Progress Energy

New Nuclear Baseload Generation Addition

Evaluation of Carolina Sites

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NGG Nuclear Generation Group

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Executive Summary & Recommendation

Based on detailed review/analysis of data collected and evaluated in accordance with EPRI Siting Guide, the review team recommends that the existing site at Shearon Harris Nuclear Plant be selected as the location for a Combined Operation License (COL) application for the advanced reactor technology planned for deployment in the Carolina(s) in 2015.

The graphical depiction provided later in this section shows how the Carolina's alternative sites ranked against the evaluation criteria and the attachments in the following sections of this document provide detailed scoring and analysis that yielded the graphical summary results.

This recommendation is based on the bounding key assumptions described in the next section of this document, and takes into account the relative scoring results across criteria and considerations relevant to a new nuclear plant siting. Industry experts with knowledge of site suitability issues in the Carolinas, experience with the NRC licensing processes, experience with NuStart's site selection process, and involvement with the development of the EPRI siting guidance, were contracted to complete the detailed analysis for site selection of a "region of interest" (the Carolinas service territory) provided by Progress Energy. This report provides the method of evaluation employed, key assumptions applied, and results achieved.

The EPRI Siting Guide as adopted for the Progress Energy siting study provides four steps in the site selection process whereby the "**regions of interest**" are initially subjected to exclusionary considerations. The resulting "**potential sites**" are further analyzed against avoidance considerations reducing to a small number of "**candidate sites**". A suitability evaluation of specific criteria then determines the highest ranked "**alternative sites**" best suited for a nuclear plant. These sites are finally subjected to business strategy considerations to determine the "**preferred site**".

Potential site locations under consideration included green field sites, previously considered nuclear facility locations, and existing nuclear plant sites. They were subjected to exclusionary and avoidance criteria such as identification of inadequate water supply, adverse environmental impacts, insufficient land area, or unavailable transmission lines. The potential site locations were thereby reduced to four "alternative sites" subjected to a detailed suitability evaluation. These locations included one site previously considered for a merchant fossil plant (Marion site), and three locations with existing operating nuclear plants (Brunswick Steam Electric Plant, Shearon Harris Nuclear Plant, and H. B. Robinson Nuclear Plant).

The Harris site is the "preferred site" since it leads scoring in the following evaluation areas: Technical Evaluation, Progress Energy Strategic Considerations, and Transmission System Compatibility.

The Harris site was considered the best in regard to technical evaluation criteria which address licensing and design technical requirements to construct and operate a new nuclear plant. Harris is superior to Robinson regarding the lake cooling water and availability of Progress Energy owned property. While Brunswick has access to more than adequate river water for cooling, the transmission system upgrades required are significant. The Marion site had the largest land area but also the largest percentage of wetland acreage, and less than desirable geotechnical features. The Harris site has the least wetland acreage, and the benefit of being a solid rock site as compared to deep soil of the alternative locations.

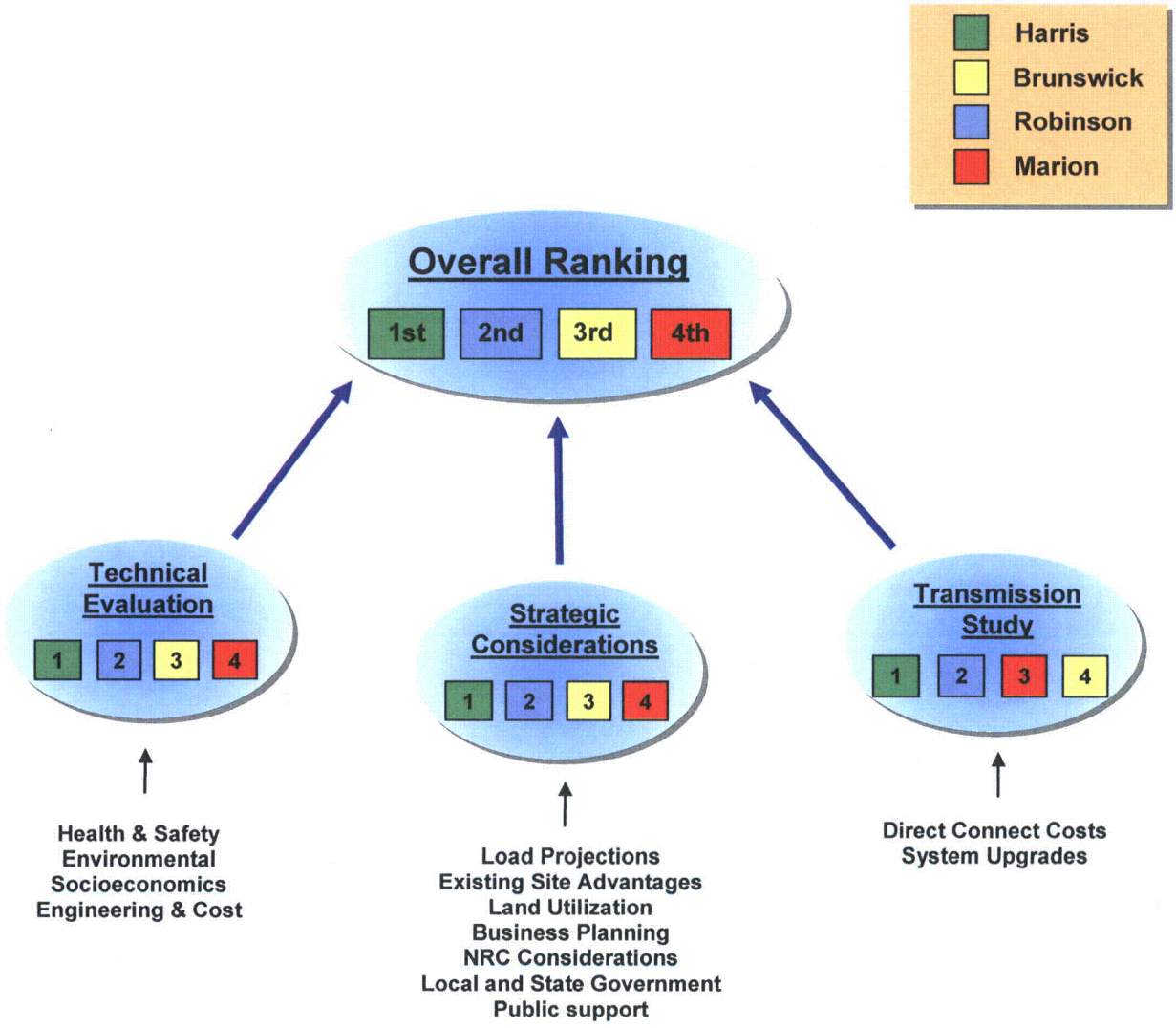
In regards to Progress Energy strategic considerations, the Harris site also ranks the highest. The NRC indicates preference to existing nuclear plant sites based on licensing reviews and detailed site characterization already completed to support the existing nuclear plant, which places the Marion site at a disadvantage. The existing nuclear plant locations further provide an advantage due to the ability to leverage existing site facilities and resources, such as warehousing, security, operator training, etc. Harris demonstrated an advantage over Brunswick and Robinson due to larger acreage of Progress Energy owned property, and the clear ability to accommodate additional future generation capacity.

Transmission deliverability analysis has further concluded the Harris site was best suited to the existing transmission system requirements. Harris site has minimal transmission impact costs for the installation of an 1100 MW nuclear unit. All other sites evaluated had considerable overloads identified with the addition of an 1100 MW nuclear unit (during various contingency scenarios), and required significant transmission system upgrades as compared to Harris. Brunswick required the most extensive transmission system upgrades to remedy current overloads, estimated to be > 300 $ Million in cost.

A point of consideration identified specifically with the Harris site is population density which was determined to be acceptable. Considering the Harris site is located near a growing population center, a detailed analysis was completed that concluded the Harris site is in compliance with the NRC regulatory guidance for population density. In addition, there are a number of beneficial factors associated with the Harris site as compared to other acceptable locations that are near lower density population centers. These include transmission deliverability and proximity to load, available land area, adequate water supply for multiple units, minimal environmental impact, and existing nuclear site advantages.

Considering the collective results of all these reviews and analysis, the Harris Site is recommended as the preferred location for new reactor technology deployment in the Carolinas. The next page graphically depicts the overall ranking of the four alternative sites and recommendation.

Summary Results



Key Assumptions and Evaluation Criteria

This document includes the results of the evaluation for locating an optimal site for building and operating an advanced reactor type for new nuclear baseload generation. During the evaluation process certain key assumptions and/or criteria were used as "bounding conditions" to aid in the evaluation process. By invoking these key assumptions and/or criteria, the relative scores for a particular attribute of the various siting locations, such as cooling water supply, were determined.

