements, raw water line, and Harris Reservoir expansion. The results of the field-delineation for these components of the Harris alternative are used for quantifying the potential impacts resulting from these alternative project components. The GIS-based evaluation is being used to approximate the potential extent of aquatic resources in a conceptual footprint of the transmission line upgrades identified for the Harris alternative, as well as the Brunswick alternative 400-acre power block and support facilities area, and transmission line upgrades identified for the Brunswick alternative.

For the GIS-based evaluation, data were extracted and quantified in Geodatabases from National Hydrography Dataset (High Resolution), National Wetlands Index Wetlands and Watershed Polygons, USGS Land Use Land Cover Grids, and the Natural Resources Conservation Service SSURGO Soils. These data were overlaid onto USGS Topographic Digital Raster Graphics and 2008 National Aerial Imagery Program 1-meter Orthoquads, and supplemented by USGS National Map Seamless Server LiDAR derived elevation files to develop a general picture of site condition. Following compilation and preliminary review of available GIS data, limited field evaluations were undertaken to refine the GIS-based aquatic resource impact estimates. Based on training data collected in the field, the estimated location and extent of wetlands were refined for comparable areas exhibiting similar landform, soils, vegetation, and hydrologic influence. Wetland habitats were characterized by the North Carolina Wetlands Assessment Method (NCWAM) dichotomous key for determining wetland types to facilitate comparison. Following refinement of wetlands approximations, site visits were conducted to review general accuracy at sites that had not been visited previously, with collection of additional training data as needed for further refinement of approximations. A field visit was held in the Brunswick County area on August 18, 2009 with the USACE to review methodology and preliminary results of the wetland approximations for the transmission line evaluation. Additional refinement of the aquatic resource estimated extent and NCWAM characterization occurred following site reviews at additional sites undertaken for functional assessment data collection in June 2010.

Aquatic resources identified as subject to potential impact that could result in functional changes as a result of either the Harris or Brunswick alternative were characterized as one of three types:

- wetland (further characterized by NCWAM type within categories as tidal, riverine, or non-riverine);
- stream (further characterized as tidal, perennial, intermittent, or naturalized ditch/canal); or
- non-linear surface water (further characterized as reservoir or pond).

Potential physical impacts to aquatic resources that could result in functional changes were identified as resulting from one of four general actions:

- fill associated with infrastructure development;
- inundation from reservoir expansion;
- trenching for pipelines; or
- clearing for transmission line upgrades.

2.2 Functional Assessment Methods

No single functional assessment method was identified that evaluates the functions and anticipated functional changes for all three types of aquatic resources affected. Different functional assessment methods were utilized for wetland (see Section 2.2.1), stream (see Section 2.2.2), and reservoir (see Section 2.2.3) habitats.

2.2.1 Wetland Functional Assessment Approach

NCWAM was identified as having the potential to provide a suitable basis for evaluating relative function of existing wetlands and to evaluate potential changes expected to occur as a result of some project impacts. NCWAM was developed through a collaboration process begun in 2003 among several state and federal agency staff, the North Carolina Wetland Functional Assessment Team (NCWFAT). The most recent version (NCWAM Version 3.0) was issued in March 2010. Although not yet fully implemented, the USACE, EPA, N.C. Division of Water Quality (DWQ), and N.C. Division of Coastal Management (DCM) intend to use this methodology to make wetland functional assessments in North Carolina (USACE 2009). The purpose of NCWAM is to provide the public and private sectors with an accurate, consistent, rapid, observational, and scientifically-based field method to determine wetland departure from reference condition (when appropriate) for each general wetland type identified within North Carolina (NCWFAT 2010). Functional ratings are calculated for each assessed wetland type, based on the condition of the assessment area compared to reference conditions. The 404(b)(1) Guidelines require the applicant to document the effects of a project on the physical, chemical and biological integrity of a special aquatic site, including wetlands. NCWAM's functional assessment uses different terminology, but the overall categories are consistent with EPA's physical, chemical and biological parameters. NCWAM recognizes three major functions: hydrology, water quality, and habitat.

- ***Hydrology*** - The hydrology function is divided into: 1) surface storage and retention; and 2) sub-surface storage and retention. Scores are weighted differently depending on the type of wetland being assessed and the amount of disturbance to the assessment area.

- ***Water Quality*** - The water quality function is divided into: 1) particulate change; 2) soluble change; 3) pathogen change; 4) physical change; and 5) pollution change. The first four water quality sub-functions are considered for riverine wetlands and the fifth water quality sub-function is considered for non-riverine wetlands. Unique to the water quality function, NCWAM generates two wetland functional ratings: the first is a reflection of wetland condition as represented by on-site indicators of function; the second is wetland condition as modified by wetland opportunity. Wetland opportunity is determined by the condition of the watershed draining to a specific wetland. The proximity of wetlands to disturbances within a watershed may only increase the functional rating. Wetlands located within a relatively undeveloped watershed may have little opportunity to improve water quality. This is the case for many of the wetlands that were assessed during this study because of the primarily rural nature of the study areas, particularly the transmission line corridors for both alternatives.

- ***Habitat*** - The habitat function is divided into: 1) physical structure; 2) landscape patch structure; and 3) vegetative composition. All wetland types provide beneficial habitat, at some level, for wetland and aquatic dependent species. The physical structure can include snags and other large woody debris. Landscape patch structure is the area's connectivity to other undisturbed habitats. The structure and landscape patch structure are more important for the forested wetlands. Vegetative composition can heavily influence habitat ratings for both forested and non-forested wetlands.

Twenty-two field metrics are listed on the NCWAM assessment form and these metrics are weighted differently based on the wetland type being evaluated (NCWFAT 2010). Functions are considered to vary among these particular wetland types, but are relatively consistent within each wetland type when wetlands of a particular type are located in the same ecoregion (NCWFAT 2010).

ESI assessed a subset of wetlands representing the NCWAM wetland types identified associated with the Harris alternative (including proposed reservoir expansion and transmission line upgrades) and the Brunswick alternative (including proposed transmission line upgrades). When assessing NCWAM types located along both the Harris and Brunswick transmission lines, ESI selected sites where the wetland type could be represented both outside the maintained ROW (i.e., existing conditions) and inside the ROW limits (i.e., post-construction conditions). NCWAM allows for this through the following rule provided in the NCWAM Manual: "Wetlands with alterations (man-made or natural) should generally be classified as the original, naturally occurring type if this determination can be made." ESI assessed those areas where the wetlands, if routine ROW maintenance was discontinued, would revert to the naturally occurring type located just out the ROW limits. This allowed use of NCWAM to identify what functional changes can be expected through additional ROW clearing based on the wetland rating model. Any stressors that could affect the wetland were also documented and taken into account in the assessment. These stressors include, but are not limited to: ditching, beaver activity, vegetation removal, livestock, soil compaction, rutting, bedding, pollutants, and exotic species.

ESI utilized NCWAM, which assigns functional ratings of high, medium, or low, for representative wetlands associated with both the Harris and Brunswick alternatives. Anticipated changes to existing function were evaluated for the principal project components for the Harris and Brunswick alternatives. These anticipated changes were incorporated into a summary of potential physical impacts and anticipated resulting functional changes for all three aquatic resource types in an effort to document whether either alternative can be demonstrated to have "less adverse impact on the aquatic ecosystem", as required under Section 404(b)(1) Alternatives Analysis Guidelines, and to describe and compare the changes in aquatic function associated with both alternatives.

2.2.2 Stream Functional Assessment Approach

The intent of the stream functional evaluation was to identify the relative aquatic resource function provided by the diversity of streams impacted by project alternatives in order to identify to what degree and how those functions are expected to be changed by the project alternatives. Unlike the NCWAM developed by NCWFAT for evaluation of wetland functions in North Carolina, a comparable functional assessment methodology is not yet available for streams. ESI evaluated several stream assessment protocols that have been developed for various purposes, but none were determined to be suitable for the purposes of this evaluation. Identified evaluation protocols appeared to be either too narrowly focused on single factors like geomorphology or biodiversity, which would not provide an adequate assessment of overall relative function, or were developed by other states for mitigation determination purposes. During a meeting on July 12, 2010, the USACE suggested that the Corps' qualitative assessment worksheets completed by CH2M HILL for the project be considered to determine their utility in providing a relative measure of function for streams affected by the Harris alternative. The Corps's Stream Quality Assessment Worksheet (SQAW) identifies 23 characteristics that are evaluated in the field and assigned scores based on relative strength or intensity exhibited by the evaluated stream reach. The SQAW categorizes these characteristics into four categories, which are among the functions provided by streams:

- ***Physical*** – The physical function consists of eleven characteristics: presence of flow/persistent pools in stream; evidence of past human alteration; riparian zone; evidence of nutrient or chemical discharge; groundwater discharge; presence of adjacent floodplain; entrenchment/floodplain access; presence of adjacent wetlands; channel sinuosity; sediment input; and size and diversity of channel bed substrate. Scores for each characteristic range from 0-4 or 0-5 for the Piedmont Ecoregion, with a cumulative maximum score of 45 for all eleven characteristics.

- ***Stability*** – The stability function consists of four characteristics: evidence of channel incision or widening; presence of major bank failures; root depth and density on banks; and impact by agriculture, livestock, or timber production. Scores for each characteristic range from 0-4 or 0-5 for the Piedmont Ecoregion, with a cumulative maximum score of 17 for all four characteristics.

- ***Habitat*** – The habitat function consists of four characteristics: presence of riffle-pool/ripple-pool complexes; habitat complexity; canopy coverage over streambed; and substrate embeddedness. Scores for each characteristic range from 0-4 or 0-6 for the Piedmont Ecoregion, with a cumulative maximum score of 20 for all four characteristics.

- ***Biology*** – The biology function consists of four characteristics: presence of stream invertebrates; presence of amphibians; presence of fish; and evidence of wildlife use. Scores for each characteristic range from 0-4 or 0-5 for the Piedmont Ecoregion, with a cumulative maximum score of 18 for all four characteristics.

ESI field-evaluated 20 SQAWs for 19 streams for the initial evaluation and determined that the SQA Worksheets were generally useful for identifying relative stream function. Twenty unique stream segments in total were evaluated with the inclusion of two reaches of one stream that were identified as warranting separate evaluation based on distinctly different characteristics identified during the jurisdictional determination. These streams were chosen based on differences in watershed size, stream order, and ease of access due to the short time frame for completing the study. These parameters were chosen because they are easily discernable and demonstrate that streams of all sizes were covered in the analysis. The assessment was focused on the Harris alternative based on concerns over potential loss of function that could occur through inundation. Clearing for additional ROW was not identified by review agencies as an action expected to result in a loss of stream function.

Preliminary methodology and results were presented to the USACE and DWQ during a meeting and field visit on August 4, 2010. The purpose of the meeting and field visit was to evaluate and solicit feedback on the proposed approach to evaluate general stream function using the existing Corps' SQAW forms generated for the project. Constructive comments and recommendations provided during and following this meeting were utilized in adjusting the approach, which was then applied to all the streams delineated for the Harris alternative.

The SQAW indicates that a total score of 100 represents the highest quality based on the qualitative assessment. For the functional assessment, the maximum potential subtotaled scores for the four functions and maximum potential total score (100) are assumed to represent the greatest opportunity and potential for providing the particular function and overall relative function respectively. ESI utilized the SQAW scores to determine whether each of the four functions and overall score ranked in the upper, middle, or lower third of maximum possible points for each. This allowed for a relative comparison of individual streams by stream type and location for an evaluation of existing function provided by the streams affected by the Harris alternative.

Additional information on aquatic resource functions provided by streams was obtained through literature review for use in evaluating anticipated changes in function that could be expected to occur from project alternative actions. These anticipated changes were incorporated into a summary of potential physical impacts and anticipated resulting functional changes for all three aquatic resource types in an effort to document whether either alternative can be demonstrated to have "less adverse impact on the aquatic ecosystem", as required under Section 404(b)(1) Alternatives Analysis Guidelines and to describe and compare the changes in aquatic function associated with both alternatives.

2.2.3 Non-linear Surface Water Functional Assessment Approach

During development of the NCWAM, the WFAT also identified four non-wetland open water types: natural water bodies, artificial water bodies, estuarine waters, and ocean; however, a method of functional assessment was not generated for these open water types (NCFAT 2010). Reservoir habitat is present only within the Harris alternative, consisting of Harris Reservoir. The reservoir functional assessment was based on utilization of existing resources, PEC monitoring reports, and literature review to provide an overview of general reservoir condition and changes expected to occur as a result of reservoir expansion. Man-made ponds, which constitute a minor component of the potential project impacts, were not evaluated, but are expected to have similar functions to reservoirs, particularly the functions present in shallow edges of reservoirs.

3.0 EXISTING CONDITIONS

3.1 Aquatic Resources Present

Aquatic resources identified as subject to potential impact that could result in functional changes as a result of either the Harris or Brunswick alternative were characterized as one of three basic types: wetlands, streams, or non-linear surface waters.

Wetland Types

The wetlands identified and classified according to NCWAM for both the Harris and Brunswick alternatives can be divided into two general categories, as defined by NCWAM (NCWFAT 2010): riverine and non-riverine wetlands. Although NCWAM treats tidal wetlands within the riverine wetland category, tidal wetlands are categorized as distinct from non-tidal wetlands by the USACE (33 CFR 328.2), and for the present assessment tidal wetlands are evaluated separately from other NCWAM riverine wetlands. The three general categories of wetlands evaluated are: tidal wetlands, riverine wetlands, and non-riverine wetlands.

- **Tidal Wetlands** - Tidal wetlands are not present in any areas affected by the Harris alternative, but are present in areas affected by the Brunswick alternative. Tidal wetland types as identified by the NCWAM dichotomous key are wetlands affected by lunar or wind tides, and may include woody areas adjacent to tidal marsh. Under the USACE definition, tidal wetlands are located channelward of the high tide line, which is defined at 33 CFR 328.3.d. Tidal wetlands that were evaluated as part of this study include salt/brackish marsh, tidal freshwater marsh, and estuarine woody wetland.

    - ***Salt/Brackish Marsh*** – NCWAM identifies salt/brackish marsh as wetlands subject to regular or occasional flooding tides, including wind tides, provided that: 1) water salinities equal or exceed 0.5 parts per thousand (ppt) during the period of average, annual flow; 2) flooding by saline waters is not limited to storm events; and 3) woody vegetation constitutes less than 50 percent coverage of the community.

    - ***Estuarine Woody Wetland*** – NCWAM identifies estuarine woody wetland as a transitional community type typically fringing marsh and having the following attributes: 1) subject to occasional flooding from salt or brackish water; 2) subject to occasional flooding by tides, including wind tides; and 3) dominated (greater than 50% coverage) by woody vegetation including shrubs and trees. Due to typically unstable hydrological and chemical influences, the plant community is one adapted to disturbance.

    - ***Tidal Freshwater Marsh*** – NCWAM identifies tidal freshwater marsh as a wetland type located on the margins of estuaries and in lower reaches of streams and rivers where the community type is saturated most of the time and also subject to regular or occasional flooding by tides, including wind tides. Salinities are typically below the 0.5 ppt threshold, but higher salinities may occur as a result of storm events. Tidal freshwater marshes typically support a larger diversity of plant species than either non-tidal freshwater marshes or salt/brackish marshes.

- **Riverine Wetlands** - NCWAM defines riverine as a term referring to wetland types typically found in one or more of the following landscape positions: within a geomorphic floodplain or a natural topographic crenulation; abutting/adjacent to natural tributaries, natural water bodies greater than 20 acres or artificial impoundments; or subject to tidal flow regimes. For the purposes of this evaluation, wetlands subject to tidal flow regimes are treated as a separate category (tidal wetlands) for consideration of impacts, functions, and changes in function. Riverine wetlands that were evaluated as part of this study include non-tidal freshwater marsh, bottomland hardwood forest, riverine swamp forest, headwater forest, and floodplain pool.

- ***Non-Tidal Freshwater Marsh*** – Non-tidal freshwater marsh, as defined by NCWAM, is characterized as found along floodplains, along linear conveyances, in headwaters, and along shorelines of large water bodies. These wetlands are subject to inundation or saturation for extended periods during the growing season, but are typically not subject to regular or occasional tides, including wind tides. Vegetation is predominately herbaceous (less than 50 percent coverage by living woody species). Non-tidal freshwater marshes may occur naturally along the fringes of streams, rivers, and large lakes, but also commonly occur in association with impoundments, whether man made or natural (beaver impoundments), and in association with disturbed areas (maintained utility-line corridors). For the Harris alternative, most of the non-tidal freshwater marsh wetlands within the existing reservoir also have an abutting lacustrine fringe wetland, which according to NCWAM should be included in the assessment of the non-tidal freshwater marsh (emergent wetlands) as long as herbaceous vegetation is dominant in the overall assessment area. This guidance was applied to the lacustrine fringe identified in the delineation effort and resulting jurisdictional determination.

- ***Bottomland Hardwood Forest*** – Bottomland hardwood communities are located on 2^{nd} order or greater stream systems. Bottomland hardwoods are characterized by a more seasonal hydrologic regime that generally ranges from intermittently to seasonally inundated for long durations.

- ***Riverine Swamp Forest*** – Riverine swamp forest wetlands can be located on streams of any order, in topographic crenulations without a stream, or along the shorelines of large lakes (20 acres or larger in size) and artificial impoundments of any size. They differ from bottomland hardwood forest wetlands because of an extended hydroperiod (seasonally to semi-permanently inundated). Seasonal fluctuations in large lakes may mimic the seasonal fluctuations of rivers. These wetlands are vegetated typically by more water tolerant species and are often affected by downstream beaver activity.

- ***Headwater Forest*** – Headwater forest wetlands are located along 1^{st} order streams or in topographic crenulations without a stream channel (natural linear conveyance). Headwater forests are typically found along ephemeral or intermittent streams. Overbank flooding is not a substantial source of water for this wetland type and headwater forests are relatively dry when compared to other riverine wetland types.

- ***Floodplain Pool*** – Floodplain pools are localized depressions found in geomorphic floodplains of streams or rivers. These areas are generally small in size, typically occur on mineral soils, and are semi-permanently to permanently inundated. Sources of water are primarily groundwater, precipitation, and sometimes overbank flooding. NCWAM indicates that a distinctive feature of floodplain pools is that they usually dry out at some point of the year. Trees are commonly found along the edges of floodplain pools rather than within the pool, with vegetation within the pool sparse or variable consisting of a variety of herbaceous species.

- **Non-riverine Wetlands** - Non-riverine wetlands are not in a geomorphic floodplain or topographic crenulation, not associated with a natural lake greater than or equal to 20 acres, or artificial water body, nor subject to tidal flow regimes. Non-riverine wetlands evaluated in this study include pocosin, pine flat, pine savanna, hardwood flat, and basin wetland, and seep.
  - ***Pocosin*** – NCWAM characterizes pocosin wetlands as found on poorly drained, interstream flats and in basins of various sizes. Pocosins can be seasonally saturated or inundated by a high or perched water table. Vegetation is dominated by dense, waxy evergreen shrubs often mixed with pond pine and evergreen hardwoods such as loblolly bay, swamp bay, and sweet bay.
  - ***Pine Flat*** – NCWAM characterizes this wetland type as found on poorly drained, interstream flats. These areas are usually seasonally saturated or intermittently to seasonally inundated by a high water table or poor drainage. The primary source of hydrology is a high water table resulting from precipitation or overland runoff. This wetland type may be dominated by forest, early successional forest/shrub, or managed pine plantation. This wetland type is typically managed and is often characterized by low species diversity and structural complexity.
  - ***Pine Savanna*** – NCWAM characterizes this wetland type as found on poorly drained, interstream flats. Pine savannas are usually seasonally saturated by a high water table or poor drainage, but have a shorter hydroperiod than non-riverine swamp forest. The primary sources of water are a high water table resulting from precipitation and overland runoff. NCWAM characterizes this wetland type as dominated by long-leaf pine and pond pine, with scattered, low shrubs and grassy/herbaceous ground cover. Regular burns provide conditions for very high herb species diversity.
  - ***Hardwood Flat*** – NCWAM characterizes this wetland type as found poorly drained, interstream flats. Hardwood flats are usually seasonally saturated or intermittently to seasonally inundated by a high water table or poor drainage, but have a shorter hydroperiod than non-riverine swamp forests. The primary source of water is a high water table resulting from precipitation and overland runoff. These systems are commonly dominated by hardwood tree species.
  - ***Basin Wetland*** – NCWAM characterizes this wetland type as one occurring in depressions surrounded by uplands, usually on interstream flats or in localized depressions, but also occurring on the fringe of small water bodies (less than 20 acres in size). NCWAM indicates that wetlands fringing larger water bodies are subject to hydrology more closely matching riverine conditions and are therefore considered riverine swamp forest or non-tidal freshwater marsh. Basin wetlands are seasonally to semi-permanently inundated but may lose surface hydrology during later portions of the growing season. Vegetation structure may vary from forested to herbaceous.
  - ***Seep*** – NCWAM identifies this wetland type as one where groundwater is discharged to the surface on a slope not within a geomorphic floodplain or a natural topographic crenulation. Wetlands of this type usually occupy small areas on sloping hillsides in interstream divides or on the outer rim of floodplains and are semi-permanently to permanently saturated by groundwater. This wetland type does not have sufficient

surface flow to form channels. Vegetation is variable and may range from sparse to dense wetland herbs or shrubs to forest cover.

Stream Types

Four stream types were identified for the Harris and Brunswick alternatives: tidal, perennial, intermittent, and ephemeral. The definition for tidal streams is based on 33 CFR 328.3.f, and perennial, intermittent, and ephemeral streams from the Federal Register 72(47): 11196-11197. Ephemeral streams, as considered here, are stormwater conveyances not meeting criteria necessary to be considered jurisdictional Waters of the United States under Section 404. From a practical standpoint, the non-jurisdictional determination for ephemeral streams was made by the USACE for the areas delineated as part of the Harris alternative, and the distinction between perennial and intermittent streams was based on the DWQ Stream Identification Form (Version 3.1) completed by CH2M HILL as part of the jurisdictional determination package. For the Brunswick alternative and Harris alternative transmission line upgrade component, the distinction was based on the designation provided by the National Hydrography Dataset. At the request of the USACE and DWQ for streams delineated for the Harris alternative, streams present in the Triassic Basin were evaluated separately from streams not present in the Triassic Basin.

- ***Tidal Streams*** – Tidal streams were identified as linear features where tidal waters are present in a defined and identifiable channel. Based on USACE definition, tidal waters rise and fall in a predictable and measurable rhythm or cycle due to the gravitational pulls of the moon and sun. Tidal waters end where the rise and fall of the water surface can no longer be practically measured in a predictable rhythm due to masking by hydrologic, wind, or other effects.

- ***Perennial Streams*** – Based on USACE definition, a perennial stream has flowing water year-round during a typical year. The water table is located above the stream bed for most of the year. Groundwater is the primary source of water for stream flow. Runoff from rainfall is a supplemental source of water for stream flow.

- ***Intermittent Streams*** – Based on USACE definition, an intermittent stream has flowing water during certain times of the year, when groundwater provides water for steam flow. During dry periods, intermittent streams may not have flowing water. Runoff from rainfall is a supplemental source of water for stream flow.

- ***Naturalized Ditch/Canal*** – Naturalized ditches or canals are man-made features that intercept enough groundwater to have either intermittent or perennial flow. These channels have enough flow to support aquatic life and would be considered waters of the United States.

- ***Ephemeral Stream*** – Based on USACE definition, an ephemeral stream has flowing water only during and for a short duration after precipitation events in a typical year. Ephemeral stream beds are located above the water table year-round. Groundwater is not a source of water for the stream. Runoff from rainfall is the primary source of water for stream flow. Features identified as ephemeral streams were not determined to be jurisdictional by the USACE during review of the Harris alternative jurisdictional delineation, and are not considered further for the functional assessment.

Non-linear Surface Water Types

Two non-linear surface water types were identified for the Harris and Brunswick alternatives: reservoir and pond.

- ***Reservoir*** – Reservoirs were identified as surface water features greater than 20 acres in size formed by impoundment of waters otherwise defined as waters of the United States.

- ***Pond*** – Ponds were identified as non-linear, non-wetland, surface water features less than 20 acres in size.

Aquatic resources may be subject to impacts from either the Harris or Brunswick alternative by one of four general actions: filling associated with infrastructure development; flooding from reservoir expansion; trenching for pipelines; or clearing for transmission line upgrades. The types and approximate amounts of aquatic resources affected by Harris and Brunswick alternatives are summarized below.

3.1.1 Harris Alternative Aquatic Resources

The three principal components of the Harris alternative for which physical impacts to aquatic resources have been identified include construction of the 400-acre power block and support facilities area (including new/relocated roads, and raw water line), reservoir expansion, and transmission line upgrades. Wetland and stream fill associated with infrastructure improvements as well as wetland and stream impacts resulting from pipeline construction are part of the overall Harris alternative impact scenario. Roadway improvements may result in fill in an area that would otherwise be subject to affect by reservoir expansion. Until roadway alternatives are fully evaluated and design developed for the selected improvements, these potential impacts can only be shown as "filling or flooding" for this analysis. Reservoir expansion will result in conversion of wetland and stream habitat to non-linear surface water habitats. Pipeline construction will require clearing and temporary excavation for pipeline installation. Wetland habitats and stream banks will be cleared and maintained for additional ROW needed for transmission line upgrades, resulting in conversion of forested wetland habitats to herbaceous wetland habitats.

Five NCWAM wetland types have been identified as potentially affected by the Harris alternative based on a combination of limited field-truthing and GIS-based evaluation: non-tidal freshwater marsh, headwater forest, bottomland hardwood forest, riverine swamp forest, and floodplain pool. Streams potentially affected include perennial and intermittent reaches, and naturalized ditch/canal. Non-linear surface waters present within the Harris alternative include reservoir and ponds. Table 3.1 presents the potential physical impacts to aquatic resources by Harris alternative actions.

Table 3.1. Potential Physical Impacts to Aquatic Resources for Harris Alternative.

<table>
<tr><th rowspan="2">Aquatic Resource</th><th colspan="5">Impact Type</th></tr>
<tr><th>Filling</th><th>Filling or Flooding</th><th>Flooding</th><th>Trenching</th><th>Clearing</th></tr>
<tr><td colspan="6">Wetlands (ac)</td></tr>
<tr><td>Non-tidal Freshwater Marsh</td><td>0</td><td>0</td><td>422 [a]</td><td>0</td><td>4</td></tr>
<tr><td>Headwater Forest</td><td rowspan="4">5 [b]</td><td rowspan="4">0</td><td rowspan="4">177 [b]</td><td rowspan="4">1 [b]</td><td>19</td></tr>
<tr><td>Bottomland Hardwood Forest</td><td>68</td></tr>
<tr><td>Riverine Swamp Forest</td><td>4</td></tr>
<tr><td>Floodplain Pool</td><td>0</td></tr>
<tr><td>Total Wetlands (ac):</td><td>5</td><td>0</td><td>598</td><td>1</td><td>95</td></tr>
<tr><td colspan="6">Streams (mi)</td></tr>
<tr><td>Perennial Stream</td><td>0.3</td><td>0.4</td><td>15.8</td><td>0.5</td><td>1.5</td></tr>
<tr><td>Intermittent Stream</td><td>0.5</td><td>0.2</td><td>10.9</td><td>0.1</td><td>3.6</td></tr>
<tr><td>Naturalized Ditch/Canal</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0.2</td></tr>
<tr><td>Total Streams (mi):</td><td>0.8</td><td>0.6</td><td>26.8</td><td>0.6</td><td>5.3</td></tr>
<tr><td colspan="6">Non-linear Surface Waters (ac)</td></tr>
<tr><td>Reservoir</td><td>0</td><td>0</td><td>3,321</td><td>0</td><td>0</td></tr>
<tr><td>Pond</td><td>5</td><td>0</td><td>10</td><td>0</td><td>23</td></tr>
<tr><td>Total Non-linear Surface Waters (ac):</td><td>5</td><td>0</td><td>3,331</td><td>0</td><td>23</td></tr>
</table>

[a] emergent wetlands and wetland fringe
[b] forested wetlands

General note: totals may differ based on rounding.

The original delineation for the Harris power block and support facilities and reservoir expansion did not differentiate between forested types; all were labeled as forested. The NCWAM evaluation described herein characterizes these wetlands as bottomland hardwood, riverine swamp forest, headwater forest, or floodplain pool. All of these wetlands types are considered to be riverine wetlands. Not every forested wetland area identified through delineation or GIS-based methods was visited during this phase of the study; therefore certain assumptions were made with regard to assigning NCWAM types to those wetlands that were not specifically visited by ESI. Previous mapping was reviewed along with supplemental data sources to aid in the NCWAM classification. For example, some forested wetlands are classified as being either headwater forest or riverine swamp forest because they occur on 1st order streams or in topographic crenulations without streams. Similarly, some forested wetlands are classified as being riverine swamp forest or bottomland hardwood because of their location on 2nd order or greater streams. However, the exact NCWAM type cannot be determined without visiting and assessing the hydrology of these wetlands, especially the wetland areas influenced by hydrologic conditions in proximity to Harris reservoir, therefore these forested wetlands are treated together for the Harris site and reservoir area impacts in Table 3.1.

3.1.2 Brunswick Alternative Aquatic Resources

The two principal components of the Brunswick alternative for which physical impacts to aquatic resources have been identified include the 400-acre power block and support facilities and transmission line upgrades. Based on review agency concerns for consideration of avoidance and minimization of impacts, as well as consideration for the effects of future potential sea level rise, PEC re-evaluated the initial 400-acre power block area evaluated in the alternatives analysis document. Complete avoidance of impacts to wetlands and streams was identified as not practicable, and the present evaluation is based on minor adjustments resulting from preliminary identification of site constraints as well as avoidance and minimization efforts for sensitive aquatic resources. Construction of the power block and support facilities (including new/relocated roads) will result in fill in wetlands and streams. Transmission upgrades will result in clearing and maintenance of wetland and stream bank habitats to provide the additional required ROW, resulting in conversion of conversion of forested wetland habitats to herbaceous wetland habitats.

Potential impacts have not been evaluated for pipeline construction that may be necessary to provide sufficient treated freshwater for process and service water for the Brunswick alternative. BSEP receives water from Brunswick Public Utilities, and from 1996 to 2001, BSEP's water use ranged from approximately 0.22 mgd to 0.25 mgd, with an average consumption of 0.25 mgd (BSEP ER 2.9.1). Brunswick Public Utilities does not currently have the necessary capacity to meet the process and service water needs for the two AP1000 units; however, the additional infrastructure requirements and resulting impacts that may be necessary to provide the two AP 1000 units with an average-day use of 1.58 mgd and maximum-day use of 5.8 mgd have not been determined.

Thirteen NCWAM wetland types have been identified as potentially affected by the Brunswick alternative based on a combination of limited field-truthing and GIS-based evaluation: salt/brackish marsh, estuarine woody wetland, tidal freshwater marsh, non-tidal freshwater marsh, riverine swamp forest, headwater forest, bottomland hardwood forest, pocosin, pine flat, pine savanna, hardwood flat, basin wetland, and seep. Streams potentially affected include tidal, perennial, and intermittent reaches, and naturalized ditch/canal. Non-linear surface waters present within the Brunswick alternative include ponds. Table 3.2 presents the potential physical impacts to aquatic resources by Brunswick alternative actions.

Table 3.2. Potential Physical Impacts to Aquatic Resources for Brunswick Alternative.

Aquatic Resource	Impact Type	
	Filling	Clearing
Wetlands (ac)		
Salt/Brackish Marsh	11	3
Estuarine Woody Wetland	5	0
Tidal Freshwater Marsh	0	24
Non-Tidal Freshwater Marsh	0	2
Riverine Swamp Forest	12	443
Headwater Forest	7	127
Bottomland Hardwood Forest	0	93
Pocosin	0	421
Pine Flat	0	291
Pine Savanna	0	37
Hardwood Flat	0	6
Basin Wetland	0	2
Seep	0	<1
Total Wetlands (ac)	**35**	**1,450**
Streams (mi)		
Tidal Stream	1.2	0.2
Perennial Stream	0.2	4.6
Intermittent Stream	0.4	7.1
Naturalized Ditch/Canal	0	0.8
Total Streams (mi)	**1.8**	**12.7**
Non-linear Surface Waters (ac)		
Pond	0	28
Total Non-linear Surface Waters (ac):	**0**	**28**

As with the Harris alternative, not every wetland area identified through GIS-based methods was visited during this phase of the study; therefore certain assumptions were made with regard to assigning NCWAM types to those wetlands that were not specifically visited by ESI. Wetlands impacted by fill include tidal wetlands, a category not impacted by the Harris alternative. Riverine wetlands are also affected by fill for the Brunswick alternative. Twelve different NCWAM wetland types were identified within the area subject to clearing activities for transmission upgrades, including tidal wetland types, riverine wetland types, and non-riverine wetland types.

3.1.3 Summary of Physical Impacts to Aquatic Resources

Table 3.3 provides a comparison of the potential physical impacts to aquatic resource types for the Harris and Brunswick alternatives.

Table 3.3. Summary of Potential Physical Impacts to Aquatic Resources.

Aquatic Resource	Impact Type									
	Filling		Filling or Flooding		Flooding		Trenching		Clearing	
	Harris	Bruns	Harris	Bruns	Harris	Bruns	Harris	Bruns	Harris	Bruns
Wetlands (ac)										
Tidal Wetlands	0	16	0	0	0	0	0	0	0	27
Riverine Wetlands	5	19	0	0	598	0	1	0	95	665
Non-riverine Wetlands	0	0	0	0	0	0	0	0	0	758
Total Wetlands (ac):	**5**	**35**	**0**	**0**	**598**	**0**	**1**	**0**	**95**	**1,450**
Streams (mi)										
Tidal Stream	0	1.2	0	0	0	0	0	0	0	0.2
Perennial Stream	0.3	0.2	0.4	0	15.8	0	0.5	0	1.5	4.6
Intermittent Stream	0.5	0.4	0.2	0	10.9	0	0.1	0	3.6	7.1
Naturalized Ditch/Canal	0	0	0	0	0	0	0	0	0.2	0.8
Total Streams (mi):	**0.8**	**1.8**	**0.6**	**0**	**26.8**	**0**	**0.6**	**0**	**5.3**	**12.7**
Non-linear Surface Waters (ac)										
Reservoir	0	0	0	0	3,321[a]	0	0	0	0	0
Pond	5	0	0	0	10	0	0	0	23	28
Total Non-linear Surface Waters (ac):	**5**	**0**	**0**	**0**	**3,331**	**0**	**0**	**0**	**23**	**28**

[a] Acreage for open water habitat of Harris Reservoir, does not include wetlands delineated below normal operating pool level (220 ft).
General note: totals may differ based on rounding.