The following key assumptions and/or criteria were established for this evaluation:

- **The new nuclear baseload generation must reach commercial in-service status by mid 2015.**
- **The new nuclear plant siting location must be suitable to envelope the range of specific design parameters contemplated for deployment of a standard plant design as certified by the NRC.**
- **The location must be compatible with Progress Energy's System Operation and Transmission Delivery capabilities.**
- **The recommended site's expected licensing path and regulatory outlook must reduce Progress Energy's schedule and financial risk for establishing new nuclear baseload generation.**
- **The cost of the new nuclear generation as impacted by the location must be reasonable and fair, and methods to ensure greater certainty of the cost/schedule during the licensing, design engineering, and construction phases of the project must be included.**
- **Evaluation criteria and methodology established as part of the EPRI Early Site Permit Demonstration Program will be employed in the nuclear plant site selection process. Specifically, the EPRI Siting Guide: Site Selection and Evaluation Criteria for an Early Site Permit Application dated March 2002 will be utilized.**
- **The evaluation and selection process will include "greenfield" (e.g., locations with no current generation facilities), existing nuclear generation plant locations, and other sites previously characterized by Progress Energy.**
- **Compliance with current NRC regulations and NRC guidance (as of November 2005), including 10 CFR Part 50 – "Domestic Licensing of Production and Utilization Facilities", 10 CFR Part 52- "Early Site Permits, Standard Design**

Certifications, and Combined Licenses for Nuclear Power Plants", SECY-05-0139, "Semi-annual Update of the Status of New Reactors Licensing Activities and Future Planning for New Reactors", dated August 4, 2005.

- **Compliance with NEPA – National Environmental Policy Act of 1996 requirements.**

Evaluation Methodology

Review Team

The siting technical evaluation, Progress Energy strategic considerations, transmission study, and population analysis were reviewed by a comprehensive team representing several disciplines as follows:

Executive Team Lead - Joe Donahue, VP- Nuclear Engineering & Services Department (NESD)

Management Lead - Garry Miller, Manager – License Renewal

Reviewers/ Disciplines - Talmage Clements (engineering)
Cristina Ionescu (licensing)
James Nevill (engineering and construction)
Mark Byrd (transmission)
Bryan Guy (transmission)
Paul Snead (environmental)
McCallum–Turner Inc. (siting consultants)

Detailed Evaluation Process

In accordance with the EPRI Siting Guide, the site selection process typically involves sequential application of exclusionary, avoidance, and suitability criteria evaluation (includes site reconnaissance, topographic data collection), and technical screening by application of scoring and associated weighting factors applied to the suitability criteria. The exclusionary, avoidance, and suitability criteria address a full range of considerations important in nuclear power facility siting, including health and safety, environmental, socioeconomic and land use, and engineering and cost aspects.

The evaluation and selection process involves a series of activities starting with identification of a "**region of interest**" or a geographic area within which a site must be located. For the Carolinas, the region of interest became the Progress Energy service territory. This geographic area was derived from Progress Energy fundamental business decisions on the economic viability of a nuclear facility, the market for the facility's output, and the general geographic area where the facility should be deployed to serve the market.

The region of interest is screened using exclusionary criteria to identify the "**potential sites**" by eliminating areas in which it is not feasible to site a nuclear facility due to regulatory, institutional, facility design impediments, or environmental constraints. Further screening is performed using avoidance criteria to eliminate feasible but less favorable

areas, thus reducing the areas remaining under consideration to an adequate and reasonable number of "**candidate sites**" for continued screening.

The candidate site list is further screened using refined exclusionary and avoidance criteria to identify optimum areas for a facility. Protected lands, population features, ecologically protected resources (e.g., wetlands), and resources set aside for cultural or historical reasons, result in reducing the potential site list to a fewer number of "**alternative sites**". The alternative sites for the Carolinas are Harris, Brunswick, Robinson, and the Marion site.

From the application of these exclusionary and avoidance features, alternative sites are identified as discrete parcels of land approximately the size of an actual nuclear site, thus eliminating large tracts of land that do not exhibit conditions suitable to a nuclear facility site. The process then becomes one of comparing the small number of alternative sites, and identifying a site that possesses the most favorable set of conditions for siting a nuclear power facility. The evaluation technique to this point ensures the remaining alternative sites have no fatal flaws which could result in extended licensing delays and increased costs.

Thus, the remaining alternative sites are evaluated against suitability criteria, resulting in a transition from the elimination approach to an evaluation approach of the suitable sites. The objective of evaluation against suitability criteria is to rank the small number of alternative sites for determination of the **preferred site**(s).

The suitability criteria are grouped into four categories listed below with features in each category relevant to the specific aspects of facility development that are weighted and scored to provide a relative comparison of the candidate sites. The multiple features of the suitability criteria are combined into one composite value for each of the alternative sites.

- Health and Safety
- Environmental
- Land Use and Socioeconomics
- Engineering and Cost-related

At the conclusion of the above **Technical Evaluation** process, the technically acceptable and ranked sites then undergo a final evaluation and verification to ensure compliance and compatibility with Progress Energy transmission and generation business strategy. This analysis allows the decision of site selection to consider tradeoffs in business requirements and identification of basis for differentiation among sites, thereby ensuring the optimal site is chosen.

The two components of this final step include a list of strategic considerations and transmission deliverability. **Strategic Considerations** address existing nuclear site advantages, proximity to load, NRC considerations, local and state government support, business planning, and public support. The **Transmission Study** provides input for each site regarding direct connection costs and system upgrade costs.

Summary Evaluation Results

Results of the Technical Evaluation, Strategic Considerations, and Transmission Study for the alternative sites in the Carolina(s) are summarized below.

Technical Evaluation

The **Technical Evaluation** concluded all three existing nuclear sites are technically suitable for a new nuclear power plant; the Marion site ranks significantly lower than the existing sites, as a result of high transmission upgrade costs and seismic issues. Of the existing nuclear sites, Harris rated the highest and was followed by Robinson and Brunswick. Robinson rated lower primarily due to potential cooling water supply operational limitations, and a lower rating in the geology/seismic category. Brunswick rated lower primarily due to transmission deliverability system upgrade challenges.

Refer to **Attachment I** for the summary Technical Evaluation screening and ranking results, and **Attachment V** for the detailed McCallum-Turner consultants siting study report.

Population Analysis

The existing Harris location has one attribute that warranted additional analysis to confirm the best choice was being recommended. The Harris location is close to a high population center in North Carolina. Therefore, a population analysis was completed for compliance with the NRC guidance for population density.

NRC guidance provided in Regulatory Guide 4.7 states: "Preferably a reactor would be located so that, at the time of initial site approval and within about 5 years thereafter, the population density, including weighted transient population, averaged over any radial distance out to 20 miles (cumulative population at a distance divided by the circular area at that distance), does not exceed 500 persons per square mile. A reactor should not be located at a site whose population density is well in excess of the above value."

The Harris site area population growth projections (derived from 2000 Census data) resulted in a density of approximately 500 persons per square mile out to 20 miles in the year 2015. Based on a planned date of license approval in 2010, this places the Harris site in compliance with the NRC regulatory guidance.

In addition, the Harris site offers obvious advantages and benefits that ensure environment stewardship, satisfy the business objectives of Progress Energy, and comply with regulatory requirements.

A discussion paper completed by McCallum-Turner consultants on population density issues and siting advantages of the Harris location is included in **Attachment IV**.

Strategic Considerations

The evaluation of **Strategic Considerations** determined that the Harris site demonstrates a significant advantage due to the large property acreage already owned by Progress Energy, existing nuclear site advantages, and proximity to the system load growth. Existing nuclear sites have already been characterized in great detail in support of the operating nuclear units, have corresponding Environmental Reports / Environmental Impact Statements, and have been collecting site specific meteorological data for years. The NRC has clearly indicated a preference to licensing new nuclear plants at existing sites based on these considerations. The proximity to a higher populated and growing region offered benefit to market place access and the strongest infrastructure.

Based on these strategic consideration results, the Harris site would be the "preferred site" for preparation of the Progress Energy Combined Operating License Application in the Carolinas.

Refer to **Attachment II** for Strategic Considerations evaluation criteria ranking.

Transmission Study

The **Transmission Study** results concluded that the Harris site would experience the lowest transmission upgrade related costs.

The analysis shows that an 1100 MW nuclear plant can be sited at Harris with minimal transmission upgrades over-and-above the direct connection costs. The remaining sites considered had various degrees of overloads identified during contingency scenarios, resulting in larger capital expenditures for required transmission system upgrades. Brunswick required the most extensive transmission system upgrades estimated to be ~ 309 $ million. Marion had estimated transmission upgrade costs of ~ $ 205 Million, and the Robinson site had estimated transmission upgrade costs of ~ $ 143 Million.

Refer to **Attachment III** for the Transmission Evaluation criteria ranking, and **Attachment VI** for the Navigant Consultants Transmission System Impact Study report.