- *Filling* - The Brunswick alternative would result in greater impact from filling activities than the Harris alternative. The Brunswick alternative may result in fill to nearly 19 acres of tidal wetlands and streams (approximately 16 acres of tidal wetlands and 1.2 miles [2.5 acres] of tidal stream channel) and 19 acres of riverine wetlands. The Harris alternative may result in impacts to approximately 5 acres of riverine wetlands. The Harris alternative would result in less fill impacts to stream channel on a linear basis, 0.8 mile compared to 1.8 miles, although the Harris alternative may also result in additional fill of up to 0.6 mile of stream channel for road improvements (this 0.6 mile of stream channel would be subject to flooding from reservoir expansion if the road improvement alternative resulting in fill is not selected). However, the Brunswick alternative stream fill would occur to 1.2 miles of tidal stream as well as 0.2 mile of perennial stream and 0.4 mile of intermittent stream while the Harris alternative stream fill would occur in perennial streams (0.3 to 0.7 mile) and intermittent streams (0.5 to 0.7 mile). The areal coverage of the tidal stream fill for the Brunswick alternative is substantially greater (approximately 3 acres) than the expected stream fill for the Harris alternative (approximately 1 acre).

- ***Flooding*** – The Harris alternative would result in flooding impacts not occurring for the Brunswick alternative. The Harris alternative would result in flooding approximately 598 acres of riverine wetlands, 26.8 miles of stream (or up to 27.4 miles if road improvement alternatives do not result in fill), and 3,331 acres of non-linear surface waters (primarily deepening of the existing Harris Reservoir). The flooding impacts would result in the conversion of the wetland and stream habitat, as well as upland habitat, to an expanded reservoir and associated habitats.

- ***Trenching*** – The Harris alternative would result in trenching impacts not identified as occurring for the Brunswick alternative. However, potential impacts have not been evaluated for Brunswick alternative that may be required to construct water pipelines needed to provide sufficient treated freshwater for process and service water. Trenching impacts for the Harris alternative may include temporary impacts to streams and wetlands from trenching activities. The wetlands within the ROW will also be permanently cleared and maintained as ROW.

- **Clearing** – The Brunswick alternative would result in substantially greater clearing impacts for transmission line upgrades than the Harris alternative. Approximately 1,450 acres of wetlands are present within the preliminary alignment evaluated for the expanded Brunswick ROW, and 95 acres are within the preliminary alignment evaluated for the expanded Harris ROW. The actual clearing impacts for the Brunswick alternative may be higher than those that have been identified. The potential Brunswick impacts are based on the initial siting study which only considered transmission upgrades required for addition of an 1100-MWe generating unit (requiring upgrades to four of eight 230-kV transmission lines), while the potential Harris impacts are based on construction of two AP1000 reactors (approximately 2,000 MWe). Additional transmission upgrades required for the additional generating capacity provided by construction of two AP1000 reactors (approximately 2,000 MWe) for the Brunswick alternative has not been evaluated and may result in additional impacts.

3.2 Existing Functions

The field evaluations undertaken for selected wetlands and streams provide a basis for general discussion of functions and relative degree of function provided by the evaluated features. However, not every aquatic resource site identified through delineation or GIS-based methods was visited or evaluated as part of this review. Function can vary among sites of the same aquatic resource type and vary within an individual feature. The information obtained from the NCWAM evaluations undertaken and stream data extracted from SQAW forms is presented to provide a summary for some of the existing functions identified for existing wetlands and streams potentially affected by project alternatives. This information is supplemented by additional information obtained from various literature sources on functions expected to be provided by the different aquatic resource types. Results from this review of aquatic resource functions are provided for wetlands (3.2.1), streams (3.2.2), and non-linear surface waters (3.2.3). Changes in function expected to result from different project alternative actions are presented in Sections 4.1 through 4.4.

3.2.1 Wetlands

Field evaluations were conducted using NCWAM for 35 wetland sites representing the five wetland types identified for the Harris alternative power block and support facilities area as well as the reservoir expansion area. The NCWAM evaluation was used to confirm wetland type and identify relative function through the overall NCWAM rating obtained for each wetland visited and evaluated. Table 3.4 presents the results of this portion of the NCWAM evaluation.

Table 3.4. NCWAM Results for Harris Alternative Power Block and Reservoir Expansion.

NCWAM Type	Approx. Acreage	Number of Sites Evaluated	Overall NCWAM Rating (Number of Sites)		
			Low	Medium	High
Non-Tidal Freshwater Marsh	422 [a]	18	0	3	15
Floodplain Pool	183 [b]	3	1	0	2
Riverine Swamp Forest		3	0	0	3
Bottomland Hardwood		4	1	2	1
Headwater Forest		7	1	0	6
TOTAL:	**605**	**35**	**3**	**5**	**27**

[a] emergent wetlands and wetland fringe
[b] forested wetlands

General note: totals may differ based on rounding.

Field evaluations were conducted using NCWAM for 26 wetland sites representing the twelve wetland types identified as subject to clearing for new ROW on either alternative. The NCWAM evaluation was used to confirm wetland type and identify relative function through the overall NCWAM rating obtained for each wetland visited and evaluated. Table 3.5 presents the results of this NCWAM evaluation.

Table 3.5. NCWAM Results for Harris and Brunswick Transmission Line Upgrades.

NCWAM Type	Alternative	Approx. Clearing Acreage	Number of Sites Evaluated	Overall NCWAM Rating (Number of Sites)		
				Low	Medium	High
Salt/Brackish Marsh	Harris	NA[1]	NA	-	-	-
	Brunswick	3	1	-	-	1
Tidal Freshwater Marsh	Harris	NA	NA	-	-	-
	Brunswick	24	1	-	-	1
Non-Tidal Freshwater Marsh	Harris	4	1	-	-	1
	Brunswick	2	1	-	-	1
Bottomland Hardwood	Harris	68	4	-	1	3
	Brunswick	93	2	-	1	1
Riverine Swamp Forest	Harris	4	2	1	-	1
	Brunswick	443	2	-	-	2
Headwater Forest	Harris	19	2	-	-	2
	Brunswick	127	2	-	1	1
Pocosin	Harris	NA	NA	-	-	-
	Brunswick	421	2	-	1	1
Pine Flat	Harris	NA	NA	-	-	-
	Brunswick	291	2	-	-	2
Pine Savanna	Harris	NA	NA	-	-	-
	Brunswick	37	1	-	-	1
Hardwood Flat	Harris	NA	NA	-	-	-
	Brunswick	6	1	-	1	-
Basin Wetland	Harris	NA	NA	-	-	-
	Brunswick	2	1	-	-	1
Seep	Harris	NA	NA	-	-	-
	Brunswick	<1	1	-	-	1
TOTAL:	**Harris**	**95**	**9**	**1**	**1**	**7**
	Brunswick	**1,450**	**17**	-	**4**	**13**

[1] NA = Not Applicable; no wetlands of this type identified within preliminary alignment identified for transmission upgrade for this alternative.
General note: totals may differ based on rounding.

Overall, most of the wetlands evaluated for the Harris alternative power block and support facilities area, Harris reservoir expansion area, and transmission line upgrade areas for Harris and Brunswick alternatives rated high using NCWAM (47 out of 61 wetland areas evaluated). Relatively few wetland areas evaluated rated low using NCWAM (4 out of 61). The same trend of mostly high-rated wetlands and relatively few low-rated wetlands was identified when comparing the wetlands evaluated along the Harris transmission line upgrades to the wetlands evaluated along the Brunswick transmission line upgrade. The same trend was identified when comparing all wetlands evaluated for the Harris alternative to the Brunswick alternative. No wetlands were evaluated within the owner-controlled areas for the Brunswick alternative or Harris alternative, which contain all or most of the wetlands that would be impacted by the power block and support facilities. The trend towards high-rated wetlands along the transmission line upgrades and the Harris reservoir area is attributed to the relatively rural and undeveloped setting for much of the area subject to impact.

General descriptions of the relative functions identified for the wetland types subject to potential impact by the Harris and Brunswick alternatives are provided for consideration. These are based on results from the evaluation of representative sites for the wetland types as well as general information on functions provided by the wetlands obtained from literature sources.

Tidal Wetlands

Salt/Brackish Marsh – One (1) salt/brackish marsh associated with the Brunswick alternative was evaluated using NCWAM and it received a high rating. Most examples of salt/brackish marsh are considered by the regulatory agencies as high-quality wetlands (NCWFAT 2010). Many tidal salt marshes, including those adjacent to the Brunswick plant, are designated as primary nursery areas and essential fish habitat because of their value to coastal fish populations. Primary nursery areas and essential fish habitat are also afforded additional protection beyond what is normally applied by Sections 404 and 10 of the Clean Water Act.

This wetland type forms an important interface between terrestrial and marine habitats (Mitsch & Gosselink 1986). Salt/brackish marsh can receive water both from the ocean through incoming tides as well as from inland areas as freshwater flows into these tidal marshes from inland sources. As such these wetland types can provide hydrology functions such as velocity reduction and floodwater attenuation. Water quality functions provided by salt/brackish marsh wetlands are primarily associated with nutrient cycling and its ability to trap suspended sediment from the water column. Tidal salt marshes are among the most productive ecosystems in the world, with up to 25 metric tons per hectare of plant material (2,500 g/m^2 per year) produced annually in the southern Coastal Plain of North America (Niering and Warren 1977). This high level of primary productivity fuels a multitude of different energy pathways and food chains in these coastal ecosystems.

- ***Estuarine Woody Wetland*** – Although this wetland type is present at the Brunswick plant, it was not evaluated because of its location inside the owner controlled area. Therefore, an NCWAM rating for estuarine woody wetland is not available.

  Estuarine woody wetlands are transitional areas between uplands and the fringing salt/brackish marsh or tidal freshwater marsh. These wetlands are subject to occasional flooding from salt or brackish water and are dominated by woody vegetation. Being at the transition from upland to marsh, these wetland types also intercept upland runoff before it enters the nearby marsh habitat and tidal stream. Water quality functions are similar to those found in other riverine forested wetlands such as bottomland hardwood forest and riverine swamp forest.

- ***Tidal Freshwater Marsh*** – These wetlands vary in size from small, narrow, fringing bands to broad patches extending for hundreds of acres (NCWFAT 2010). One (1) tidal freshwater marsh associated with the Brunswick alternative was evaluated using NCWAM and it received a high rating. No tidal freshwater marsh sites were identified and evaluated for the Harris alternative.

  Tidal freshwater marshes are riverine wetlands and are subject to regular or occasional flooding by tides and are characterized by predominantly herbaceous vegetation (NCWFAT 2010). Hydrology functions provided by tidal freshwater marshes include velocity reduction and floodwater attenuation. Water quality functions are numerous and include primary productivity ranging from 1,000 to 3,000 g/m^2 per year (Mitsch & Gosselink 1986). This results in both export and accumulation of organic carbon providing energy for numerous food chains. Habitat functions for tidal freshwater marsh are also numerous. The detritus export from these wetland types provides a food source for benthic invertebrates, which in turn provide a food source for fish, birds, etc. Tidal freshwater marshes are also important habitats for many nektonic species that use the area for spawning, year-round food and shelter, and as a nursery zone and juvenile habitat (Mitsch & Gosselink 1986). Of all wetland habitats, coastal tidal freshwater marshes probably support the largest and most diverse populations of birds, including the federally endangered wood stock (*Mycteria americana*), which is listed for Brunswick County. Odum *et al.* (1984) compiled a list of 280 species of birds that utilize tidal freshwater marshes. He also compiled a list of 102 species of reptiles and amphibians that frequent tidal freshwater marshes along the Atlantic coast (Mitsch & Gosselink 1986). Numerous mammals also are dependent on the diverse habitats found in tidal freshwater marshes.

Riverine Wetlands

- ***Non-Tidal Freshwater Marsh*** – This wetland type is the most abundant wetland type at the Harris Reservoir site with an estimated 422 acres occurring around Harris Reservoir within the limits of the proposed flooding and infrastructure improvements. The original wetland delineation classified all non-forested wetlands as either emergent or herbaceous wetlands. NCWAM characterizes these emergent wetlands as well as the original wetland fringe as non-tidal freshwater marsh. Additional herbaceous wetlands encountered at the Harris site were also included under this wetland type. The non-tidal freshwater marsh total is comprised of the following:

  - Emergent wetlands below 220-ft contour: ± 341 acres *man-induced wetlands*
  - Lacustrine fringe: ± 64 acres (included as non-tidal freshwater marsh acreage based on NCWAM guidance) *man-induced wetlands*
  - Wetlands originally classified as forested, but reclassified as non-tidal freshwater marsh using NCWAM: ± 14 acres
  - Herbaceous wetlands: ± 3 acres

  The USACE defines man-induced wetlands as an area that has developed at least some characteristics of naturally occurring wetlands due to either intentional or incidental human activities. Examples of man-induced wetlands include irrigated wetlands, wetlands resulting from impoundment (e.g., reservoir shorelines), wetlands resulting from filling deepwater habitat, dredged material disposal areas, and wetlands resulting from stream channel realignment

(Environmental Laboratory 1987). The non-tidal freshwater marsh and wetland fringe surrounding Harris Reservoir that formed on non-hydric soils are, by definition, man-induced wetlands. They are a direct result of the creation of the reservoir and their establishment is a normal process seen in many reservoir systems.

Due to the transitional nature of this wetland type, reference wetlands are not available for this type. Since the general wetland type has no reference, the condition of non-tidal freshwater marsh may be difficult to discern (NCWFAT 2010). Eighteen (18) non-tidal freshwater marsh sites located around the Harris Reservoir and one (1) site along the Harris transmission lines were visited and evaluated using NCWAM. The NCWAM ratings obtained for these 19 non-tidal freshwater marsh sites evaluated all range from medium to high. One (1) non-tidal freshwater marsh site associated with the Brunswick alternative was visited and received a high NCWAM rating. Hydrology functions for non-tidal freshwater marsh are typically high by default based on the NCWAM rating system because these wetland types require extended periods of inundation. Water quality functions range from medium to high and habitat functions range from low to high. NCWAM habitat function ratings resulted in either a low or high rating.

Wetland functions provided by non-tidal freshwater marshes are numerous. This wetland type is extensive along the existing shoreline of Harris Reservoir and also occurs along larger stream systems for both alternatives. Due to their high levels of nutrients, non-tidal freshwater marshes are one of the most productive ecosystems. Known water quality functions of lake-margin wetlands, such as the non-tidal freshwater marsh areas, include sediment and nutrient retention and removal of sediment and nutrients from inflowing waters (USGS 2010). Non-tidal freshwater marsh wetlands also reduce wave energy reaching the shoreline, thus reducing the amount of erosion. Beneficial habitat functions provided by non-tidal freshwater marsh areas include, but are not limited to, waterfowl feeding and nesting habitat and fish spawning/nursery areas. Low habitat functions typically resulted from the dominance of non-native species such as hydrilla (*Hydrilla verticillata*) and creeping water primrose (*Ludwigia grandiflora* ssp. *hexapetala*), which occupy large areas in Harris Reservoir. These exotic species were not observed for the Brunswick alternative.

- ***Bottomland Hardwood Forest*** – Four (4) bottomland hardwood forested wetland sites located around Harris Reservoir and 4 sites along the Harris transmission lines were evaluated using NCWAM. Overall NCWAM ratings for the bottomland hardwood forest wetlands associated with the Harris alternative range from low to high depending on the amount of disturbance when compared to reference conditions. Two (2) bottomland hardwood forest wetland sites associated with the Brunswick alternative were evaluated and received a medium and high NCWAM rating respectively.

Bottomland hardwood communities are located on 2nd order or greater stream systems and are characterized by a more seasonal hydrologic regime that generally ranges from intermittently to seasonally inundated for long durations. These seasonal fluctuations allow these wetland types to provide beneficial hydrology, water quality, and habitat functions to the surrounding environment. Important hydrology functions include surface and sub-surface storage capacity as well as flood attenuation and velocity reduction. Two of the most important water quality functions of southern bottomland hardwood forests include: 1) nutrient (nitrogen [N] and phosphorus [P]) removal from surface, subsurface, and groundwaters; and 2) export of organic carbon and associated nutrients to downstream aquatic ecosystems (Walbridge and Lockaby 1994). Numerous species of wildlife depend on bottomland forested wetland habitat at some stage in their life cycle. Wetland and aquatic dependant species also utilize this wetland type during the wet season. The wet season also allows bottomland hardwood forest to export organic forms of nutrients and detritus to downstream waters thus providing the basis for numerous food chains (Mitsch and Gosselink 1986).