Results of the Technical Evaluation, Strategic Considerations, and Transmission Study composite ratings against the evaluation criteria summarized above are displayed in the following tables.

Composite Rating Comparison

Siting Evaluation Criteria:		Alternative Site Compliance							
		Harris		Brunswick		Robinson		Marion	
	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Site Comparison of Technical Evaluation									
Composite Score for Technical Evaluation of Suitability Criteria	40	100%	40	89.9%	36.0	91.8%	36.7	73.3%	29.3
Normalized Scores			40		36.0		36.7		29.3

Siting Evaluation Criteria:		Alternative Site Compliance							
		Harris		Brunswick		Robinson		Marion	
	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Site Comparison with Progress Energy Strategic Considerations									
Composite Score for Evaluation of Business Strategy	20	100%	20	85.3%	17.1	88.8%	17.8	36.5%	7.3
Normalized Scores			20		17.1		17.8		7.3

Siting Evaluation Criteria:		Alternative Site Compliance							
		Harris		Brunswick		Robinson		Marion	
	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Site Comparison of Transmission System Impacts									
Composite Score for Evaluation of Transmission System Impact	40	100%	40	23.8%	9.5	61.9%	24.8	42.8%	9.08
Normalized Scores			40		9.5		24.8		17.12

Attachment I - Technical Evaluation

The EPRI Siting Guide as adopted for the Progress Energy siting study provides four steps in the site selection process whereby the "**regions of interest**" are initially subjected to exclusionary considerations. The resulting "**potential sites**" are further analyzed against avoidance considerations reducing to a small number of "**candidate sites**". A suitability evaluation of specific criteria then determines the highest ranked "**alternative sites**" best suited for a nuclear plant. These sites are finally subjected to business strategy considerations to determine the "**preferred site**". The four step evaluation and selection process is summarized below.

Step 1 Exclusionary considerations for the potential sites in the Region of Interest:
- Lack of water
- Population Restrictions
- Federal or State Parks
- Geologic Features

Step 2 Avoidance considerations for the candidate sites:
- Water Use Moratoriums
- Cultural or Historical Limitations
- State or Local Governmental Restrictions
- Presence of Wetlands

Step 3 Application of Suitability Criteria to score and rank alternative sites:
- Health and Safety Criteria
- Environmental Criteria
- Socioeconomic Criteria
- Engineering and Cost Related Criteria

Step 4 Verification and confirmation whereby site differentiation draws conclusion to the preferred site for Progress Energy:
- Business Strategic Considerations
- Transmission Modeling and Analysis

The technical evaluation details for the first three steps are provided in the following sections of this attachment. Step 4 is addressed in **Attachment II**, Strategic Considerations, and **Attachment III**, Transmission Evaluation.

Steps 1 and 2:

Progress Energy identified the "region of interest" to include areas within the states of North Carolina and South Carolina that are generally within the Progress Energy service territory. Locations subjected to review and evaluation included greenfield sites and locations with operating nuclear plants. Sites previously considered for a nuclear facility were also included. The results of the application of exclusionary and avoidance considerations to narrow the number of potential sites are included in the table below.

Carolinas Site Identification and Analysis Status				
#	Site Description and Location	Identified By	Evaluation	Status
Carolinas locations identified as candidate sites for further consideration:				
1	**Harris Nuclear site**	NGG existing site	Existing nuclear power plant site; no issues to preclude consideration for COL site. This site was originally developed to accommodate much more electrical capacity and has much of the infrastructure to support units already in place.	Carried forward as candidate site.
2	**Brunswick Nuclear site**	NGG existing site	Existing nuclear power plant site; no issues to preclude consideration for COL site.	Carried forward as candidate site.
3	**Robinson Nuclear Site**	NGG existing site	Existing nuclear power plant site; no issues to preclude consideration for COL site. This site is challenged from thermal limits on the lake, based on existing operating experience.	Carried forward as candidate site.
4	**Marion County** { }	Identified by Emerson Gower	Site identified as being available for acquisition, with adequate land area and water supply from the Pee Dee River.	Carried forward as candidate site.
Carolina Sites eliminated from further consideration:				
5	**Southeast of Marion** { }	Identified by Emerson Gower	Site identified as being available for acquisition, with adequate land and water. Initial evaluation of the site indicated a high likelihood that it would not meet seismic requirements for existing and planned certified reactor designs.	Eliminated from further consideration.

Carolinas Site Identification and Analysis Status				
#	Site Description and Location	Identified By	Evaluation	Status
6	**Fayetteville Area**	Proposed by the Mayor	This site was identified on a volunteer basis by the Mayor of Fayetteville. Preliminary analysis indicates that there is no block of suitable land of sufficient size in a low population zone without wetlands. The area is also generally too flat for development of the large lake that would be required for a cooling water reservoir, and the site would require considerable expense to make it viable from an engineering perspective.	Eliminated from further consideration.
7	**"South River" site {** **}**	Previously considered site within PGN	This site was previously considered by Progress Energy for a potential nuclear plant. Soil liquefaction issues have been identified that could make the site unsuitable for a certified plant design, and cooling tower make-up water sources are not adequate. The site also appears to be environmentally sensitive.	Eliminated from further consideration.
8	**Three (3) sites close together – {** **}**	Talmage Clements as previously considered sites	This site grouping was identified based on { } previous Progress site selection studies. The site would require major transmission upgrades and a new cooling water reservoir would likely be needed { }.	Eliminated from further consideration.
9	**Savannah River Reservation (SRS)**	NuStart site	This site (which is outside the Progress Carolinas service territory) was identified because SRS has aggressively pursued a new nuclear plant on the reservation with PGN, Duke, and SCANA. The site is not close to the Progress service territory and therefore would have high transmission costs. In addition, SRS controls the onsite cooling water loop from which cooling water would be drawn; the need for operational water arrangements with SRS to obtain cooling water was not desirable.	Eliminated from further consideration.

Carolinas Site Identification and Analysis Status				
#	Site Description and Location	Identified By	Evaluation	Status
10	**Eastern NC – { } in Beaufort county**	Identified by { }	The site is available and has been identified in previous Progress siting studies; and is actively being considered for a future ~ 800 MW fossil plant. { }.	Eliminated from further consideration.
11	**Eastern NC - Craven County site { }**	Identified by { }	The site is available and has been identified in previous Progress siting studies; and is actively being considered for a future ~ 800 MW fossil plant. { }.	Eliminated from further consideration.

From the exclusionary and avoidance criteria reviews in Steps 1 and 2 above, the following 4 alternative sites were identified:

- Harris site located at Shearon Harris Nuclear Power Plant
- Brunswick site located at Brunswick Steam Electric Plant
- Robinson site located at H B Robinson Nuclear Plant
- Marion site located at a prior proposed fossil plant site

Step 3:

The third step to screen alternative sites against suitability criteria was completed for specific screening criteria followed by an evaluation of general criteria to determine suitability of the locations for licensing and deployment of a new nuclear plant. The following two tables contain the weighting and scoring results for the screening of alternative sites and the results of General Criteria evaluation for the Technical Evaluation of the alternative sites.

Screening Results for Technical Evaluation of Suitability Criterion:

Siting Evaluation Criterion:		Alternative Site Compliance							
		Harris		Brunswick		Robinson		Marion	
Screening Criteria	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Summary Comparison of Technical Evaluation									
P1 – Cooling Water Supply	9.8	4	39.2	5	49	3	29.4	4	39.2
P2 - Flooding	4.4	1	4.4	1	4.4	3	13.2	1	4.4
P3 - Population	8.6	1	8.6	2	17.2	2	17.2	2	17.2
P4 - Hazardous Land Uses	5.9	2	11.8	1	5.9	2	11.8	2	11.8
P5 - Ecology	5.6	3	16.8	3	16.8	4	22.4	4	22.4
P6 - Wetlands	5.6	5	28	4	22.4	4	22.4	1	5.6
P7 - Railroad Access	6.7	5	33.5	5	33.5	5	33.5	3	20.1
P8 - Transmission Access	7.4	5	37	1	7.4	3	22.2	2	14.8
P9 - Geology / Seismic	9.8	4	39.2	3	29.4	2	19.6	2	19.6
P10 - Land Acquisition	6.3	5	31.5	5	31.5	5	31.5	3	18.9
Total Weighted Scores			250		217.5		223.2		174
Normalized Scores			100%		87.0%		89.3%		69.6%

Evaluation Results of General Siting Criteria:

Progress Energy Carolinas General Site Criteria Ratings										
EPRI Guide Section	Criteria	Weight Factor	Shearon Harris		Brunswick		Robinson		Marion	
			Rating	Score	Rating	Score	Rating	Score	Rating	Score
1.1.1	Geology/Seismology	**3.77**	4	15.08	3	11.31	2	7.54	2	7.54
1.1.2	Cooling System Requirements	**3.27**	4	13.08	5	16.35	3	9.81	4	13.08
1.1.3	Flooding	**2.4**	1	2.4	1	2.4	3	7.2	1	2.4
1.1.4	Nearby Hazardous Land Uses	**3.35**	2	6.7	1	3.35	2	6.7	2	6.7
1.1.5	Extreme Weather Conditions	**2.36**	3	7.08	1	2.36	3	7.08	3	7.08
1.2	Accident Effect Related	**4.09**	3	12.27	3	12.27	4	16.36	4	16.36
1.3.1	Surface Water – Radionuclide Pathway	**2.5**	4	10	5	12.5	4	10	4	10
1.3.2	Groundwater Radionuclide Pathway	**2.55**	5	12.75	3	7.65	3	7.65	3.5	8.925
1.3.3	Air Radionuclide Pathway	**2.5**	5	12.5	5	12.5	5	12.5	5	12.5
1.3.4	Air-Food Ingestion Pathway	**2.5**	4	10	5	12.5	2	5	3	7.5
1.3.5	Surface Water-Food Radionuclide Pathway	**2.41**	3	7.23	5	12.05	5	12.05	5	12.05
1.3.6	Transportation Safety	**2.14**	5	10.7	5	10.7	5	10.7	5	10.7
2.1.1	Disruption of Important Species/Habitats	**2.64**	4	10.56	3	7.92	4	10.56	4	10.56
2.1.2	Bottom Sediment Disruption Effects	**2.14**	4	8.56	4	8.56	2	4.28	2	4.28
2.2.1	Disruption of Important Species/Habitats and Wetlands	**3.18**	4	12.72	3	9.54	4	12.72	2	6.36
2.2.2	Dewatering Effects on Adjacent Wetlands	**2.77**	5	13.85	3	8.31	5	13.85	1	2.77
2.3.1	Thermal Discharge Effects	**3.64**	4	14.56	4	14.56	3	10.92	4	14.56
2.3.2	Entrainment/Impingement Effects	**3.23**	3	9.69	3	9.69	3	9.69	3	9.69

Progress Energy Carolinas General Site Criteria Ratings										
EPRI Guide Section	Criteria	Weight Factor	Shearon Harris		Brunswick		Robinson		Marion	
			Rating	Score	Rating	Score	Rating	Score	Rating	Score
2.3.3	Dredging/Disposal Effects	**2.36**	4	9.44	3	7.08	3	7.08	3	7.08
2.4.1	Drift Effects on Surrounding Areas	**2.36**	4	9.44	3	7.08	4	9.44	4	9.44
3.1	Socioeconomics – Construction – Related Effects	**2**	5	10	5	10	5	10	5	10
3.3	Environmental Justice	**1.95**	5	9.75	5	9.75	5	9.75	5	9.75
3.4	Land Use	**3.8**	5	19	5	19	5	19	2	7.6
4.1.1	Water Supply	**3.7**	5	18.5	5	18.5	5	18.5	3	11.1
4.1.2	Pumping Distance	**3.05**	5	15.25	5	15.25	5	15.25	3	9.15
4.1.3	Flooding	**2.9**	1	2.9	1	2.9	3	8.7	1	2.9
4.1.5	Civil Works	**3.4**	3	10.2	3	10.2	3	10.2	2	6.8
4.2.1	Railroad Access	**2.6**	5	13	5	13	5	13	3	7.8
4.2.2	Highway Access	**2.8**	5	14	5	14	5	14	3	8.4
4.2.3	Barge Access	**2.85**	1	2.85	5	14.25	1	2.85	1	2.85
4.2.4	Transmission Access	**4.8**	5	24	1	4.8	3	14.4	2	9.6
4.3.1	Topography	**2.55**	4	10.2	4	10.2	4	10.2	4	10.2
4.3.2	Land Rights	**2.75**	5	13.75	5	13.75	5	13.75	3	8.25
4.3.3	Labor Rates	**3.3**	5	16.5	5	16.5	5	16.5	5	16.5
Composite Site Rating			389		361		367		300	
Normalized Score			100%		92.8%		94.3%		77.1%	
Average Score for Screening and General Criteria			**100%**		**89.9%**		**91.8%**		**73.3%**	

Attachment II – Strategic Considerations

Siting Evaluation Criteria: Compliance with Progress Energy Business Strategic Considerations	Weight	Alternative Site Compliance								Basis of Evaluation Finding
		Harris		Brunswick		Robinson		Marion		
		Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	
Existing Site Advantages Sharing of existing resources and facilities associated with security, maintenance, training, warehousing, and emergency planning.	10	10	100	10	100	10	100	0	0	The three sites with operating nuclear units have resources and facilities that can provide support for a new plant, and result in costs savings.
NRC Considerations Preference of existing nuclear facility sites facilitating the COLA review process.	10	10	100	10	100	10	100	0	0	The three existing plant locations provide an advantage with NRC licensing review due to existing site characterization, meteorological towers, environmental reports, etc.
Proximity to System Load Location to load center to ensure transmission delivery capabilities and system operations.	10	10	100	5	50	5	50	5	50	The Harris site transmission connections were originally constructed for two nuclear units and the site is nearest the high growth load area of Progress Energy's service territory.

Siting Evaluation Criteria: Compliance with Progress Energy Business Strategic Considerations		Alternative Site Compliance								Basis of Evaluation Finding
		Harris		Brunswick		Robinson		Marion		
	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	
Business Planning The selected site must promote assurance of satisfying schedule and budget for COL approval.	5	10	50	8	40	8	40	4	20	The three sites with existing nuclear plants offer the best opportunity to satisfy licensing requirements since they have already demonstrated an ability to license a nuclear plant. Harris has an advantage considering the original licensing was based on 4 operating units and the existing environmental impact statement for 2 nuclear units.
Local and State Government Support Incentives and support associated with infrastructure improvements, rate base impact, emergency planning, employment training, etc.	5	8	40	8	40	9	45	9	45	Existing sites have a current arrangement of support. Visible support displayed by state level government officials in South Carolina was evident during the site selection process of the NuStart demonstration project.

Siting Evaluation Criteria: Compliance with Progress Energy Business Strategic Considerations	Weight	Harris Score	Harris Weighted Score	Brunswick Score	Brunswick Weighted Score	Robinson Score	Robinson Weighted Score	Marion Score	Marion Weighted Score	Basis of Evaluation Finding
Public Support General public desire for safe and efficient nuclear power generation and avoidance of nonproductive intervention.	5	6	30	6	30	8	40	8	40	Harris and Brunswick did experience intervention resistance during their original license reviews, but they have operated for ~20 years. Harris experienced a contested hearing during expansion of the spent fuel storage pools.
Land Utilization Leverage of Progress Energy land for potential applications of public benefit.	1	10	10	7	7	7	7	2	2	Harris has the largest property acreage and currently allows public access for recreational uses (i.e., boating). Robinson currently provides recreational opportunities. Brunswick utilizes a public waterway. Marion would require development.
Total Weighted Scores			430		367		382		157	
Normalized Scores			100		85.3%		88.8%		36.5%	

Attachment III – Transmission Study

The evaluation of transmission impact was based on analysis completed by Navigant Consulting to provide basis for differentiating each of the alternative sites in relation to transmission upgrade and tie-in costs, and other criteria to ensure the best site was selected for a new nuclear plant location. Criteria included in the following matrix were weighted based on importance to Progress Energy generation and service territory requirements, and scored for each alternative site.

Siting Evaluation Criteria: Comparison of Transmission System Impacts		**Alternative Site Compliance**								**Basis of Evaluation Finding**
		Harris		**Brunswick**		**Robinson**		**Marion**		
	Weight	Score	**Weighted Score**	Score	**Weighted Score**	Score	**Weighted Score**	Score	**Weighted Score**	
Transmission system Upgrade Costs Cost associated with transmission line upgrades to remedy predicted current overloads with the addition of an 1100 MW unit.	10	10	100	2	20	6	60	4	40	The Harris Site requires no major system upgrades. Brunswick will require the highest transmission system upgrades estimated at ~ $ 309 Million, followed by Marion site at ~ $ 205 Million, and Robinson at ~ $ 143 Million.
System Direct Connect Costs Interconnection availability, need for breaker bays and substations.	1	5	5	5	5	5	5	5	5	No significant direct connection costs were identified between the various sites.
Total Weighted Scores			105		25		65		45	
Normalized Scores			100		23.8%		61.9%		42.8%	

Refer to **Attachment VI** for details of the Navigant Consulting transmission system impact study.

Attachment IV – Population Analysis

Site Selection Study, Discussion Paper:
Shearon Harris Site Population Density Issues

Objective – The objective of this paper is to address the high population density in the vicinity of the Shearon Harris Nuclear Power Plant (Harris) site:

1. Conformance of the site with NRC guidance for population density and
2. Justification of the site as one for which "no obviously superior alternative exists." (NRC guidance does not require applicants to select the "best" site but only that the selected site be one for which no "obviously superior" alternative exists.)