- ***Riverine Swamp Forest*** – The size of this wetland type varies widely from narrow strips of backwater at the toe of floodplain slopes to broad expanses extending for hundreds of acres (NCWFAT 2010). Three (3) riverine swamp forest wetland sites located around Harris Reservoir and 2 sites along the Harris transmission lines were evaluated using NCWAM. Four of the five sites received a high rating and one site received a low rating. Two (2) riverine swamp forest wetland sites associated with the Brunswick alternative were evaluated and received high NCWAM ratings.

  Because they can be found in a variety of landscape positions, the hydrology of riverine swamp forests is characterized as seasonal to semi-permanent inundation. As a result, hydrology functions provided by riverine swamp forest wetland are similar to those provided by bottomland hardwood forest wetlands including storage of floodwater and groundwater recharge (Mitsch and Gosselink 1986). Many water quality functions are also comparable to other riverine wetland types. Riparian forested wetlands in North Carolina have been shown to remove and immobilize as much as 3.15-7.30 kilograms of P per hectare per year (Yarbro 1979). North Carolina floodplain swamps, such as the riverine swamp forests described herein, have been shown to contribute as much as 523 grams of litter fall per square meter per year (Mulholland and Kuenzler 1979). This litter fall is an important component of the detritus cycle that forms the basis for many food webs that serve multitudes of terrestrial and aquatic wildlife species.

- ***Headwater Forest*** – Seven (7) headwater forest wetland sites located around Harris Reservoir and 2 sites along the Harris transmission lines were evaluated using NCWAM. All but one site received a high NCWAM rating. Two (2) headwater forest wetland sites associated with the Brunswick alternative were evaluated and they received medium and high NCWAM ratings respectively.

  Headwater forest wetlands are abundant in the landscapes affected by both alternatives. Headwater forest wetlands are relatively dry when compared to other riverine wetlands; however they still provide important hydrology functions such as velocity reduction and floodwater storage and attenuation. Since they are often near the upper reaches of individual watersheds, they may be the first wetland type that surface runoff enters as it flows through a watershed. This wetland type is characterized by relatively flat ground surface that provides little water storage. Riverine wetlands, such as headwater forest, bottomland hardwood forest, and riverine swamp forest are typically net importers of inorganic forms of nutrients and net exporters of organic forms (Mitsch and Gosselink 1986). Because of their more widely fluctuating hydrologic cycle, headwater forest wetland may provide beneficial habitat to more varied assemblages of species than those wetlands located lower in the watershed that tend to have longer hydroperiods.

- ***Floodplain Pool*** – Three (3) floodplain pool wetland sites located around Harris Reservoir were evaluated using NCWAM. Two sites received a high NCWAM rating and one site received a low NCWAM rating. No floodplain pools were identified and evaluated for the Brunswick alternative.

Floodplain pools typically provide beneficial water quality functions such as surface water storage and retention unless they have been significantly disturbed. Many floodplain pools are located at the toe of slopes along the landward edge of floodplains and are the first wetland type to receive runoff from these slopes. This interception of runoff provides important hydrology and water quality functions for the entire floodplain system. Other types of floodplain pools occur in abandoned stream or river channels. Regardless of where they occur, floodplain pools usually dry out at some point in the year and thereby provide important habitat for amphibians due to the lack of fish communities (NCWFAT 2010).

Non-riverine Wetlands

- ***Pocosin*** – Two (2) pocosin wetland sites associated with the Brunswick alternative were evaluated using NCWAM. One site received a high rating and one site received a medium rating. No pocosin sites were identified and evaluated for the Harris alternative.

  Pocosin wetlands are non-riverine and the primary source of water is a high water table resulting from precipitation and slow drainage (NCWFAT 2010). Hydrology functions provided by pocosin wetlands include sub-surface storage and retention and aquifer recharge. As with all non-riverine wetlands, the water quality function associated with pocosin wetlands is associated with pollution change. NCWAM indicates that pollution change is applicable only to non-riverine wetlands and is a combination of the four water quality functions of riverine wetlands (particulate change, soluble change, pathogen change and physical change). Pocosin wetlands provide beneficial habitat for a variety of plant and animal species. At least two federally protected plant species are known to occur in pocosin wetland habitat, rough-leaved loosestrife (*Lysimachia asperulaefolia*) and Cooley's meadowrue (*Thalictrum cooleyi*). Pocosin wetlands can also sustain the federally endangered red-cockaded woodpecker (*Picoides borealis*) if there is a clear bole for pond pines emerging above the thick shrub layer.

- ***Pine Flat*** – Almost all pine flats are successional in nature and represent altered variants of pine savanna, hardwood flat or non-riverine swamp forest; therefore, there are no reference wetlands for this type (NCWFAT 2010). Two (2) pine flat wetland sites associated with the Brunswick alternative were evaluated using NCWAM and both sites received a high rating. No pine flat sites were identified and evaluated for the Harris alternative.

  Pine flat wetlands are non-riverine and therefore are influenced primarily by precipitation, groundwater, and upland runoff. They do not provide the same level of surface hydrology function as riverine wetlands do, however they are an important provider of subsurface hydrology function such as sub-surface water storage and groundwater recharge. Water quality functions provided by pine flat wetlands are also diminished by the lack of surface hydrology. The primary water quality function provided by non-riverine wetlands, including pine flat wetlands, is pollution change. Habitat function of pine flat wetlands can be highly variable depending primarily on the amount of disturbance to the area and the surrounding landscape.

- ***Pine Savanna*** – The few examples of pine savanna remaining in North Carolina are located primarily in the southeastern portion of the state. Size of this wetland type is dependent on long-term fire frequency (NCWFAT 2010). One (1) pine savanna wetland site associated with the Brunswick alternative was evaluated using NCWAM and received a high rating. No pine savanna sites were identified and evaluated for the Harris alternative.

Pine savanna wetlands are non-riverine and therefore are influenced primarily by precipitation, groundwater, and upland runoff. This wetland type is characterized by relatively flat ground surface that provides little surface water storage. They do not provide the same level of surface hydrology function as riverine wetlands do, however they are an important provider of subsurface hydrology function such as sub-surface water storage and groundwater recharge. Water quality functions provided by pine savanna wetlands are also diminished by the lack of surface hydrology. The primary water quality function provided by non-riverine wetlands, including pine savanna wetlands, is pollution change. Habitat function of pine savanna wetlands can be highly variable depending primarily on the amount of disturbance to the area and the surrounding landscape. These wetland types are known to harbor diverse plant communities if they are close to reference conditions, including several federally threatened or endangered plant species such as American chaffseed (*Schwalbea americana*), Cooley's meadowrue, and rough-leaved loosestrife. Pine savannas also provide important nesting and foraging habitat for the red-cockaded woodpecker.

- ***Hardwood Flat*** – This wetland type may vary widely in size, but can be quite large, dependant on landscape position and disturbance (NCWFAT 2010). One (1) hardwood flat site associated with the Brunswick alternative was evaluated using NCWAM and received a medium rating. No hardwood flat sites were identified and evaluated for the Harris alternative.

  Hardwood flat wetlands are non-riverine and therefore are influenced primarily by precipitation, groundwater, and upland runoff. They do not provide the same level of surface hydrology function as riverine wetlands do, however they are an important provider of subsurface hydrology function such as sub-surface water storage and groundwater recharge. Water quality functions provided by hardwood flat wetlands are also diminished by the lack of surface hydrology. The primary water quality function provided by non-riverine wetlands, including hardwood flat wetlands, is pollution change. Habitat function provided by hardwood flat wetlands can be highly variable depending primarily on the amount of disturbance to the area and the surrounding landscape.

- ***Basin Wetland*** – One (1) basin wetland site associated with the Brunswick alternative was evaluated using NCWAM and it received a high rating. Basin wetlands are non-riverine and are seasonally to semi-permanently inundated. Hydrology is provided by a perched water table, groundwater discharge, runoff, and precipitation (NCWFAT 2010). Hydrology functions provided by basin wetlands include both surface and sub-surface storage and retention. Water quality functions are limited primarily to pollution change. Habitat functions are similar to those provided by floodplain pools, which were noted to provide good habitat for amphibians.

- ***Seep*** – One (1) seep wetland site associated with the Brunswick alternative was evaluated using NCWAM and it received a high rating. No seep wetland sites were identified and evaluated for the Harris alternative.

  Seep wetlands are non-riverine and occur on slopes where groundwater intercepts the ground surface. Hydrology and water quality functions of seep wetlands are not as pronounced as other non-riverine wetland types because they are almost always expressing groundwater and provide little functional opportunity. Because it is on a slope, there is little opportunity for the seep wetland to store or retain surface water or ground water and little chance to offer pollution change as the other non-riverine wetlands can provide. Seep wetland do provide habitat for amphibians and certain wetland dependent species because they are typically semi-permanently to permanently saturated.

3.2.2 Streams

Field evaluations were conducted to review general stream condition at sites represented by 20 existing SQAW forms (19 streams) within the area potentially affected by the Harris alternative reservoir expansion. The SQAW form was not specifically designed nor intended for use as a functional assessment tool, but has a stated purpose that:

> This channel evaluation form is intended to be used only as a guide to assist landowners and environmental professionals in gathering the data required by the United States Army Corps of Engineers to make a preliminary assessment of stream quality. The total score resulting from the completion of the form is subject to USACE approval and does not imply a particular mitigation ratio or requirement.

The field review of the 20 sites generally confirmed that the information and scoring used on the SQAW forms was reasonable in describing the general condition and relative function provided by the evaluated features. The scoring for 164 SQAW forms for the streams delineated for the area potentially affected by the Harris alternative filling, trenching, and inundation actions was used to identify general trends in stream function using the qualitative information as a relative measure of overall function. No streams were evaluated along the potential transmission line upgrade routes or for the Brunswick alternative. Table 3.6 presents the results of the scoring information extracted from the SQAW forms.

Table 3.6. Summary of Harris Reservoir and Infrastructure Stream Assessment Results.

Stream Type	Approx. Length (mi)	Number of Sites Evaluated	Score Distribution (100 Possible Total Points)			Distribution of Site Scores (Percentage)		
			Low Score	Median Score	High Score	Point Range 0-33	34-66	67-100
Perennial – Triassic	14.1	36	21	51.5	80	14	69	17
Intermittent – Triassic	10.8	104	18	40	70	18	81	1
Perennial – Non-Triassic	3.0	13	54	65	73	0	62	38
Intermittent – Non-Triassic	0.9	11	38	49	58	0	100	0
Totals	**28.8**	**164 [a]**				**15%**	**78%**	**7%**

[a] Eight stream segments were not included in analysis due to the lack of available SQAW form.

A score of 100 represents a stream of the highest quality according to instructions for the SQAW worksheet. Overall, most streams evaluated for the Harris alternative power block and support facilities area and Harris reservoir expansion area scored between 34 and 66 out of a possible 100 points. Relatively few scored above 67 total points or below 33 points. The same general trend was identified when comparing the perennial streams to intermittent streams, and streams within the Triassic Basin to streams not in the Triassic Basin. No streams outside the Triassic Basin scored below a 34.

Perennial streams outside the Triassic Basin collectively tended to score higher than perennial streams inside Triassic Basin as evidenced by median score, but the highest scoring stream was a perennial stream in the Triassic Basin. A similar trend was seen for intermittent streams, with intermittent streams outside the Triassic Basin collectively tending to score higher than those inside the Triassic Basin, but the highest scoring intermittent stream was in the Triassic Basin. Perennial streams collectively tended to score higher than intermittent streams, whether inside the Triassic Basin or outside the Triassic Basin.

Additional information on stream quality was evaluated for each of the four groupings of parameters representing physical, stability, habitat, and biology characteristics. Tables 3.7 through 3-10 present the results of the scoring information for these four groupings extracted from the SQAW forms.

Table 3.7. Summary of Harris Reservoir and Infrastructure Stream Physical Score Results.

Stream Type	Approx. Length (mi)	Number of Sites Evaluated	Score Distribution (45 Possible Points)			Distribution of Site Scores		
						Point Range		
			Low Score	Median Score	High Score	0-15	16-30	31-45
Perennial – Triassic	14.1	36	11	25	36	6%	72%	22%
Intermittent – Triassic	10.8	104	8	19.5	32	19%	79%	2%
Perennial – Non-Triassic	3.0	13	20	29	33	0	69%	31%
Intermittent – Non-Triassic	0.9	11	17	23	29	0	100%	0
TOTAL:	**28.8**	**164** [a]				**13%**	**78%**	**9%**

[a] Eight stream segments were not included in analysis due to the lack of available SQAW form.

Physical score results show similar trends to those noted for the overall score results. Perennial streams collectively tended to score higher than intermittent streams, and although the highest scoring perennial and intermittent streams were in the Triassic Basin, streams outside the Triassic Basin collectively tended to score higher than those inside the Triassic Basin.

Table 3.8. Summary of Harris Reservoir and Infrastructure Stream Stability Score Results.

Stream Type	Approx. Length (mi)	Number of Sites Evaluated	Score Distribution (17 Possible Points)			Distribution of Site Scores (Percentage)		
						Point Range		
			Low Score	Median Score	High Score	0-5	6-11	12-17
Perennial – Triassic	14.1	36	3	10	14	17%	56%	28%
Intermittent – Triassic	10.8	104	3	9	14	8%	80%	12%
Perennial – Non-Triassic	3.0	13	9	12	14	0	15%	85%
Intermittent – Non-Triassic	0.9	11	7	10	13	0	64%	36%
TOTAL:	**28.8**	**164** [a]				**9%**	**68%**	**23%**

[a] Eight stream segments were not included in analysis due to the lack of available SQAW form.

Stability score results show similar trends to those noted for the overall score results, with the exception that more perennial streams outside the Triassic Basin scored relatively higher. Perennial streams collectively tended to score higher than intermittent streams, and although the highest scoring perennial and intermittent streams were in the Triassic Basin, streams outside the Triassic Basin collectively tended to score higher than those inside the Triassic Basin based on review of lowest and median scores. Overall, the highest scores recorded for each of the four categories of stream evaluated are similar, median scores are relatively close, but lowest scores lower for Triassic perennial and intermittent streams.

Table 3.9. Summary of Harris Reservoir and Infrastructure Stream Habitat Score Results.

Stream Type	Approx. Length (mi)	Number of Sites Evaluated	Score Distribution (20 Possible Points)			Distribution of Site Scores (Percentage)		
			Low Score	Median Score	High Score	Point Range 0-6	7-13	14-20
Perennial – Triassic	14.1	36	4	10	16	14%	58%	28%
Intermittent – Triassic	10.8	104	3	8	16	26%	69%	5%
Perennial – Non-Triassic	3.0	13	12	14	17	0	38%	62%
Intermittent – Non-Triassic	0.9	11	8	11	14	0	82%	18%
TOTAL:	**28.8**	**164** [a]				**20%**	**65%**	**15%**

[a] Eight stream segments were not included in analysis due to the lack of available SQAW form.

Habitat score results show similar trends to those noted for the overall score results. Perennial streams collectively tended to score higher than intermittent streams, and streams outside the Triassic Basin collectively tended to score higher than those inside the Triassic Basin based on review of low, median, and high scores for each category.

Table 3.10. Summary of Harris Reservoir and Infrastructure Stream Biology Score Results.

Stream Type	Approx. Length (mi)	Number of Sites Evaluated	Score Distribution (18 Possible Points)			Distribution of Site Scores (Percentage)		
			Low Score	Median Score	High Score	Point Range 0-6	7-12	13-18
Perennial – Triassic	14.1	36	1	7	15	44%	50%	6%
Intermittent – Triassic	10.8	104	0	5	12	83%	17%	0
Perennial – Non-Triassic	3.0	13	3	9	14	31%	61%	8%
Intermittent – Non-Triassic	0.9	11	0	4	10	64%	36%	0
TOTAL:	**28.8**	**164** [a]				**69%**	**29%**	**2%**

[a] Eight stream segments were not included in analysis due to the lack of available SQAW form.

Biology score results differ from the trends noted for the overall score results and the other three functional categories in terms of distribution of site scores. Overall, intermittent streams tended to score lower than perennial streams based on distribution of site scores and median scores. The majority of intermittent sites achieved less than a third of the total points. Perennial streams collectively tended to score higher than intermittent streams, and streams outside the Triassic Basin collectively tended to score slightly higher than those inside the Triassic Basin based on review of low, median, and high scores for each category and overall distribution of site scores.

General descriptions of the relative functions identified for the stream types subject to potential impact by the Harris and Brunswick alternatives are provided for consideration. These are based on results from the evaluation of representative sites for the stream types for which SQAW forms were available for the Harris alternative as well as general information on functions provided by streams obtained from literature sources.

- **Tidal Streams** - Tidal streams are not present in any areas affected by the Harris alternative, but are present in areas affected by the Brunswick alternative. The tidal stream segment subject to fill for the Brunswick alternative is the upper tidal portion of Nancy's Creek and associated smaller tidal channels. Nancy's Creek is classified as High Quality Waters (HQW) by the DWQ. Waters can be designated as HQW through rating as excellent based on biological and physical/chemical characteristics through DWQ monitoring or special studies or primary nursery areas (PNA) and other function nursery areas designated by the marine Fisheries Commission. This tidal stream system would be considered to be high-functioning and supports aquatic habitats that are considered essential fish habitat by the National Marine Fisheries Service.