Discussion – The technical analysis conducted by the Enercon/McCallum-Turner Team indicates that the Harris site is the most suitable site for the Progress Energy Carolinas COL. Population density in the site vicinity is projected to reach NRC guidance values in the mid-2010s.

The population density considerations are discussed below.

Regulatory Position – Applicable NRC regulatory guidance in Regulatory Guide 4.7 states:

"Preferably a reactor would be located so that, at the time of initial site approval and within about 5 years thereafter, the population density, including weighted transient population, averaged over any radial distance out to 20 miles (cumulative population at a distance divided by the circular area at that distance), does not exceed 500 persons per square mile. A reactor should not be located at a site whose population density is well in excess of the above value."

"If the population density of the proposed site exceeds, but is not well in excess of the above preferred value, the analysis of alternative sites should pay particular attention to alternative sites having lower population density. However, consideration will be given to other factors such as safety, environmental, or economic considerations, which may result in the site with the higher population density being found acceptable."

Analysis – The Harris UFSAR reports that 20-mile population density is expected to be about 456, 564, and 674 persons per square mile in 2010, 2020 and 2027, respectively. Interpolation of the Harris UFSAR population projections indicates that the 20-mile population density would be approximately 500 persons per square mile in the 2015 timeframe (approximately 5 years after scheduled issuance of the Progress Energy COL). Thus, projected population densities 5 years after initial site approval would be consistent with and not "well in excess of" the "preferred value".

Other considerations that justify selection of Harris as acceptable are identified below. These other considerations indicate the Harris site having safety, environmental, and economic advantage as a nuclear power plant site: In addition, it is the only existing Progress Energy site located where it can serve the largest and fastest growing service territory in the Carolinas:

1. Minimum transmission construction cost, line losses and environmental impact,
2. Maximum transmission reliability,
3. Adequate land area and water supply for four units based on previously granted NRC construction permits
4. Seismic criteria allowing for increased margin of safety in the standard design due to low peak ground acceleration.

Conclusion – The above unique advantages over other potential sites in the Carolinas service area as quantified and documented in the site selection report justify selection of Harris as the preferred site for a new nuclear plant.

Attachment V – McCallum-Turner Siting Study

Progress Energy
Nuclear Power Plant Siting Study
Report
January 10, 2006

1.0 Background and Introduction

Progress Energy (Progress) intends to prepare a Combined Operating License (COL) application for a new nuclear power plant in its service territory in North and South Carolina. An early step in this process is selection of a site that will provide the geographic setting for the COL application. This document describes processes and criteria used to identify and evaluate alternative sites and select a proposed site as the geographic location for the Carolinas COL application.

The overall objective of the siting process was to identify a nuclear power plant site that 1) meets Progress's business objectives for the COL project, 2) satisfies applicable Nuclear Regulatory Commission (NRC) site suitability requirements, and 3) is compliant with National Environmental Policy Act (NEPA) requirements regarding the consideration of alternative sites.

Although a reactor technology for the COL application had not been chosen at the time of the evaluation, sites were evaluated based on the assumption that a twin-unit plant, AP1000 design will be built and operated; characteristics of the plant as they relate to site characteristics are documented in *AP1000 Siting Guide: Site Information for an Early Site Permit*, Westinghouse Electric Company, LLC, April 2003. This assumption provided a realistic, consistent basis for evaluation of site conditions against site requirements for a nuclear power plant design.

The balance of this report is organized as follows. Section 2.0 provides an overall description of the site selection evaluation and decision process implemented to identify a site for the Carolinas COL. Section 3.0 contains a description of the Region of Interest for the siting study, identifies several potential sites that were considered, and provides a rationale for the identification of four candidate sites for detailed study. Sections 4.0 and 5.0, respectively, present the results of screening and general site criterion evaluations; the rationale for identification of a proposed site for the Carolinas COL also appears in Section 5.0

2.0 Siting Process Overview

The site study was conducted in accordance with the overall process outlined in Figure 2-1 of the industry standard EPRI *Siting Guide: Site Selection and Evaluation Criteria for an Early Site Permit Application* (*Siting Guide*), March 2002. This process, as adapted for the Progress site selection study, is depicted in Figure 2-1.

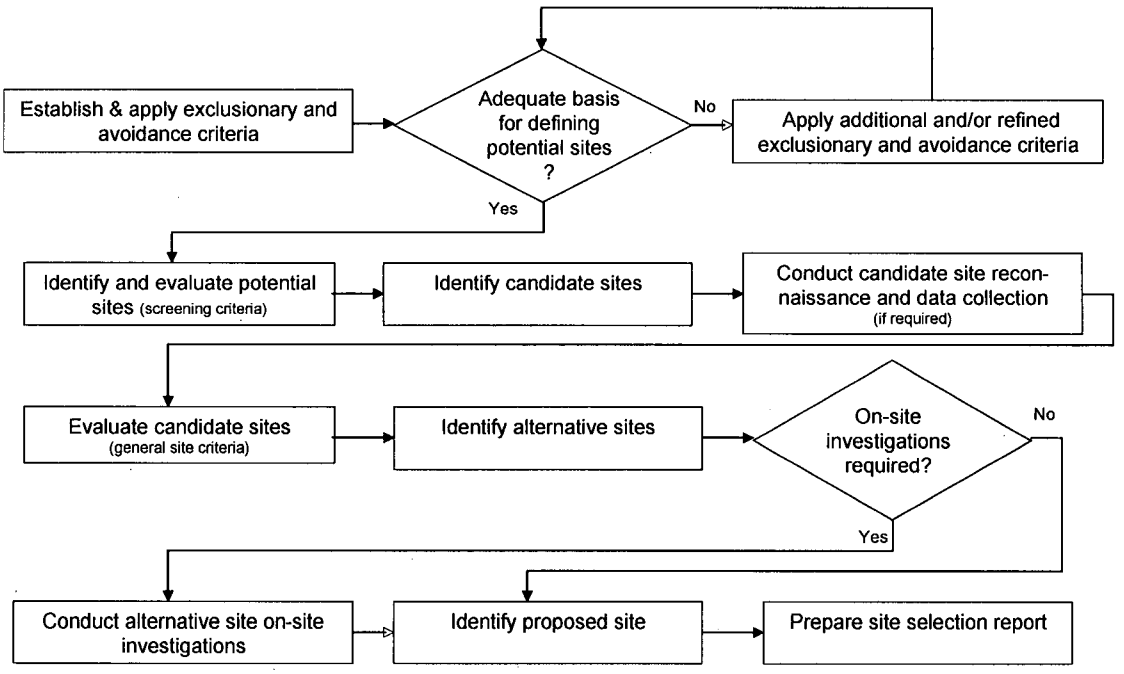


Figure 2-1 Site Selection Process Overview

This process began with evaluation and update of the basis for selecting sites considered in the site selection study. This analysis was based on a review of available sites identified by Progress, examined, as applicable, using publicly available data. Based on this analysis, a list of four candidate sites was identified for further study in succeeding stages of the process.

Data collection and analysis to support further evaluation of these sites was initiated in parallel with the effort described in the previous paragraph. Screening-level criteria developed from the EPRI Existing Site Criteria (Table 4.2 of the EPRI *Siting Guide*) were applied. Once these initial screening-level evaluations were developed, a decision was made that reconnaissance-level on-site data collection would not be necessary to support this phase of the site selection analysis. All four candidate sites were carried forward for evaluation as alternative sites, as described below.

Using available data and criteria developed based on the EPRI general site criteria (Section 3.0 of the EPRI *Siting Guide*), detailed site suitability evaluations of the alternative sites were conducted. Overall composite site suitability ratings were developed for the four alternative sites. On-site investigations were not required because of the high confidence in site information at the existing sites. A proposed site for the Carolinas Progress COL application was selected based on these composite ratings and other applicable considerations related to Progress business plans.

3.0 Identification of Candidate Sites

The basic Region of Interest (ROI) for the siting study was the Progress Carolinas service territory (Figure 3-1).

Eleven potential sites were identified as possible locations for the Progress Carolinas COL, based on a review of previous siting studies and knowledge of the sites potentially available for acquisition and development as power plant sites. A listing of the potential sites identified, results of the analysis of these sites against exclusionary criteria and Progress business objectives, and the disposition of each site is provided in Table 3-1.