- **Perennial Streams** – Perennial streams evaluated in areas subject to inundation by reservoir expansion ranged in total SQAW score from 21 to 80 (out of 100). This represents a fairly large range for the qualitative assessment, which is indicative of a wide range in the function provided. Both extremes in score are for streams in the Triassic Basin. The silt-clay soils of the Triassic Basin have low permeability which inhibits infiltration and promotes surface runoff during rainstorms, and are also very erodible, which creates a concern for Triassic Basin streams (Durham 2003). Several of the perennial streams in the Triassic portion of the project exhibited evidence of past disturbance which appears to have resulted in scouring of stream banks, widening of stream channel, and deposition of large amounts of unconsolidated sediment into the streams. Most of these streams show signs of being in various stages of natural recovery, with channels appearing to be adjusting to new patterns, profiles, and dimensions. Non-Triassic perennial streams evaluated for the Harris alternative ranged total SQAW score from 54 to 73 (out of 100). Non-Triassic streams are limited in the project area to the southeastern portion of the Harris Reservoir watershed. These streams tended to score higher overall, with all non-Triassic perennial streams scoring higher than the median score for Triassic perennial streams.

  Overall, the perennial streams delineated within the Harris alternative exhibited variable quality, with some scoring very low on the SQAW form which indicates that some may not be functioning as highly as others. Some appear to be experiencing sediment load issues and may not be transporting bedload efficiently. Perennial streams noted with extensive, unconsolidated sand deposition do not provide as much habitat diversity and complexity for stream organisms as other streams. Benthic macroinvertebrate sampling following NCDENR Protocols undertaken in seven perennial streams in the reservoir expansion area resulted in a Good-Fair characterization for the one stream in the non-Triassic portion, and Poor to Fair characterizations for the six streams in the Triassic portion (COLA ER 2.4.2.1.3). At the other end of the functional spectrum, several perennial streams evaluated within the Harris alternative scored relatively highly, within the Triassic portion as well as non-Triassic portion. Field evaluations confirmed that several of these streams exhibited relatively good stability, contained riffle-pool complexes, contained a diversity of benthic macroinvertebrate organisms, and would be considered to have relatively high function.

- **Intermittent Streams** –Intermittent streams evaluated in areas subject to inundation by reservoir expansion ranged in total SQAW score from 18 to 70 (out of 100). This represents a fairly large range for the qualitative assessment, which is indicative of a wide range in the function provided. As with the perennial streams evaluated, both extremes in score for intermittent streams are for streams in the Triassic Basin. Most of the intermittent streams evaluated also exhibited similar signs of past disturbance and various stages of recovery.

Intermittent streams represent an intermediate hydrologic regime in a continuum from stormwater-driven ephemeral streamflow to perennial streamflow. Collectively, intermittent streams and first order perennial streams constitute headwater streams that comprise a relatively large percentage of the total stream length in a watershed. Small, first order headwater streams are reported to contribute up to 70% of the mean-annual water volume and 65% of the nitrogen removal to second order streams and 55% of the mean-annual water volume and 40% of the nitrogen removal to higher order streams (DWQ 2009b). These small streams also influence biodiversity of downstream water bodies by acting as organic matter sources, providing unique habitat niches, and providing refugia from competitors and predators (DWQ 2009b). The higher scoring intermittent streams evaluated are expected to have relatively higher function for these and other functions, while the lower scoring intermittent streams, particularly those with apparent stability issues, are expected to have relatively lower function.

- **Naturalized Ditch/Canal** – No naturalized ditches or canals were identified within the Harris or Brunswick power block and support facilities areas or Harris reservoir expansion area. Naturalized ditches and canals were identified along potential transmission line routes for both the Harris and Brunswick alternatives, primarily based identification from National Hydrography Dataset. Additional features that may be considered naturalized ditches or canals may be present along the transmission line routes, particularly in areas containing extensive agricultural or silvicultural drainage systems. Features characterized as naturalized ditches and canals are man-made channels that exhibit perennial or intermittent stream flows as a result of intercepting groundwater. These features have been excavated in locations that did not previously support a stream feature, which distinguishes them from natural streams that have been altered by straightening, relocation, or other human activities.

  No naturalized ditches and canals were evaluated in the field, but such features that are considered waters of the United States are expected to support functions of streams at variable levels depending on flow regime, stability of banks, sediment load, complexity of "in-stream" habitat, and condition of riparian vegetation, among other parameters.

3.2.3 Non-linear Surface Waters

Reservoir habitat is present only within the Harris alternative. The primary function of Harris Reservoir is to provide adequate water storage for the safe and reliable operation of the Shearon Harris Nuclear Plant. The reservoir was not created for flood control, public water supply, or recreation. Reservoirs, created by damming of a stream, have characteristics of both rivers and lakes (EPA 2006). Baker and Dycus (2006) also suggest that a reservoir typically has characteristics of both lakes and rivers, with river-like characteristics in the upper reaches and more lake-like near the dam. This appears to reflect the current conditions on Harris Reservoir with the deeper, clearer, more lake-like habitats occurring closer to the dam. The upper reaches more closely resemble a wide river with fringing marsh, shallower water, and more suspended sediment in the water column.

PEC conducts monitoring in Harris Reservoir, which is summarized in annual reports. In addition, the DWQ has also conducted sampling, including four times in the summer of 2008 (DWQ 2009a). DWQ reported the following based on its 2008 sampling:

> Secchi depths in 2008 were generally greater than 1.0 meter (range 0.9 to 2.0 meters) and were representative of good water clarity. These secchi depths also agreed with low turbidity values observed throughout the reservoir. Nutrient analysis indicated low concentrations of ammonia and nitrite plus nitrate, and elevated concentrations of total Kjeldahl nitrogen (range 0.58 to 0.68 mg/L). Total phosphorus was generally present in moderate amounts in 2008. Possible sources for the nutrients found in this lake are discharges from the wastewater treatment plant in the Town of Holly Springs upstream as well as non-point source runoff in the rapidly developing urban watershed.
>
> Aquatic plants, including the nuisance macrophyte *Hydrilla verticillata*, were found in Harris Lake in 2008 in several locations, most notably in the White Oak Creek arm. The presence of excessive aquatic macrophyte growth in the White Oak arm has been observed on previous DWQ sampling trips.

DWQ summarized its assessment as:

> In 2008, chlorophyll *a* levels in Harris Lake were generally moderate with lakewide means ranging from 18 to 25 µg/L. No violations of the state standard for chlorophyll *a* were noted. Based on the calculated NCTSI scores, the trophic state of Harris Lake was determined to be very biologically productive (eutrophic). This trophic state was also observed in 2003 when this lake was previously monitored by DWQ. Use support for Harris Lake could not be determined since fewer than ten sampling events occurred. However, the eutrophic status of the lake and large amounts of Hydrilla warrant future monitoring.

PEC has been monitoring Harris Reservoir since construction, and water quality data are summarized in the COLA ER (sections 2.3.3.2 and 2.4.2.1.2). PEC's monitoring results are consistent with DWQ's recent monitoring conclusions. The COLA ER (2.4.2.1.2) summarizes the general condition of Harris Reservoir as:

> Harris Reservoir is a biologically productive reservoir, similar to other impoundments in the Research Triangle area. Although it has many of the characteristics of eutrophic southeastern reservoirs (e.g., 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 quality and low turbidity.

3.2.4 Summary of Existing Functions

One of the objectives of this evaluation was to identify the relative function provided by existing aquatic resource types potentially impacted by the Harris and Brunswick alternatives. A comprehensive and systematic functional assessment protocol was not identified that would readily and reasonably identify the level of relative physical, chemical, and biological function provided by the different aquatic resource types (wetland, stream, and non-linear surface water). Based on the results of the functional evaluation techniques used, the following general observations can be made:

- **Wetlands** – The majority of wetlands potentially affected by the Harris and Brunswick alternatives rated High based on NCWAM evaluations (77% for both Harris and Brunswick alternatives). Other evaluated wetlands rated medium to poor. Expansion of NCWAM evaluations to all wetland sites potentially affected by either alternative could result in a different distribution of ratings, but based on the relatively undeveloped nature of the potential impact areas, most wetlands are expected to rate high or medium.

- **Streams** – The majority of streams potentially affected by the Harris Reservoir expansion and site construction scored in the middle third of possible maximum points based on use of existing SQAW form results. Triassic Basin streams, which constitute the majority of the streams, tended to score lower than those not in the Triassic Basin. These streams are expected to exhibit functions ranging from low (for relatively unstable reaches) to high (for relatively stable reaches). No evaluation was undertaken for streams along the transmission lines or for the construction portion of the Brunswick alternative. The tidal stream (Nancy's Creek) subject to fill from Brunswick alternative construction activities is classified as HQW and a PNA, and as such is assumed to have high function in the absence of any identifiable disturbance.

- **Non-linear Surface Waters** – No functional evaluation was undertaken in the field for these waters. A review of existing data summaries from water quality monitoring studies for Harris Reservoir indicates that Harris Reservoir has relatively good water quality and is expected to have relatively good function.

4.0 ANTICIPATED FUNCTIONAL CHANGES

Functional changes anticipated to occur to aquatic resources as a result of project activities are provided for impacts due to filling (section 4.1), trenching (section 4.2), flooding (section 4.3), and clearing (section 4.4).

4.1 Filling Impacts

Impacts from filling activities are expected as a result of site development for the power block and support facilities, as well as road improvements and relocations. Filling will convert the affected aquatic resources to uplands occupied by industrial development and impervious surfaces. Existing aquatic resource functions will be permanently lost in wetlands, streams, and ponds subject to fill. The loss of primary nursery areas and essential fish habitat through tidal wetland fill for power block improvements under the Brunswick alternative will remove a valuable habitat function from the natural environment.

4.2 Trenching Impacts

Impacts from trenching activities are expected as a result of pipeline construction for makeup water system pipelines. Trenching activities will include clearing for ROW, excavation for pipe installation, and regrading following installation. Excavation is expected to result in temporary loss of function in affected streams until regrading is complete and stream beds and banks are stabilized. Affected wetlands are expected to experience a temporary loss of function from excavation until regrading is complete and the wetland surface is restored and stabilized. Some permanent diminishment of wetland function may occur as a result of clearing forested wetlands for ROW and subsequent maintenance activities in the ROW to prevent regrowth of trees. See section 4.4 for expected functional changes expected to result from ROW clearing and maintenance activities.

4.3 Flooding Impacts

Impacts from flooding are not expected for the Brunswick alternative, but are expected for the Harris alternative from expansion of Harris Reservoir. Although the physical impact caused by inundating wetlands and streams is considered a loss by the USACE under regulatory guidelines for permitting and mitigation purposes, inundation does not result in a complete loss of aquatic function but rather represents a conversion of one aquatic type to another that also provides aquatic function. Increasing the normal pool elevation of Harris Reservoir from 220 to 240 ft NGVD29 will affect wetland, stream, and non-linear surface water and is expected to result in functional changes in the individual aquatic resources affected.

Since 1991, EPA has been promoting the Watershed Protection Approach as a framework for meeting water resource challenges (EPA 2006):

> The watershed approach is an integrated, holistic strategy for more effectively protecting and managing surface water and ground water resources and achieving broader environmental protection objectives using the naturally defined hydrologic unit (the watershed) as the integrating management unit. Thus, for a given watershed, the approach encompasses not only the water resource, such as a stream, river, lake, estuary, or aquifer, but all the land from which water drains to the resource. The watershed approach places emphasis on all aspects of water resource quality: physical (e.g., temperature, flow, mixing, habitat); chemical (e.g., conventional and toxic pollutants such as nutrients and pesticides); and biological (e.g., health and integrity of biotic communities, biodiversity).

Harris Reservoir, created to provide cooling water storage for HNP, is a prominent feature of the Buckhorn Creek watershed. Harris Reservoir currently occupies approximately 7.8 percent of its drainage area, and with the proposed expansion will occupy approximately 16 percent (COLA ER 2.3.1.2.1). Harris Reservoir was created by inundating approximately 3,610 acres of uplands, wetlands, and streams following Main Dam completion in late 1980 and filling to the full-pool elevation of 220 msl by early 1983. Reservoirs created by damming of streams have characteristics of both rivers and lakes, and can be divided into three zones, which correspond to flowing, river-like conditions; transition to lake conditions; and non-flowing, lake-like conditions near the dam (EPA 2006). Reservoir expansion will result in inundation of streams and wetlands. The majority of wetlands affected by inundation have formed within the normal pool of the reservoir since construction and filling was complete. Streams affected by inundation either currently flow directly into the reservoir or are tributary to streams that flow into the reservoir.

Wetlands affected by flooding for the Harris alternative are all characterized as riverine wetlands by NCWAM. Expected functional changes for the non-forested wetlands, consisting of non-tidal freshwater marsh, are discussed in section 4.3.1. Expected functional changes are similar for the forested wetland types based on location and physical habitat changes and these are treated together in section 4.3.2. Expected functional changes for streams are discussed in section 4.3.3. Expected functional changes to non-linear surface waters resulting from reservoir expansion are discussed in section 4.3.4.

4.3.1 Non-Forested Wetland Functional Changes

The majority of the wetlands that will be affected by reservoir expansion are non-forested wetlands and can be characterized as non-tidal freshwater marsh located along the existing shoreline of Harris Reservoir, and also extending below the 220-foot normal pool level out to a maximum depth of 6.6 feet. The non-tidal freshwater marsh and associated fringe wetlands, which are currently part of the lake's riparian zone, were formed as a result of the original Harris Reservoir construction and are man-induced (artificial) wetlands. Because reservoirs are entirely artificial environments, "natural reference condition" has no meaning (EPA 1998). Likewise, there is no reference under NCWAM for non-tidal freshwater marsh (NCWFAT 2010). An assessment of soils mapping data published by USDA before Harris Reservoir was formed shows that much of the non-tidal freshwater marsh areas now considered jurisdictional have formed on non-hydric soil mapping units or non-hydric soil units that contained minor hydric inclusions along drainageways.

Certain water quality functions may be affected as a result of flooding non-tidal freshwater marsh wetlands surrounding Harris Reservoir. Known water quality functions of lake-margin wetlands, such as the non-tidal freshwater marsh areas, include sediment and nutrient retention and removal of sediment and nutrients from inflowing waters (USGS 2010). Due to their high levels of nutrients, freshwater marshes are one of the most productive ecosystems. Non-tidal freshwater marsh wetlands also reduce wave energy reaching the shoreline, thus reducing the amount of erosion. Clear water in a lake can be beneficial to aquatic fauna both in the lake and downstream due to lowered sedimentation and organic content in the water. Unless mitigative measures are undertaken, the loss of the non-tidal freshwater marsh wetlands will likely result in a temporary decrease in water clarity due to increased erosion along the shoreline until new fringing wetland areas become established. The effects to these functions are expected to be temporary based on the relatively rapid development of these wetland types within and surrounding Harris Reservoir following its original construction and filling as documented in PEC's post-construction biological monitoring reports.

PEC's annual monitoring reports following construction and filling of Harris Reservoir document that the non-tidal freshwater marsh wetland community began to become established within the first growing season following establishment of the reservoir pool. Natural establishment continued such that by the end of the second growing season wetland communities covered large areas of the shallow areas of the reservoir. A considerable part of the non-tidal freshwater marsh community that will be inundated is now dominated or constituted entirely by hydrilla either individually or in combination with creeping water primrose. Hydrilla is present in deepwater habitats of Harris Reservoir as well, and is noted as able to root in water to depths of 10 feet in North Carolina, depending on water clarity (NCSU 2010a). However, based on USACE wetlands criteria, only those hydrilla-dominated areas established in less than 6.6 feet of water were delineated as wetlands and included in the total reported for impacted wetlands. For reasons that are largely unknown, the establishment of hydrilla and other submerged aquatic vegetation that grows in large monocultures will result in increased water clarity (Langeland 1996).

The following is a summary for the establishment of non-tidal freshwater marsh wetlands within and along the fringes of the pool of Harris Reservoir as documented in annual monitoring reports for the period following filling of the existing reservoir:

- In 1983, the first year with pool at elevation 220, a total of 25 aquatic species were observed, with aquatic vegetation dominated by shoreline emergent species. Submerged vegetation was sparse and confined to the shallow areas of major tributaries of the reservoir.

- In 1984, a total of 58 aquatic species were observed, with relict terrestrial vegetation noted as mostly dying out and replaced with herbaceous shoreline emergent species typical of that type of habitat. Large quantities of floating-leaf and submersed vegetation were noted as having developed between 1983 and 1984. The submersed community increased to cover large areas of the shallow regions of the reservoir less than 2 meters in depth.

- In 1985, a total of 66 aquatic species were observed. The increase between 1984 and 1985 was noted as not being as great as in previous years, but emergent vegetation coverage was noted as narrow zone around most of the lake. Submerged and floating leaf vegetation was noted as having slightly expanded in coverage over the previous year.

- In 1986, a total of 70 aquatic species were observed. The emergent community was noted as having expanded in the headwater areas of the White Oak and Little White Oak Creek arms. The floating-leaf community was noted as expanded in coverage, and the submersed vegetation was noted as having expanded greatly in coverage such that by October most areas of Harris Reservoir less than 3 meters in depth supported submersed vegetation.

- In 1987 and 1988, the composition and coverage of aquatic vegetation was noted as remaining relatively constant in the reservoir.

- Hydrilla, an exotic, invasive aquatic species that was first observed in the reservoir in 1988, is reported to have expanded to cover 30 hectares (74 acres) by 1989. Coverage by hydrilla is reported to have expanded to 240 hectares (593 acres) in 1990 and further expanded to 425 hectares (1,050 acres) in 1991. Coverage is reported to have expanded to 445 hectares (1,100 acres) by 1994, which was noted as being approximately 77% of the available habitat, and has been reported as remaining fairly stable through 2008 (last year of available data). Creeping water primrose, another exotic, invasive aquatic species, was first noted in the reservoir in 1985 and by 1995 was noted as present with hydrilla in the littoral zone throughout the reservoir except in areas lacking suitable substrate.

Beneficial habitat functions provided by non-tidal freshwater marsh areas, that will be temporarily lost as a result of reservoir expansion, include primarily waterfowl feeding and nesting habitat and fish spawning/nursery areas. Non-native aquatic species such as the invasive creeping water primrose and hydrilla have become well established in Harris Reservoir. These species are generally considered to have a detrimental effect to the native aquatic vegetation in these marsh areas although they do provide valuable water quality and habitat functions. However, the presence of these non-native species, and dominance or co-dominance within much of the non-tidal freshwater marsh evaluated within and fringing Harris Reservoir, does not appear to have adversely affected the overall function of these wetland areas as evidenced by the generally High ratings (15 of 18 sites rated High, the other 3 as Medium) for these wetlands. As water levels rise in Harris Lake as a result of this project, much of the existing hydrilla beds will be inundated by up to 20 feet of additional water and will likely die off. However, hydrilla is very resilient and will likely reestablish itself once the lake level reaches its new elevation. In North Carolina hydrilla usually grows to depths of approximately 10 feet, except where erosion has produced very turbid conditions. In virtually all cases, the depth of hydrilla growth is greater than that of competing submersed plant species (NCSU 2010a). Based on its invasive nature, hydrilla may be able to keep pace with the gradual rise of the pool elevation as the expanded reservoir fills and quickly colonize suitable habitat. The rapid reestablishment of this species could be beneficial to the timely reestablishment of lacustrine physical, biological, and chemical function after the normal pool elevation change occurs. Hydrilla has been found to be beneficial to some sport fish, such as largemouth bass, and is eaten by waterfowl (Langeland 1996).

4.3.2 Forested Wetland Functional Changes

Forested wetlands are located landward of the reservoir shoreline primarily along the numerous drainages feeding Harris Reservoir. These forested wetland types include bottomland hardwood forest, riverine swamp forest, headwater forest, and floodplain pool. Similar to much of the non-forested wetland areas, many of the forested wetlands identified in the Harris Reservoir study area are thought to be the direct result of the original reservoir impoundment. Broad floodplains bordering the larger 2nd and 3rd order streams draining into the reservoir were inundated during reservoir construction. Wake County soils mapping (USDA 1970) and soils data from Chatham County that pre-date Harris Reservoir construction indicate that most of the larger streams systems were located on large floodplains, most of which appear to have been comprised largely of hydric soil mapping units, particularly Wehadkee silt loam and Wehadkee and Bibb soils mapping units. The majority of these hydric soil mapping unit areas that were inundated by the original reservoir pool are now within the deeper portions of the reservoir. The forested wetlands present above the normal pool elevation (220 feet NGVD29) are more extensive than the hydric soil mapping units would indicate. The hydrologic influence of the reservoir appears to have provided suitable hydrologic conditions for forested wetlands formation in areas that may not have previously supported wetlands, particularly in the floodplains of White Oak Creek and Little White Oak Creek at the upper end of the reservoir. Similar hydrologic conditions resulting from reservoir expansion may result in similar conducive conditions for expansion of forested wetlands in floodplains above the new reservoir normal pool. However, the existing forested wetlands will be affected by the reservoir expansion by clearing and inundation, with a resulting change in functions.

Hydrology functions provided by the forested wetlands that will be affected by flooding include surface and sub-surface storage capacity as well as flood attenuation and velocity reduction. During periods of high water, riparian forested wetlands provide for storage of floodwater and during dry periods these same wetlands provide groundwater recharge (Mitsch and Gosselink 1986). Flood attenuation and velocity reduction is also provided by both forested wetlands and non-forested wetlands. These functions are expected to be provided by the expanded reservoir such that these functions will not be lost as a result of inundation.

Two important water quality functions of southern bottomland hardwood forests include: 1) nutrient (nitrogen [N] and phosphorus [P]) removal from surface, subsurface, and groundwaters; and 2) export of organic carbon and associated nutrients to downstream aquatic ecosystems (Walbridge and Lockaby 1994). Riverine wetlands, such as headwater forest, bottomland hardwood forest, and riverine swamp forest are typically net importers of inorganic forms of nutrients and net exporters of organic forms (Mitsch and Gosselink 1986). The loss of riverine forested wetlands from expansion of Harris Reservoir will reduce the amount of organic material, resulting from decomposition in the forested wetlands, from entering the downstream aquatic habitats. North Carolina floodplain swamps, such as the riverine swamp forests described herein, have been shown to contribute as much as 523 grams of litter fall per square meter per year (Mulholland and Kuenzler 1979). This litterfall is an important component of the detritus cycle that forms the basis for many food webs. Therefore, each acre of riverine swamp forest converted to a lotic system could remove as much as 2,100 kilograms of litter fall per acre from downstream aquatic habitat. The loss of the riverine wetlands in the proposed impact areas will result in a reduction of N and P removal capacity provided by these wetlands. Riparian forested wetlands in North Carolina have been shown to remove and immobilize as much as 3.15-7.30 kilograms of P per hectare per year (Yarbro 1979).

However, the expanded reservoir will provide some of these same water quality functions although through a different process (see section 4.3.3). A forested riparian zone will surround the expanded reservoir. Although the riparian zone may not be entirely or even predominately forested wetlands, upland forested areas comprising riparian zones provide similar functions, including litter fall, as wetland forested riparian zones (FISRWG 2001). The loss of approximately 53.6 miles of existing riparian buffer (assuming 28.6 miles of stream, buffer on both stream banks) will be offset by an increase of 61.9 miles of riparian buffer surrounding the expanded reservoir (reservoir perimeter increasing from approximately 86.6 miles to 148.5 miles). The loss of the riverine wetlands from reservoir expansion is not expected to result in a substantial overall change in the nutrient cycling capacity of this watershed.

Important habitat functions will also be changed as a result of flooding the forested wetlands. Some specific habitat types found in these forested wetlands will be lost as a result of clearing and flooding resulting in displacement of wetland dependent species as well as other species that utilize forested areas but that are not wetland-dependent. This represents a loss of habitat for specific species utilizing these wetland habitats, but a gain for other species utilizing the resulting aquatic habitats. For example, loss of riverine swamp forest and the bottomland hardwood forest will reduce habitat available to some species of neotropical migrant bird species that nest and feed in these wetland habitats, but the resulting expanded reservoir will benefit other bird species, such as various waterfowl, shorebirds, wading birds, and bald eagles, will benefit from the additional aquatic habitats present within and along the larger perimeter of the expanded reservoir.

4.3.3 Stream Functional Changes

Inundation of streams for the reservoir expansion will affect stream functions within the stream reaches subject to flooding. Certain functions may be lost or diminished for the affected reaches, but the overall function may not be greatly affected at a watershed level. A watershed has been defined as an area of land that drains water, sediment, and dissolved materials to a common outlet at some point along a stream channel (FISRWG 2001). The streams affected by reservoir expansion have already been affected by the creation of Harris Reservoir and either flow directly into Harris Reservoir, or are tributary to these streams. Table 4.1 provides a summary for streams previously affected by creation of Harris Reservoir, proposed to be affected by the Harris alternative, and remaining in the watershed.

Table 4.1. Summary of Streams within Buckhorn Creek Watershed. [a]

Watershed Area	Streams (miles)		
	Perennial	**Intermittent**	**Total**
Inundated by Existing Harris Reservoir	25.4	17.3	42.7
Inundated by Proposed Reservoir Expansion	15.8	10.9	26.8
Remaining Upstream of Harris Reservoir	35.2	90.5	125.7
Remaining in Watershed Downstream of Dam	14.5	14.9	29.4
Total in Watershed:	90.9	133.6	224.5

[a] Based on delineation results for area inundated by proposed reservoir and NHD GIS data for other areas.

The physical stream bed features are not expected to be lost as a result of inundation. Continued stream flow in perennial streams and periodic flow in intermittent streams from upstream is expected to keep channel features open, but some sediment deposition may occur within or adjacent to these features within the reservoir pool. Water and sediment that was transported by the affected stream reaches into existing Harris Reservoir will continue to be transported into the expanded Harris Reservoir by the stream reaches upstream of the impounded reaches. Chemical processes undertaken within streams may be affected for the affected reaches, but similar processes occur in reservoirs (see section 4.3.4). The greatest functional change will be the loss of habitat for fauna adapted to flowing stream habitats.

The biological diversity and abundance in streams depend on the diversity of available habitats with a stream's cross-sectional shape and dimensions, slope and confinement, grain-size distribution of bed sediments, and planform affecting aquatic habitat (FISRWG 2001). The stream reaches affected by the proposed inundation vary widely in overall habitat availability and quality. Many of the Triassic Basin streams are largely sand-bed streams that have been affected by past land-use practices, with some evidence of recent destabilization likely caused by activities higher up in the watershed. Uniform sediment size in a streambed provides less potential habitat diversity than a bed with many grain sizes represented (FISRWG 2001). Overall, most of the streams showed evidence of being in some state of recovery to a more stable form, which is consistent with the understanding that once the source of disturbance is removed many stream systems can return to functional condition in a reasonable time frame, but significant disturbance and alteration may require several decades for a stream to recover stability (FIWRWG 2001). Other streams, in the Triassic Basin as well as outside, appear to provide a diversity of habitats that would be expected to provide suitable habitat for a relatively diverse group of aquatic organisms.

The upstream migration of aquatic life, where suitable conditions allow, has been identified as a trend by the North Carolina Department of Water Quality (DWQ) in various documents. This trend is summarized in "Stream Mitigation Requirements and the 401 Water Quality Certification and Isolated Wetland Programs: Proposed changes in internal DWQ policy" (DWQ 2008):

> Intermittent stream segments have a much more even mix of terrestrial and aquatic species, with the composition shifting as the water table rises above the stream bed or falls below it. When the water table is above the elevation of the stream bed, the stream is wet and short-lived aquatic species, such as amphipods, isopods, winter stoneflies, diving beetles, and various dipteran (fly) larvae, dominate the community. Most of these aquatic organisms are also found downstream in the perennial reaches since only a few species (e.g. the dipteran *Dasyhela* and the larvae of the aquatic beetle *Helichus*) live

> only in the intermittent segments. These observations are similar to those of Boulton and Lake (1992); del Rosario and Resh (2000); and Feminella (1996) who found that rather than being discrete communities, biota in ephemeral, intermittent and perennial segments mostly are distributed along a gradient – the more tolerant or drought resistant the species, the further up the Ephemeral/Intermittent/Perennial (E/I/P) continuum it can be found. This community continuum shifts up and down the stream depending on the season and the wetness or dryness of the year. . . . Species living downstream in perennial reaches include nearly all the species found in intermittent segments, plus a suite of species that require water year around to complete their life cycles. These groups include mayflies, stoneflies (non-winter), caddisflies, dobsonflies, dragonflies, damselflies, some beetles (riffle beetles and water pennies), most mollusks, larval salamanders and fish.

Running water organisms live in a medium which is constantly moving past them in one direction. This has resulted in the evolution of benthic rather than planktonic or nektonic forms (Williams and Williams 1993). Many lotic animals are rheotactic, meaning they respond to a moving current and tend to crawl against the current, but the distances moved and the numbers of individuals moving that have been recorded in literature seems generally insufficient to compensate for displacement through downstream drift. It has been proposed, that for insects, any loss from headwaters is counteracted by upstream dispersal and oviposition flights by newly emerged females, however, evidence is highly variable (Williams and Williams 1993). In the case of this particular reservoir expansion, the lower reaches of the existing stream channels will be inundated and a new normal pool elevation will be approximately 20 feet higher than that observed today. The upslope migration as intermittent streams are gradually inundated will likely be comprised primarily of aquatic organisms such as crayfish, amphibians, certain snails, and certain aquatic insects. The ability of most adult aquatic insects to fly upstream will help offset the loss of aquatic life at lower reaches in the affected stream channel. Small fish and other water dependant organisms dependent of shallow, flowing water of perennial channels will also be able to migrate upstream assuming the rise in reservoir elevation does not force them into the zone where the streams becomes more intermittent in nature. Gammarid amphipods (scuds) can also move upstream, often for long distances, as long as there is continuous water (Minckley 1964). This upstream migration process is obviously not entirely efficient and some organisms may be lost. However, the process will serve to move an undetermined number of aquatic organisms to new stream channel habitats higher in the local watershed so that the remaining channel can continue to provide some function with regard to input to the aquatic food cycle.

Organisms occupying stream habitats may be either of two general types, habitat specialists or habitat generalists. Habitat specialists are dependent on the specific ecological conditions present in the habitat in which they occur for some or all of their life cycle. Habitat specialists dependent on ecological conditions within the affected stream reaches that would be lost by inundation include various species of insects with aquatic larvae dependent on flowing water conditions (e.g., some species of mayflies, stoneflies, and caddisflies), and some species of fish (e.g., some species of shiners and suckers) that also require flowing, well-oxygenated water. Species that are habitat generalists would be expected to continue to utilize the aquatic habitats provided by the expanded reservoir, particularly the shallow littoral areas.

- Baseline sampling conducted from 1972-1977 at stream locations prior to inundation by Harris Reservoir identified a total of 53 species of fish. Sampling conducted from 1983-1987 following inundation found 46 species of fish, some of which were not documented in the baseline sampling. Habitat for some fish species may be lost as a result of inundation, but habitat for other species will be gained. None of the fish species identified as present within the streams subject to inundation are nationally or regionally rare and suitable habitat will continue to exist within the Buckhorn Creek watershed above the expanded reservoir as well as downstream from the dam. Fish that occur in Harris Reservoir that thrive in reservoir habitats (e.g., largemouth bass, black crappie, and native catfish) are expected to benefit from expanded habitat areas.

- Inundation will result in the loss of stream habitats required by certain invertebrate habitat specialists. Many of the benthic macroinvertebrates present in streams are present for the larval stage of their lifecycle, but are terrestrial and able to fly as adults. None of the benthic macroinvertebrate species identified as present within the streams subject to inundation are nationally or regionally rare and suitable habitat will continue to exist within the Buckhorn Creek watershed above the expanded reservoir as well as downstream from the dam. Macroinvertebrates adapted to reservoir settings will be able to occupy the new habitats provided by the expanded reservoir, particularly along the shallow littoral areas.

In general, within a zone located at and near the new reservoir pool level, perennial waters associated with the new pool elevation of the lake are expected to partially mimic lower perennial stream systems in the more confined valley types found along the shoreline of Harris Lake. The existing intermittent channel reaches influenced by the presence of perennial waters are expected to experience a shift from intermittent stream-based aquatic life to aquatic life more consistent with perennial water bodies. As described in DWQ's Methodology for Identification of Intermittent and Perennial Streams and Their Origins, Version 4 (2010), the North Carolina stream definitions do not require water to be flowing, but only present to meet the definition of intermittent or perennial flow for regulatory purposes. This document also indicates that within the regulatory framework an intermittent or perennial steam origin is defined as a specific location in a stream, but further states that "in most cases, stream origins usually occur as transition zones in which the location and length of the zone is subject to fluctuations in groundwater levels and precipitation."

4.3.4 Non-linear Surface Water Functional Changes

Approximately 3,331 acres of non-linear surface waters will be affected by flooding by an additional 20 feet vertical depth of water. This includes approximately 3,321 acres of existing Harris Reservoir and 10 acres of man-made ponds. Aquatic functions provided in the shallow areas of these waters will be generally lost due to the increased water depth and resulting changes in physical and chemical processes, but will be replaced in the shallow areas of the expanded reservoir. Table 4.2 provides a summary of anticipated changes in shoreline, surface area, and littoral area.

Table 4.2. Anticipated Changes to Harris Reservoir.

Attribute	Existing Reservoir (220 feet NGVD29)	Expanded Reservoir (240 feet NGVD29)	Change
Perimeter [a]	86.6 miles	148.5 miles	+ 61.9 miles
Surface Area [b]	3,672 acres	7,572 acres	+ 3,900 acres
Littoral Area [c]	959 acres	1,389 acres	+ 430 acres

[a] COLA ER 4.1.2.
[b] Based on topographic contours and includes existing delineated wetlands within existing normal pool.
[c] Identified as areas from normal pool edge to depth of 6.6 feet.