As noted in Table 3-1, the following four sites were carried forward to the screening evaluation (Section 4.0):

Brunswick Steam Electric Plant (Brunswick)
H. B. Robinson Plant (Robinson)
Shearon Harris Nuclear Plant (Harris)
Marion Site (Marion)

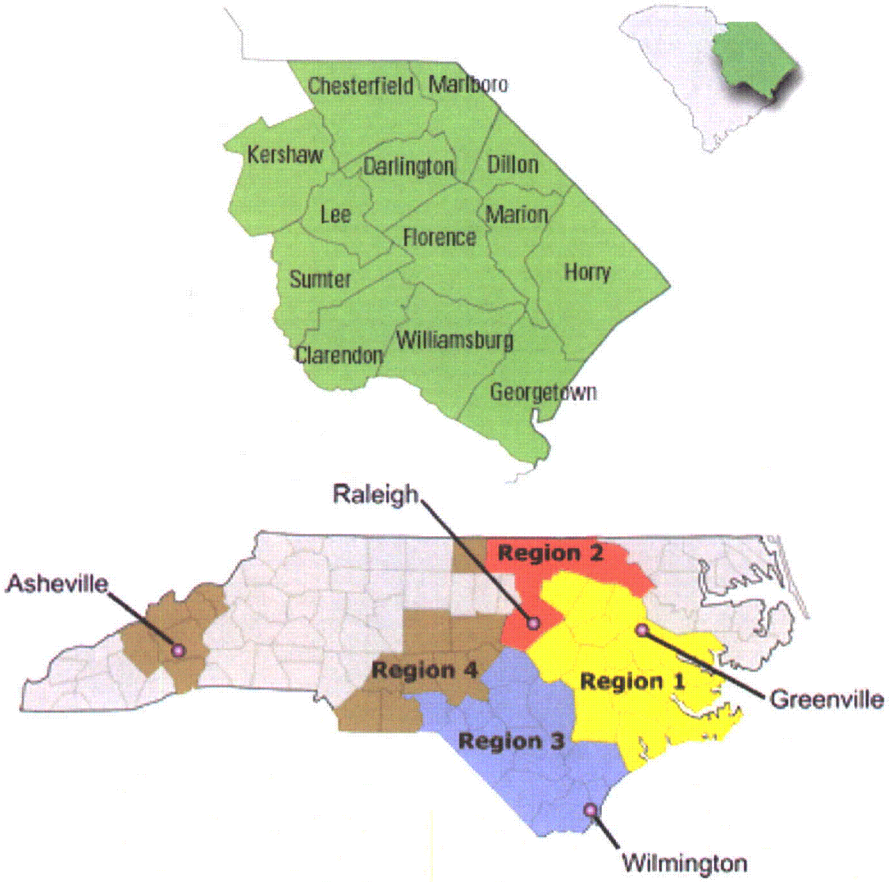


Figure 3-1 Progress Carolinas Service Territory

Table 3-1 Carolinas Potential Sites

Site Description and Location	Evaluation	Status
Harris Nuclear site	Existing nuclear power plant site; no issues to preclude consideration for COL site. This site was originally developed to accommodate much more electrical capacity and has much of the infrastructure to support units already in place.	Carried forward as candidate site.
Brunswick Nuclear site	Existing nuclear power plant site; no issues to preclude consideration for COL site.	Carried forward as candidate site.
Robinson Nuclear site	Existing nuclear power plant site; no issues to preclude consideration for COL site. This site is challenged from thermal limits on the lake, based on existing operating experience.	Carried forward as candidate site.
Marion County { }	Site identified as being available for acquisition, with adequate land area and water supply from the Pee Dee River.	Carried forward as candidate site.
Southeast of Marion { }	Site identified as being available for acquisition, with adequate land and water. Initial evaluation of the site indicated a high likelihood that it would not meet seismic requirements for existing and planned certified reactor designs.	Eliminated from further consideration.
Fayetteville Area	This site was identified on a volunteer basis by the Mayor of Fayetteville. Preliminary analysis indicates that there is no block of suitable land of sufficient size in a low population zone without wetlands. The area is also generally too flat for development of the large lake that would be required for a cooling water reservoir, and the site would require considerable expense to make it viable from an engineering perspective.	Eliminated from further consideration.
"South River" site { }	This site was previously considered by Progress Energy for a potential nuclear plant. Soil liquefaction issues have been identified that could make the site unsuitable for a certified plant design, and cooling tower make-up water sources are not adequate. The site also appears to be environmentally sensitive.	Eliminated from further consideration.

Site Description and Location	Evaluation	Status
Three (3) sites close together – { }	This site grouping was identified based on { } and previous Progress site selection studies. The site would require major transmission upgrades and a new cooling water reservoir would likely be needed { }.	Eliminated from further consideration.
Savannah River Site (SRS)	This site (which is outside the Progress Carolinas service territory) was identified because SRS has aggressively pursued a new nuclear plant on the reservation with PGN, Duke, and SCANA. The site is not close to the Progress service territory and therefore would have high transmission costs. In addition, SRS controls the onsite cooling water loop from which cooling water would be drawn; the need for operational water arrangements with SRS to obtain cooling water was not desirable.	Eliminated from further consideration.
Eastern NC – { } in Beaufort county	The site is available and has been identified in previous Progress siting studies; and is actively being considered for near-term development of an 800-1000 MW fossil plant. { }.	Eliminated from further consideration.
Eastern NC - Craven County site { }	The site is available and has been identified in previous Progress siting studies; and is actively being considered for near-term development of an 800-1000 MW fossil plant. { }.	Eliminated from further consideration.

4.0 Screening-Level Evaluation of Candidate Sites

The overall process for potential site evaluation was comprised of the following elements, each of which is described in the following paragraphs; results from applying the process are described in Appendix A.

- Develop criterion ratings for each site
- Develop weight factors reflecting the relative importance of each criterion
- Develop composite site suitability ratings

Criterion Ratings – Each site was assigned a rating of 1 to 5 (1 = least suitable, 5 = most suitable) for each of the potential site evaluation criteria, using the rationale listed in Table 1. Information sources for these evaluations included publicly available data, information available from Progress files and personnel, and large scale satellite photographs.

Weight Factors - Weight factors reflecting the relative importance of these criteria were synthesized from those developed for previous nuclear power plant siting studies. The weight factors were originally derived using methodology consistent with the modified Delphi process specified in the Siting Guide. Weight factor used (1 = least important, 10 = most important) are listed in the table below.

Criterion Number	Criterion	Weight Factor
P1	Cooling Water Supply	9.8
P2	Flooding	4.4
P3	Population	8.6
P4	Hazardous Land Uses	5.9
P5	Ecology	5.6
P6	Wetlands	5.6
P7	Railroad Access	6.7
P8	Transmission Access	7.4
P9	Geology/Seismic	9.8
P10	Land Acquisition	6.3

Composite Suitability Ratings – Ratings reflecting the overall suitability of each site were developed by multiplying criterion ratings by the criterion weight factors and summing over all criteria for each site.

Criteria presented in Table 4-2, below, were derived from the criteria listed in Section 4.2 of the EPRI *Siting Guide: Site Selection and Evaluation Criteria for an Early Site Permit Application* (Siting Guide), March 2002. They are intended to provide insights into the overall site suitability trade-offs between the four sites and to take advantage of data available at this stage of the site selection process.

Results of the screening evaluation are presented in the following table and figure. A detailed discussion of the technical basis for these ratings is provided in Appendix A.

All three existing plant sites are suitable for a new nuclear power plant; the Marion site ranks significantly lower than the existing sites, as a result of high transmission costs and seismic, land acquisition and wetlands issues. Of the existing sites, Harris rated highest. Harris was followed by Robinson and Brunswick. Robinson rated somewhat lower, primarily due to potential cooling water supply operational limitations and a lower rating in the geology/seismic category. Brunswick rated lower primarily due to transmission challenges as well as being slightly less favorable with respect to ecology and nearby hazardous land uses.

Based on these results, the Harris site would be the primary site for preparation of the Progress COL application in the Carolinas. All four sites were carried forward as alternative sites for more detailed evaluation, as described in Section 5.0.