Once the process of raising the reservoir level begins, wetland evolution will also begin. Previous studies suggest shallow water zones can be colonized in as quickly as three years (Reed and Willard 1987). Floodplain soils typically hold propagules of wetland plants deposited during past floods. Impounding streams with broad, flat floodplains can, therefore, foster establishment of wide expanses of even-aged wetlands in only a few years (Reed and Willard 1987). Some wetlands created by reservoir expansion show a similar sequence of succession following siltation. Changes in water depth, however, determine the areal extent of plant growth, as well as the direction and rate of expansion. Wetlands can expand in reservoirs in the same way river deltas form, as inflowing streams deposit silt (Reed and Willard 1987). Both non-tidal freshwater marsh and fringe wetlands are expected to reform upon stabilization of the new lake level and those wetland functions temporarily lost will resume. These wetlands originally formed on non-hydric soils and non-hydric soils with minor hydric inclusions and are expected to repeat that process at the new pool elevation. The amount of both non-tidal freshwater marsh and fringe wetlands are expected to be considerably greater than what will be lost through flooding. A study at the newly flooded Harris Reservoir conducted by Carolina Power & Light in 1983 indicated that rising water levels caused many of the terrestrial species to be replaced by emergent aquatic species. This change occurred in a narrow band approximately 2 meters wide adjacent to the shoreline of the lake. Above this band, no changes were observed (CP&L 1984). This describes the formation of what has been described herein, and in previous documents, as the wetland fringe. This same process can be expected to occur under the new scenario as well.

Many specific wetland and stream functions that may be affected by inundation from reservoir expansion and from other infrastructure improvements are replaced by the functions that will be performed by the expanded reservoir, the larger riparian zone surrounding the reservoir, and ultimately by the wetlands that will reform over time. The operating level of the expanded reservoir is expected to fluctuate based on inflow from the Buckhorn Creek watershed, projected supplemental pumping from the Cape Fear River, net cooling water consumption, and estimated net evaporation (CH2M HILL 2010). However, the normal pool level is expected to remain between 237 and 240 feet most of the time (based on modeling for an 80-year simulation period using of meteorological data from 1930 through 2009 to evaluate reservoir levels for a wide range of hydrologic conditions), with pool level dropping below 234 feet infrequently during drought conditions (CH2M HILL 2010). Pool level fluctuations are normal in the existing reservoir, as evidenced by the pool elevation fluctuation between 223.80 and 212.69 NGVD29 between 2001 and 2006 (COLA ER 2.3.1.2.1). Fluctuations in reservoir pool levels of approximately 7 feet below normal pool during this time period did not appear to adversely affect existing wetlands as evidenced by the extent of wetlands delineated in 2008-2009, and the generally High ratings received during the NCWAM evaluation in 2010. Fluctuation in reservoir level appears to be similar to the flood-pulse concept of streams and associated flooplains (FISRWG 2001) and would be expected to result in similar beneficial functions for nutrient cycling and habitat complexity. General summaries are provided for expected functional changes to hydrology, water quality, habitat, and other considerations resulting from expansion of Harris Reservoir:

- ***Hydrology*** - The hydrology functions provided by the forested wetlands affected by the Harris alternative are primarily surface and sub-surface storage. Surface storage will be replaced by the expanded reservoir due to the larger volumetric capacity. The expanded reservoir's capacity will also serve to attenuate flood waters. These particular hydrology functions will shift from being forested wetland functions to a function that will be provided by the expanded reservoir. Stream flow functions will be reduced by inundation with longer retention period by the reservoir, however, water collected from the watershed by remaining stream segments will continue to flow into Harris Reservoir as they do presently.

- ***Water Quality*** - Although the Harris alternative will incur losses to as much as 183 acres of forested wetlands that are providing important functions, the shoreline of the reservoir will increase from approximately 86.6 miles to 148.5 miles (COLA ER 4.1.2), an increase of approximately 61.9 miles, and the resulting shoreline riparian habitat will provide many of the water quality functions lost through forested wetland inundation. EPA defines riparian areas as vegetated ecosystems along a water body through which energy, materials, and water pass. Riparian areas characteristically have a high water table and are subject to periodic flooding and influence from the adjacent water body. These systems encompass wetlands, uplands, or some combination of these two land forms. They will not in all cases have all of the characteristics necessary for them to be classified as wetlands (EPA 1993a), but perform important hydrologic, geomorphic, and biological functions. They are particularly effective in filtering and transforming materials (such as dissolved and particulate nonpoint source pollutants) from hill slope runoff (NRC 2002).

Other important functions provided by riparian areas include production and export of organic material, sequester carbon in the soil, stabilize banks, and provide shade along the edge of the water body. The Natural Resources Conservation Service (NRCS) defines riparian areas in its General Manual as "ecosystems that occur along watercourses and water bodies. They are distinctly different from the surrounding lands because of unique soil and vegetation characteristics that are strongly influenced by free or unbound water in the soil. Riparian ecosystems occupy the transitional area between the terrestrial and aquatic ecosystems. Typical examples would include floodplains, stream banks, and lakeshores (Montgomery 1996). Some riparian areas meet the criteria established for wetlands (Cowardin et al. 1979). Others do not, because they do not possess the necessary hydrologic water regime, a predominance of hydric soils, or a prevalence of hydrophytic vegetation. Even non-wetland riparian areas, however, share many characteristics, functions, and values with wetlands (Montgomery 1996).

Lakes and reservoirs (lentic water bodies) have the potential to act as important sinks for reactive N as it is transported across the landscape because they offer ideal conditions for N burial in sediments or permanent loss via denitrification. Although reservoirs occupy just 6% of the global lentic surface area, it is estimated that they retain up to 33% of the total N that is removed from the watershed by the lentic system (Harrison *et. al.* 2009). The water retention time is the most critical single factor for removal of N. Thus, lakes remove more N than small wetlands even though the specific N retention (N retention m^2) is generally considerably higher in wetlands (Jansson *et. al.* 1994). Lake and reservoir sediments also serve as P sinks. P-containing particles settle to the substrate and are rapidly covered by sediment. Continuous accumulation of sediment will leave some P too deep within the substrate to be reintroduced into the water column. Thus, some P is removed permanently from bio-circulation (NCSU 2010b).

The role of forested wetlands in the detritus cycle is well documented and the loss of this function as provided by these forests will result from impacts from inundation. However, the littoral fringe of lacustrine systems also has the capacity to gather, decompose, and export detritus to downstream environments. Based on analysis of bathymetric data collected by PEC and topographic data for the areas above the existing reservoir, the total area of littoral fringe (measured from normal pool level to a depth of 6.6 feet) would increase from approximately 959 acres to approximately 1,389 acres. This represents an increase in approximately 430 acres that can provide littoral fringe function. The detritus-producing capabilities of the expanded reservoir will likely be greater that what is currently being produced by the forested wetlands when total acreages are compared. All else being equal, shallow lakes with large littoral areas tend to be more productive than deeper lakes with steep-sided basins and little to no littoral zone (EPA 1993b).

- ***Habitat*** - A significant amount of new aquatic habitat, both open water and vegetated shallows, will be provided by the expanded lake providing beneficial habitat functions for fish and other wildlife.

  The succession of the aquatic vegetative communities was monitored by PEC immediately after Harris Reservoir started to fill. In 1983 a total of 25 aquatic vegetative species were observed. In 1984 the total had increased to 58 aquatic vegetative species and large quantities of floating leaf and submerged vegetation had developed in the shallows. Additionally, by 1984, much of the terrestrial woody vegetation occurring at the normal pool elevation had died and was being replaced with herbaceous shoreline vegetation. It is this evolution that resulted in the wetland fringe present around the shoreline today. In 1986 a total of 70 aquatic vegetative species were documented and all areas of Harris Reservoir less than 3 meters in depth supported submersed vegetation. Hydrilla was discovered in the White Oak Creek arm of the reservoir in 1988, and by 1990 was the dominant aquatic plant of the littoral zone, displacing several native species. Creeping water primrose, another non-native species, appeared a year or so later and quickly established itself in Harris Reservoir (COLA ER 2.4.2.1.6.1).

  In the years prior to completing the construction of Harris Lake, as many as 53 species of fish were collected from streams that were to be flooded in order to construct the reservoir (CP&L 1978). In comparison, 46 fish species were collected from streams above the proposed 220-ft normal pool elevation during this same period. An August 2006 sampling event produced a combined total of 21 fish species and 1 hybrid species from the seven sampling stations representing a combination of tolerant and intermediately tolerant species (CH2M HILL 2006). The most recent biological sampling by PEC identified 23 species in the reservoir and 22 species in those streams flowing into the reservoir. The number of fish species both within the existing reservoir and within the streams flowing into the reservoir differs by only one species based on the most recent data, and the number of species identified in both categories (reservoir and streams above reservoir) has decreased over the years. The overall diversity of fish within the Harris Lake watershed appears to have decreased since the dam was completed and filling began in 1980. Fish representing the omnivore, piscivore, and herbivore trophic guilds, do however; continue to be represented in recent stream and reservoir sampling. The proposed reservoir expansion is not anticipated to result in a notable decrease in fish diversity in the watershed.

  The terrestrial animal species utilizing the existing wetlands that will be displaced by inundation will be replaced by a suite of aquatic species including fish and aquatic macroinvertebrates. The expanded reservoir will also provide more aquatic habitat that can be utilized by various species of ducks and wading birds. Most of the major groups (taxa) of biota are represented in the biological communities that occur in lakes and reservoirs, from one-celled algae to the birds and mammals that rely on aquatic ecosystems for food and habitat (EPA 1993b). Because riparian areas are located at the convergence of terrestrial and aquatic ecosystems, they are regional hotspots of biodiversity and often exhibit high rates of biological productivity in marked contrast to the larger landscape (NRC 2002).

- ***Other*** - The expanded surface area of Harris Reservoir will also provide increased beneficial recreational opportunities for the citizens of North Carolina. These activities include, but are not limited to fishing, swimming, canoeing, boating, sailing, skiing, wakeboarding, birding, and nature study. These aquatic resource benefits to the human environment represent a gain in important aquatic values resulting from the expansion of the reservoir.

4.4 Clearing Impacts

Clearing of new ROW for transmission upgrades will affect wetlands, particularly forested wetlands, through removal of vegetation and maintenance activities to prevent growth of woody species. NCWAM assessments were conducted both outside the limits of the existing ROW as well as inside the adjacent existing ROW to identify any functional changes that could be expected to occur. Summaries of these evaluations along with expected changes in function resulting from clearing activities are provided for the Harris alternative (section 4.4.1) and Brunswick alternative (section 4.4.2).

Stream function is not expected to be substantially affected by clearing activities. Clearing will reduce the riparian buffer adjacent to streams by approximately 100 feet for new ROW. The preliminary routing considered for the new ROW is collocated adjacent to existing ROW, which varies depending on the number of lines contained within the ROW. Clearing of streamside trees and other vegetation will result in more direct sunlight reaching some streams, but this is expected to result in minor or negligible diminishment of function through localized temperature increases and potential loss of habitat. A relatively minor amount of non-linear surface waters (ponds) will also be subject to clearing of riparian vegetation for ROW expansion, but this action is not expected to substantially change existing functions present. The clearing of upland streamside vegetation is not a regulated activity under Section 404, but upland streamside vegetation can contribute to aquatic function (FISRWG 2001).

4.4.1 Harris Alternative Clearing Impact Functional Changes

The necessary transmission line upgrades for the HAR project would include the following new lines: Harris to Wake 230-kV line; Harris to Erwin 230-kV line; and Harris to Fort Bragg Woodruff Street 230-kV line. The new transmission lines total approximately 103 miles in length. Formal siting studies have not yet been conducted, but the new transmission lines are anticipated to be co-located along existing ROWs where practicable, and are anticipated to require clearing of an additional 100 feet of new ROW width. Approximately 95 acres of wetlands occur along these ROWs based on earlier GIS analysis, limited ground reconnaissance, and our limited NCWAM study. Approximately 91 of the 95 acres are characterized as forested wetlands.

ESI visited nine wetland sites representing four NCWAM wetland types (riverine swamp forest, bottomland hardwood, headwater forest, and non-tidal freshwater marsh). ESI conducted the NCWAM assessment both outside the limits of the existing ROW as well as inside the adjacent existing ROW to identify any functional changes that could be expected to occur. As previously identified, riverine forested wetlands provide beneficial hydrology, water quality and habitat functions. These beneficial functions are evident in the NCWAM results from the forested wetlands located outside the existing maintained ROW which mimic baseline or pre-construction conditions. In many cases, not all, the wetland functions assessed by NCWAM shifted to a lower rating when the same wetland type was assessed inside the existing maintained ROW in a relatively undisturbed condition. These functional shifts were most evident with regards to the habitat function.

- A negative shift of the habitat function was seen in 5 of 9 (55%) of the areas assessed and occurred in all of the riverine forested wetland types.
- The hydrology function shifted in a negative direction in 3 of 9 (33%) of the areas assessed. A negative shift of the hydrology function was observed in three of the four bottomland hard areas assessed.
- The water quality function shifted in a negative direction in 2 of 9 (22%) of the areas assessed.

The majority of the riverine forested wetlands assessed did not show any notable change with regard to water quality functions under presumed post-project conditions. Non-tidal freshwater marsh and riverine swamp forest did not demonstrate any definable functional shift. The data, although limited, does show a decrease in the overall wetland ratings for bottomland hardwood and headwater forest wetlands where the ratings went from high to low (Table 4.3).

Table 4.3. Wetland Functions Reduced Through Harris Transmission Line Expansion.

NCWAM Wetland Type	Total (acres) [a]	SNHA [b] Wetlands (acres) [a]	Function Reduced			Overall Decrease in Wetland Rating
			Hydrology	Water Quality	Habitat	
Non-Tidal Freshwater Marsh	4	<1	-	-	-	-
Bottomland Hardwood	68	6	X	X	X	X
Riverine Swamp Forest	4	0	-	-	X	-
Headwater Forest	19	0	-	X	X	X
TOTAL (ac):	**95**	6	68	87	91	87

[a] Approximations based on GIS analysis with limited ground reconnaissance.
[b] Significant Natural Heritage Areas

The hydrology sub-functions affected include surface storage and attenuation. Water quality sub-functions affected include particulate change and physical change. Habitat sub-functions affected include physical structure, landscape patch structure, and vegetation composition.

Some of the wetlands affected by ROW expansion occur in identified Significant Natural Heritage Areas (SNHAs). Wetlands within SNHAs are expected to have high function based on identification of their uniqueness. Clearing for new ROW is expected to affect 6 acres of bottomland forest and less than 1 acre of non-tidal freshwater marsh within SNHAs for the Harris alternative. Diminishment of function through clearing of forested areas for ROW expansion is expected for the bottomland forest SNHA.

4.4.2 Brunswick Alternative Clearing Impact Functional Changes

The necessary transmission upgrades for the Brunswick alternative would include at least the following new transmission lines: Brunswick to Cumberland 230-kV line; Brunswick to Clinton 230-kV line; Brunswick to Jacksonville 230-kV line; and Brunswick to Wommack 230-kV line. These new transmission lines total approximately 360 miles in length. As is the case with the Harris lines, formal siting studies have not been completed, but the Brunswick transmission lines are anticipated to be co-located along existing ROWs where practicable, and are anticipated to require clearing of an additional 100 feet of new ROW width. Approximately 1,450 acres of potential impact to wetlands would result from ROW expansion and clearing for the approximately 360 miles of transmission line upgrades evaluated. Approximately 98 percent of the wetlands along the proposed ROWs (1,421 acres) are forested wetlands that would be cleared and routinely maintained as early successional ROW habitat. The remaining 29 acres comprise non-forested wetlands that would not be expected to experience any significant functional changes from ROW expansion.

ESI visited seventeen wetland sites representing twelve NCWAM wetland types comprising tidal (brackish/salt marsh and tidal freshwater marsh), riverine (riverine swamp forest, bottomland hardwood, headwater forest, and non-tidal freshwater marsh), and non-riverine wetland types (hardwood flat, basin wetland, seep, pine flat, pocosin, and pine savanna). NCWAM assessments were conducted both outside the limits of the ROW as well as inside the adjacent existing maintained ROW to identify any functional changes that could be expected to occur.

The beneficial functions provided by forested wetlands are evident in the NCWAM results from the forested wetlands located outside the maintained ROW. As observed on the Harris transmission lines, the most notable functional shifts based on the NCWAM assessments occurred to the hydrology and habitat functions. The hydrology function shifted in a negative direction in 47 percent of the areas assessed and included both riverine and non-riverine wetlands. Water quality functions shifted in a negative direction in 18 percent of the areas assessed. This negative water quality shift was only evident in non-riverine wetland types. Riverine forested wetlands did not show any notable change with regard to water quality functions. The habitat function shifted in a negative direction in 35 percent of the areas assessed and included riverine and non-riverine wetland types. Non-tidal freshwater marsh, brackish/salt marsh, basin wetland, and pine savanna did not show any discernable functional shift from outside the ROW to inside the ROW. Tidal freshwater marsh demonstrated a slight negative shift with hydrology function only. These four wetland types represent a small percentage (4%) of the overall wetland acreage along the transmission lines.

A decrease in the overall wetland ratings was observed for riverine swamp forest, hardwood flat, bottomland hardwood forest, pocosin, pine flat, and headwater forest indicating that these wetland types, in general, may not provide the same level of beneficial wetland functional after ROW construction (Table 4.4). Six of the 17 areas (35%) of the areas assessed demonstrated an anticipated loss in overall decrease in the wetland rating. Non-riverine wetlands showed the greatest decrease in water quality functions. Riverine wetlands did not show much decrease with regards to water quality, likely because the decrease in hydrology functions of riverine wetlands as a result of ROW expansion is not great enough to negatively affect their water quality functions. Conversely, impacts to the hydrology of non-riverine wetlands, which are driven more by precipitation and groundwater, do appear to have a notable negative effect on their water quality functions based on NCWAM evaluation. The two of the three most extensive wetland types along the Brunswick lines are pocosin and pine flat, both non-riverine wetlands. These two wetland types total approximately 712 acres. Based on the evaluation of these non-riverine wetlands as described above, their overall functions are expected to be greatly diminished as a result of ROW expansion.

Although little information is available on the changes in wetland function due to transmission line clearing and construction, a study was conducted by Gaskin and Nutter (1997) in the coastal plain of Georgia on mineral flat wetlands using the Hydrogeomorphic Approach (HGM) for functional assessment. Mineral flat wetlands, which receive hydrology only from precipitation, comprise the following non-riverine NCWAM wetland types: pine flats, hardwood flats, pine savanna, and non-riverine swamp forest. These non-riverine wetland types occur only along the Brunswick lines. The 1997 HGM study indicated that ROW clearing using low ground pressure vehicles during the dry season, did not significantly damage the ground surface of these mineral flat wetlands and, therefore, did not greatly affect the overall wetland function. NCWAM, which is a rapid assessment approach, does not consider the time of year that the clearing might occur. Consequently, the results for the NCWAM assessment on the mineral flat wetlands along the Brunswick transmission lines (hardwood flat, pine flat, pine savanna) suggest that the removal of the large, woody vegetation through ROW construction does reduce hydrology, water quality and habitat functions. Best management practices would dictate the equipment used and time of year that the ROW clearing may occur.

Table 4.4. Wetland Functions Reduced Through Brunswick Transmission Line Expansion.

NCWAM Wetland Type	Total (acres) [a]	SNHA [b] Wetlands (acres) [a]	Function Reduced			Overall Decrease in Wetland Rating
			Hydrology	Water Quality	Habitat	
Brackish/Salt Marsh	3	0	-	-	-	-
Tidal Freshwater Marsh	24	22	X	-	-	-
Non-Tidal Freshwater Marsh	2	0	-	-	-	-
Bottomland Hardwood	93	33	X		X	X
Riverine Swamp Forest	443	142	X		X	X
Headwater Forest	127	26	X		X	X
Pocosin	421	261	X	X	X	X
Pine Flat	291	57	X	X	X	X
Pine Savanna	37	36	-	-	-	-
Hardwood Flat	6	0	X	-	X	X
Basin Wetland	2	2	-	-	-	-
Seep	<1	<1	-	X	-	-
TOTAL (ac):	**1,450**	**580**	**1,405**	**713**	**1,381**	**1,381**

[a] Approximations based on GIS analysis with limited ground reconnaissance.
[b] Significant Natural Heritage Areas

The hydrology sub-functions affected include surface storage and attenuation as well as subsurface storage and attenuation. Water quality sub-functions affected include particulate change and pollution change. Habitat sub-functions affected include physical structure, landscape patch structure, and vegetation composition.

Some of the wetlands affected by ROW expansion occur in identified SNHAs. Wetlands within SNHAs are expected to have high function based on identification of their uniqueness. Clearing for new ROW is expected to affect approximately 580 acres wetlands within SNHAs identified along preliminary routes evaluated for the Brunswick alternative. Overall diminishment of function through clearing of forested areas for ROW expansion is expected for all the forested types expect pine savanna and seep.

5.0 SUMMARY

The following summary identifies likely impacts for two alternatives. Previous screening and alternatives analysis eliminated all but the current two sites, the Harris alternative and the Brunswick alternative. The Harris site is in the lower Piedmont and the Brunswick site is in the lower Coastal Plain. The following summary quantifies the types of impacts to aquatic resources, existing relative function of these aquatic resources, and expected functional changes. The Harris alternative affects freshwater aquatic resources, while the Brunswick alternative affects a combination of freshwater and tidal estuarine aquatic resources. A summary of functional changes expected to occur to aquatic resources is presented by impact type in Table 5.1. These functional changes are further discussed for the Harris alternative in Section 5.1 and Brunswick alternative in Section 5.2.

Table 5.1. Summary of Expected Functional Changes.

Impact Type	Aquatic Resources Affected acres (ac) or miles (mi)		Functional Change
	Harris Alternative	**Brunswick Alternative**	
Filling	5 ac Riverine Wetlands 0.3 mi Perennial Stream 0.5 mi Intermittent Stream 5 ac Pond	16 ac Tidal Wetlands 19 ac Riverine Wetlands 1.2 mi Tidal Stream 0.2 mi Perennial Stream 0.4 mi Intermittent Stream	Permanent loss of aquatic resource function.
Filling or Flooding	0.4 mi Perennial Stream 0.2 mi Intermittent Stream	NA	Change dependent on road improvement alternative selected; will either be permanent if fill, variable if flooded.
Flooding	598 ac Riverine Wetlands 15.8 mi Perennial Stream 10.9 mi Intermittent Stream 3,321 ac Reservoir 10 ac Pond	NA	Variable. Some functions of wetlands and streams provided by expanded reservoir habitats. Loss of specific aquatic habitat types but gain in other aquatic habitat types. No aquatic habitat types expected to be lost from watershed and overall biodiversity expected to be maintained in the watershed.
Trenching	1 ac Riverine Wetlands 0.5 mi Perennial Stream 0.1 mi Intermittent Stream	Undetermined	Permanent changes to wetland function resulting from clearing for ROW. Temporary loss of stream function.
Clearing	95 ac Riverine Wetlands 1.5 mi Perennial Stream 3.6 mi Intermittent Stream 0.2 mi Naturalized Ditch/Canal 23 ac Pond	27 ac Tidal Wetlands 665 ac Riverine Wetlands 758 ac Non-riverine Wetlands 0.2 mi Tidal Stream 4.6 mi Perennial Stream 7.1 mi Intermittent Stream 0.8 mi Naturalized Ditch/Canal 28 ac Pond	No substantive change in function for streams or ponds. Permanent diminishment of some function for most forested wetland types.

5.1 Harris Alternative Summary

The Harris alternative is expected to result in:

- Filling of approximately 5 acres of forested riverine wetlands, 0.8 – 1.4 miles of stream (0.6 miles will be subject to flooding if not filled), and 5 acres of non-linear surface water (pond);
- Flooding of 598 acres of riverine wetlands, 26.8 miles of streams, and 3,331 acres of non-linear surface waters (3,321 acres of existing Harris Reservoir and 10 acres of ponds);
- Trenching of up to 1 acre of riverine wetlands and 0.6 miles of stream; and
- Clearing of 95 acres of wetlands for transmission line ROW (91 acres of forested wetlands).

Filling will result in permanent loss of aquatic function for the affected aquatic resources. The wetlands subject to fill are expected to have medium to high function based on NCWAM. The 15 stream segments subject to fill (or potential fill) generally scored in the middle third of possible points on the SQAW form, with 1 stream scoring in the upper third (a Triassic Basin perennial stream), and 2 streams scoring in the lower third (both Triassic Basin, one perennial and the other intermittent).

Flooding is expected to result in some changes of aquatic function through conversion from wetland and stream habitats to reservoir habitats. The expanded reservoir is expected to contain a variety of habitats including open water and shallow littoral habitats. The shallow littoral areas of the expanded reservoir are expected to support submerged vegetation and emergent herbaceous wetlands similar to the ones that have been documented as quickly colonizing the existing reservoir following construction and establishment of normal pool. Wetland functions were determined to be generally high, with a few wetlands identified as having medium function using NCWAM. Streams scored between 18 and 80 using the SQAW form, with most scoring in the middle third of potential points. The non-linear surface water habitat present in existing Harris Reservoir was determined to have relatively good function based on results of DWQ and PEC water quality and biological monitoring studies.

Although some functions may be lost or diminished on a per-unit basis, the inundation of 598 acres of wetlands, 26.8 miles of stream (representing approximately 52 acres of streambed habitat), and 3,331 acres of non-linear surface waters will be offset by functions provided by the approximately 3,900 acre gain in reservoir habitats.

- The expansion of the reservoir will result in a gain of approximately 61.9 miles of riparian perimeter with forested buffer compared to the existing reservoir. The gain of 61.9 miles of reservoir riparian zone is expected to offset functional losses from clearing and inundation of the existing forested riparian zone (53.6 miles based on 26.8 miles of stream with buffer on both streambanks).

- Reservoir habitats contained within the shallow littoral zone (less than 6.6 feet in depth) will experience a net gain of approximately 430 acres (increasing from 959 acres to 1,389 acres).

No substantial changes in physical or chemical function are expected based on the increase in aquatic area and the functions provided by the expanded reservoir. Loss of specific aquatic habitats and associated habitat specialist species will occur within the affected areas. These habitats will not be lost from the watershed, with approximately 125.7 miles of stream remaining in the Buckhorn Creek watershed above Harris Reservoir, and 29.4 miles of stream remaining in the Buckhorn Creek watershed downstream of the dam. None of the species expected to experience habitat loss is nationally or regionally rare. The increase in reservoir habitat will provide additional habitat for aquatic fauna and waterfowl adapted to reservoir habitats.

- The majority of the wetlands that will be lost consist of artificial or man-induced wetlands associated with the existing Harris Reservoir shoreline. Approximately 405 acres of non-tidal freshwater marsh and wetland fringe (59% of total wetlands) are in this category of man-induced. Currently, the non-tidal freshwater marsh wetlands surrounding the shoreline of Harris Reservoir are of relatively high quality even though non-native, invasive species are dominant in most areas. The reestablishment of non-tidal freshwater marsh, including hydrilla, at the new elevation will replace similar habitat for these fauna lost from initial flooding and will be beneficial to the stabilization of the biologic community in Harris Reservoir. Although non-tidal freshwater marsh wetlands, including hydrilla, provide beneficial functions that will be lost or reduced due to rising lake levels, it is expected that they will reform in the coves and along the shoreline of the expanded reservoir. This wetland type is expected to reform at the new pool elevation although identifying the likely extent of the new coverage is still being evaluated by PEC and will be further addressed through mitigation planning, implementation, and monitoring. These non-native species do not currently pose any problems with regards to operation of the Shearon Harris Nuclear Plant (COLA ER 2.4.2.1.6.1).

- Harris Reservoir has evolved from a moderately productive reservoir with relatively slow-growing game fish in the 1980s into a more productive reservoir with healthy populations of largemouth bass, bluegill, redear sunfish, crappie, and catfish (COLA ER 2.4.2.1.6.2). Although considered noxious species, hydrilla and water primrose are credited with creating favorable conditions for the world-class largemouth bass fishery by fisherman who use the lake. Harris Reservoir has also been demonstrated to generate over $1 million dollars in revenue for the area over a one year period as a result of fishing activity (NCWRC 2000). Harris Reservoir is regularly reported as one of the best largemouth bass fisheries in the southeastern U.S. by many of the regional and national fishing periodicals.

Trenching is expected to result in temporary impacts to stream channel and wetlands from excavation activities, but stream channel function is expected to return following re-grading and stabilization. Wetland functions will be affected by the permanent clearing and maintenance for ROW, with some diminishment of overall function expected.

Clearing is expected to result in permanent impacts to some wetlands, but not result in any substantial changes in function for streams or non-linear surface waters as a result of ROW clearing and maintenance. The majority of wetlands within the ROW clearing areas rated High using NCWAM. Forested wetlands cleared for ROW construction will lose some functional capacity as a result of conversion. The functions diminished by ROW clearing are considered effectively permanent based on perpetual maintenance activities that will be undertaken by PEC to prevent regrowth of woody vegetation for the duration of transmission service. Only riverine wetlands occur along the proposed Harris transmission line routes that were evaluated. The primary functions that will be lost are related to hydrology and habitat function within the forested riverine wetlands, primarily headwater forest and bottomland hardwoods.

Some of the wetlands affected by ROW expansion are present in identified Significant Natural Heritage Areas (SNHAs). Wetlands within SNHAs are expected to have high function based on identification of their uniqueness. Clearing for new ROW is expected to affect 6 acres of bottomland forest and less than 1 acre of non-tidal freshwater marsh within SHNAs for the Harris alternative. Diminishment of function through clearing of forested areas for ROW expansion is expected for the bottomland forest.

5.2 Brunswick Alternative Summary

The Brunswick alternative is expected to result in:

- Filling of approximately 19 acres of tidal wetlands and streams, 19 acres of forested riverine wetlands, and 1.8 miles of stream (1.2 miles of tidal stream, 0.2 miles of perennial stream, and 0.4 miles of intermittent stream);
- Trenching impacts that may be possible for extension of water lines from Brunswick County Public Utilities (BCPU) source(s) to the site, but which have not been evaluated or quantified; and
- Clearing of approximately 1,450 acres of wetlands for transmission line ROW for upgrade of four lines (27 acres of tidal wetlands, 665 acres of riverine wetlands, and 758 acres of non-riverine wetlands); additional impacts may be possible if upgrades are required for additional lines.

Filling will result in the permanent loss of aquatic function for the affected resources. The Brunswick alternative will result in filling of approximately 19 acres of regularly-flooded tidal wetlands and tidal stream (1.2 miles) which have high function. The tidal stream, Nancy's Creek, is an estuarine water classified as High Quality Waters (HQW) by DWQ. The brackish/salt marsh and Nancy's Creek are considered Areas of Environmental Concern (AECs) per the Coastal Area Management Act (CAMA) and represent a very important coastal resource that provides numerous functions. These areas serve as a nursery area for dozens of marine fish species, as well as multitudes of other types of marine organisms each of which provides a link in the coastal food web. The habitats provided by Nancy's Creek also encompass Essential Fish Habitat that promotes further protection from the Federal and State regulatory agencies. The additional 19 acres of riverine wetlands and 0.6 mile of stream are expected to have high function as well.

Potential trenching impacts have not been determined. However, brackish water available from the intake canal is not suitable for use to meet the average-day requirement of 1.58 mgd and maximum-day requirement of 5.8 mgd of treated freshwater needed for process and service water needs. BCPU, which currently provides an average of approximately 0.22 mgd to BSEP, does not currently have the capacity to provide the additional water. There are no plans to expand the BCPU 211 Water Treatment Plant (Hazen & Sawyer 2006), which currently provides BSEP with water from groundwater sources. Additional capacity of approximately 12 mgd is being added to the BCPU Northwest Water Treatment Plant, which may require a pipeline of approximately 30 miles to BSEP.

Clearing is expected to result in permanent impacts to some wetlands, but not result in any substantial changes in function for streams or non-linear surface waters as a result of ROW clearing and maintenance. The Brunswick lines ROW expansion would affect approximately 1,450 acres of wetlands. Of this total, approximately 1,421 acres of forested wetlands would be converted to open, maintained ROW habitat under the Brunswick alternative. Most of the wetlands subject to clearing were rated as High using NCWAM. NCWAM results indicate that some functional diminishment will occur in approximately 1,405 acres representing all the wetland types except the approximately 45 acres brackish/salt marsh, pine savanna, and basin wetland. Both riverine and non-riverine wetlands demonstrate a decrease in function when comparing the assessment area outside the ROW (baseline) versus inside the ROW (post-construction). Hydrology function is negatively affected on 7 of the 12 wetland types, habitat functions are negatively affected on 6 of the 12 wetland types, and water quality functions are negatively affected on 3 of the 12 wetland types (non-riverine wetlands only). Clearing for ROW is expected to result in an overall decrease in function for 6 of the 12 wetland types totaling approximately 1,381 acres, including bottomland hardwood (93 acres), riverine swamp forest (443 acres), headwater forest (127 acres), pocosin (421 acres), pine flat (291 acres), and hardwood flat (6 acres).

Creation of new ROW for the Brunswick lines, especially in and around wetlands, will promote suitable habitat for several federally protected species such as rough-leaved loosestrife, Cooley's meadowrue, and golden sedge in those southeastern counties where these species are listed by the U.S. Fish and Wildlife Service. Conversely, the ROW expansion will also negatively impact the beneficial forested wetland habitat utilized by several species of conservation concern, including area-sensitive wetland dependent wildlife species, including many neo-tropical migrant bird species such as prothonotary warbler and Acadian flycatcher. Species adapted to or utilizing edge and early successional wetland habitats, such as red-winged blackbird and brown-headed cowbird, will benefit from the new habitat structure. ROW expansion is expected to result in some degree of functional diminishment in 544 of the 580 acres of wetlands identified within SNHAs within the ROW, and overall functional diminishment in 522 acres of these wetlands.

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