	Criterion										
	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	Composite Site Rating
	Cooling Water Supply	Flooding	Popula-tion	Hazard-ous Land Uses	Ecology	Wetlands	Railroad Access	Transmis-sion Access	Geology Seismic	Land Acquisi-tion	
	Weight Factor										
Potential Site Name	**9.8**	**4.4**	**8.6**	**5.9**	**5.6**	**5.6**	**6.7**	**7.4**	**9.8**	**6.3**	
	Site Ratings										
Brunswick	5	1	2	1	3	4	5	1	3	5	**217.5**
Harris	4	1	1	2	3	5	5	5	4	5	**250.0**
Marion	4	1	2	2	4	1	3	2	2	3	**174.0**
Robinson	3	3	2	2	4	4	5	3	2	5	**223.2**

Table 4-1 – Screening Criteria Evaluations

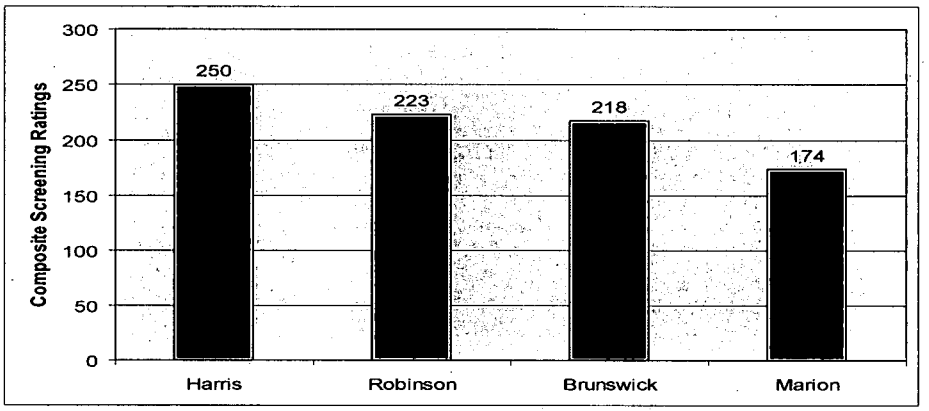


Figure 4-1 – Composite Screening Criteria Ratings

Table 4-2 - Progress Site Selection Study- Screening Evaluation Criteria

Criterion Number	Criterion	Measure of Suitability	
		Metric	Rating Rationale
P1	Cooling Water Supply	Ability of primary water source to provide adequate cooling water for twin-unit plant with cooling towers, without significant permitting issues or operational restrictions.	Analysis of water source type (e.g., reservoir, river, ocean or lake), adequacy of flow or water volume, and analysis of operating experience at existing sites. 5 = Unrestricted water supply 4 = Adequate water supply with small potential for operational restrictions 3 = Adequate water supply and/or demonstrated potential for operational restrictions 2 = Conditionally adequate water supply and/or potential for frequent operational restrictions 1 = Inadequate water supply.
P2	Flooding	Difference between nominal site grade and PMF from existing reports (and from 100-year flood elevation at Marion site); water elevation from USGS maps	5 = > 10 feet 4 = > 5 feet 3 = > 3 feet 2 = > 1 foot 1 = below PMF
P3	Population	Distance to nearest population center/high-density population area, including general surrounding population density where appropriate.	Ratings were assigned as follows based on distance in miles to nearest population center (more than 25,000 persons) and with population density > 300 persons/mi^2. 5 = > 30 miles 4 = < 30 miles 3 = < 20 miles 2 = < 10 miles 1 = < 5 miles An additional point was added or deducted based on general surrounding population density at the county-level.
P4	Hazardous Land Uses	Number of airports, pipelines, and other known hazardous industrial facilities , as determined from publicly available data	5 = No hazardous land use within 10 miles 4 = No major or multiple hazardous land use(s) within 5 miles; minor hazardous land use between 5 and 10 miles (e.g., small airport or pipeline) 3 = No hazardous land use within 5 miles; major or multiple hazardous land uses between 5 and 10 miles 2 = Minor hazardous facilities within 5 miles 1 = Major hazardous facilities within 5 miles

Criterion Number	Criterion	Measure of Suitability	
		Metric	**Rating Rationale**
P5	Ecology	Number of protected species within the 400 acre power block area	5 = 0 species 4 = 1-2 species 3 = 3-4 species 2 = 4-5 species 1 = >5 species
		Habitat: Professional judgment of the amount and quality of habitat available for species, based on poor quality aerial photographs.	5 = excellent 4 = good 3 = adequate 2 = fair 1 = poor
		Flexibility: Professional judgment of the ability optimize location of plant facilities avoid known locations of protected species and sensitive ecological areas.	5 = No species present 4 = plenty of room 3 = adequate room 2 = site is somewhat constricting 1 = insufficient room
		Site rating is numerical average of sub-criterion ratings, rounded to a whole number..	
P6	Wetlands	Total acreage of wetland within the 400 acres power block area, not including the lake or reservoir that would be the primary source of cooling water.	5 = < 1 acre 4 = 1 to 2.5 acres 3 = 2.6 to 5.0 acres 2 = 5.1 to 10 acres 1 = > 10 acres
		Acreage of higher quality wetlands, i.e., forested wetlands, within the 6000 acres.	
		Flexibility: Professional judgment of the amount of space within the 6000 acre site area to be able to avoid wetlands during construction of the facility:	5 = No or very few wetlands, easily avoided 4 = Few wetlands, easily avoided. 3 = numerous wetlands, moderately difficult to avoid 2 = Numerous wetlands difficult to avoid 1 = Too many wetland or insufficient space to avoid.
		Site rating is numerical average of sub-criterion ratings, rounded to a whole number..	
P7	Railroad Access	Estimated cost of constructing rail spur to the site, based on distance in miles to the nearest rail line and a linear cost of $3M/mile.	Ratings computed by scaling costs from lowest (rating = 5) to highest (rating = 1) 1 = >10 miles, 2 = <10 miles 3 = <7 miles 4 = <5 miles 5 = <2 miles
P8	Transmission Access	Estimated cost of transmission upgrades based on Navigant transmission study (Navigant 2006)	Ratings computed by scaling costs from lowest (rating = 5) to highest (rating = 1)

<table>
<tr><th>Criterion Number</th><th>Criterion</th><th colspan="2">Measure of Suitability</th></tr>
<tr><th></th><th></th><th>Metric</th><th>Rating Rationale</th></tr>
<tr><td>P9</td><td>Geology/Seismology</td><td colspan="2">A numerical system of weights and ratings, based upon suitability criteria, are assigned to the following five sub- categories: vibratory ground motion, capable tectonic sources, surface faulting and deformation, geologic hazards, and soil stability. These data are used to compute (i.e., rate times weight) a suitability index number for each category; methods for deriving individual sub-category indexes are discussed below. Index numbers are summed across all five sub-categories to obtain an overall suitability index for each site. The index numbers are then mapped to criterion ratings of 1 to 5 according to the following algorithm:
Index Range — Criterion Rating
5 - 21 — 5
22 - 37 — 4
38 - 53 — 3
54 - 69 — 2
70 - 85 — 1
Note: The sub-ratings for geotechnical criteria, only, are inversed where 0 is the most suitable and 5 is least suitable.</td></tr>
<tr><td></td><td></td><td colspan="2">Vibratory Ground Motion
(Weight = 5; Index Range = 0 – 50)
PGA Range PGA (%g) — Sub-Rating
0 - 3 — 1
3 - 6 — 2
6 - 9 — 3
9 - 12 — 4
12 - 15 — 5
15 - 18 — 6
18 - 21 — 7
21 - 24 — 8
24 - 27 — 9
27 – 30 — 10</td></tr>
<tr><td></td><td></td><td colspan="2">Capable Tectonic Structure
Class A Features (Weight = 2; Index Range = 0-10)
Class B Features (Weight = 1; Index Range = 0-5)
Feature Range (miles) — Sub-Rating
none within 200 mi radius — 0
greater than 100 to 200 mi — 2
greater than 50 to 100 mi — 3
greater than 25 to 50 mi — 4
0 to 25 mi — 5</td></tr>
<tr><td></td><td></td><td colspan="2">Surface Faulting and Deformation
Within 5 miles (Weight=2; Index Range = 0-10)
Within 25 miles (Weight = 1; Index Range = 0-5)
Feature/Range — Sub-Rating
Five miles to within 25 miles
No structures — 0
Potential non-capable structures — 1
Potential capable structures — 5
Within 5 miles
No structures — 0
Potential non-capable structures — 2
Potential capable structures — 3
Fault exceeds 1,000 ft. in length — 4
Capable fault exceeds 1,000 ft. in length — 5</td></tr>
</table>

<table>
<tr><th>Criterion Number</th><th>Criterion</th><th colspan="2">Measure of Suitability</th></tr>
<tr><th></th><th></th><th>Metric</th><th>Rating Rationale</th></tr>
<tr><td rowspan="2">P9
(Con't)</td><td rowspan="2">Geology/Seismology
(Con't)</td><td colspan="2">Geologic Hazard
(Weight = 1; Index Range = 0-1)
Feature Sub-Rating
No geologic hazard present 0
Geologic hazard present 1</td></tr>
<tr><td colspan="2">Soil Stability
(Weight = 2; Index Range = 0-4)
Feature Sub-Rating
Rock Site 0
Deep soil site, no known deleterious soil conditions 1
Deep soil site, potential stability issues or inadequate information to assign a sub-rating of 1 2</td></tr>
<tr><td>P10</td><td>Land Acquisition</td><td colspan="2">Ratings were assigned in accordance with anticipated cost of acquiring land for new units. Sites with existing Progress ownership were given a rating of 5 and sites that would require acquisition of significant new property were rated a 3.</td></tr>
</table>

References

Evaluation by the Division of Reactor U.S. Atomic Energy Commission in the matter of Carolina Power and Light Company H.B. Robinson Unit No. 2 Docket No. 50-261. May 18.

US AEC 1973. Safety Evaluation by the Directorate of Licensing, US Atomic Energy Commission, in the matter of Carolina Power and Light Brunswick Steam Electric Plant Units 1 and 2 Docket Nos. 50-324 and 50-325. November.

USAEC 1974. Supplement 1 to the Safety Evaluation of the Brunswick Steam Electric Plant Units 1 and 2 Docket Nos. 50-324 and 50-325. US Atomic Energy Commission Directorate of Licensing, January 31.

CP&L (Progress Energy Carolinas), [*date*]. Brunswick Updated Final Safety Analysis Report, Chapter 2 Site Characteristics.

FWS 2005. National Wetland Inventory, U.S. Fish and Wildlife Service Wetland Mapper, http://www.nwi.fws.gov

Navigant 2006, Navigant Consulting, Transmission System Impact Study In Support of Nuclear Site Selection for Progress Energy, DRAFT January 4, 2006

NRC 2003. Generic Nuclear Impact Statement for License Renewal of Nuclear Plants, Supplement 13 – Final Report. H.B. Robinson Steam Electric Plant, Unit No. 2, by Carolina Power and Light Company (CP&L), now known as Progress Energy Carolinas. NUREG 1437. Nuclear Regulatory Commission, December.

NRC 2005. Generic Nuclear Impact Statement for License Renewal of Nuclear Plants Regarding Brunswick Steam Electric Plants Units 1 and 2 (NUREG 1437 – Supplement 25). Draft Report for Comment, August.

Updated Final Safety Analysis Report [*date*], Chapter 2 Site Characteristics. Brunswick Steam Electric Plants Units 1 and 2.

Updated Final Safety Analysis Report [*date*]. Chapter 2 Site Characteristics. Shearon Harris Unit 1

US AEC 1974. Supplement 2 to the Safety Evaluation of the Brunswick Steam Electric Plant Units 1 and 2 Docket Nos. 50-324 and 50-325. US Atomic Energy Commission Directorate of Licensing. December 23.

US AEC 1974. Supplement 3 to the Safety Evaluation of the Brunswick Steam Electric Plant Units 1 and 2 Docket Nos. 50-324 and 50-325. US Atomic Energy Commission Directorate of Licensing. December 27.

US NRC [*no date*]. Supplement 4 to the Safety Evaluation Report by the Office of Nuclear Reactor Regulation in the matter of Carolina Power and Light Brunswick Steam Electric Plant Units 1 and 2 Docket Nos. 50-324 and 50-325.

US NRC 1984. Safety Evaluation Report related to the Operation of Shearon Harris Nuclear Power Plant, Unit No. 1 Docket No. STN 50-400. Carolina Power and Light Company and North Carolina Eastern Municipal Power Agency. U.S. Nuclear Regulatory Commission Office of Nuclear Reactor Regulation. NUREG-1038 Supplement No. 1, June.

US NRC 1985. Safety Evaluation Report related to the Operation of Shearon Harris Nuclear Power Plant, Unit No. 1 Docket No. STN 50-400. Carolina Power and Light Company and North Carolina Eastern Municipal Power Agency. U.S. Nuclear Regulatory Commission Office of Nuclear Reactor Regulation. NUREG-1038 Supplement No. 2 June

US NRC 1986. Safety Evaluation Report related to the Operation of Shearon Harris Nuclear Power Plant, Unit No. 1 Docket No. STN 50-400. Carolina Power and Light Company and North Carolina Eastern Municipal Power Agency. U.S. Nuclear Regulatory Commission Office of Nuclear Reactor Regulation. NUREG-1038 Supplement No. 3. May

US NRC 1986. Safety Evaluation Report related to the Operation of Shearon Harris Nuclear Power Plant, Unit No. 1 Docket No. STN 50-400. Carolina Power and Light Company and North Carolina Eastern Municipal Power Agency. U.S. Nuclear Regulatory Commission Office of Nuclear Reactor Regulation. NUREG-1038 Supplement No. 4. October

Crone, A.J. and Wheeler, R.L. 2000. Data for Quaternary faults, liquefaction features, and possible tectonic features in the Central and Eastern United States, east of the Rocky Mountain front. USGS Open File Report 00-260.

EPRI 2001. Siting Guide: Site Selection and Evaluation Criteria for an Early Site Permit Application. Electric Power Research Institute, August 2001.
Frankel, A. et. al. 1996. National Seismic Hazard Maps, Documentation. USGS Open File Report 96-532. June 1996.

US NRC. 1997. Identification and Characterization of Seismic Sources and Determination of Safe Shutdown Earthquake Ground Motion Regulatory Guide 1.165.
Stephenson, D. and Stieve, A. 1992. Structural Model of the Basement in the Central Savannah River Area, South Carolina and Georgia.

USGS Earthquakes Hazards Program. National Seismic Hazard Mapping Project. Interpolated Probabilistic Ground Motion for the Conterminous 48 States by Latitude Longitude, 2002 data.
USGS Earthquakes Hazards Program. National Seismic Hazard Mapping Project. Quaternary Fault and Fold Database for the United States, 2005.

5.0 General Site Criteria Evaluation of Alternative Sites and Selection of Proposed Site

The objective of this component of the site selection process was to further evaluate the four alternative sites and select a proposed site for the Progress COL. Section 5.1 outlines the process for evaluating alternative sites, while Section 5.2 describes process results and the selection of a proposed site.

5.1 Process for Detailed Evaluation of Alternative Sites

General siting criteria used to evaluate the sites were derived from those presented in Chapter 3.0 of the *Siting Guide: Site Selection and Evaluation Criteria for an Early Site Permit Application*, EPRI, Palo Alto, CA: 2002 (Siting Guide); criteria from the siting guide were tailored to reflect issues applicable to, and data available for, the Progress candidate sites; a list of the criteria appears Table 5-1.

The overall process for applying the general site criteria was analogous to that described in Section 4.0 and was comprised of the following elements; results from applying the process are described in Section 5.2.

Criterion Ratings – Each site was assigned a rating of 1 to 5 (1 = least suitable, 5 = most suitable) for each of the potential site evaluation criteria, using the rationale described in Appendix B. Information sources for these evaluations included publicly available data, information available from Progress files and personnel, and USGS topographic maps.

Weight Factors - Weight factors reflecting the relative importance of these criteria were synthesized from those developed for previous nuclear power plant siting studies. The weight factors were originally derived using methodology consistent with the modified Delphi process specified in the Siting Guide. Weight factors used (1 = least important, 10 = most important) are listed Table 5-2.

Composite Suitability Ratings – Ratings reflecting the overall suitability of each site were developed by multiplying criterion ratings by the criterion weight factors and summing over all criteria for each site, as summarized in Table 5-2.

5.2 Evaluation of Alternative Sites

Summary results of applying the evaluation process described in Section 5.1 to the four alternative sites are provided in Table 5-2 and Figure 5-1. Detailed discussions of the basis for site ratings for each of the criteria are provided in Appendix B.

Based on these results and on other considerations described below, Harris was selected as the proposed site for the Progress COL. In addition to its advantages as an existing nuclear power plant site, it ranked highest or equal-highest in 26 of the general site criteria and was rated as being more suitable in both the screening-level and general site criteria composite ratings.

Siting Criteria	Siting Criteria
1.1 Health and Safety Criteria: Accident Cause-Related Criteria	**Environmental Criteria: Operational-Related Effects on Aquatic Ecology, cont'd.**
1.1.1 Geology and Seismology	2.3.2 Entrainment/Impingement effects
1.1.2.1 Cooling System Requirements: Cooling Water Supply	2.3.3 Dredging/Disposal Effects
1.1.2.2.Cooling Water System: Ambient Temperature Requirements	**2.4 Environmental Criteria: Operational-Related Effects on Terrestrial Ecology**
1.1.3 Flooding	2.4.1 Drift Effects on Surrounding Areas
1.1.4 Nearby Hazardous Land Uses	**3 Socioeconomic Criteria**
1.1.5 Extreme Weather Conditions	3.1 Socioeconomic – Construction Related Effects
1.2 Health and Safety Criteria: Accident Effects-Related	3.2 Socioeconomics – Operation (deleted from evaluation, see Appendix B)
1.2.1 Population	3.3 Environmental Justice
1.2.2 Emergency Planning	3.4 Land Use
1.2.3 Atmospheric Dispersion	**4.1 Engineering and Cost Related Criteria: Health and Safety Related Criteria**
1.3 Health and Safety Criteria: Operational Effects-Related	4.1.1 Water Supply
1.3.1 Surface Water- Radionuclide Pathway	4.1.2 Pumping Distance
1.3.2 Groundwater Radionuclide Pathway	4.1.3 Flooding
1.3.3 Air Radionuclide Pathway	4.1.4 Vibratory Ground Motion (deleted from evaluation, see Appendix B)
1.3.4 Air-Food ingestion pathway	4.1.5 Civil Works
1.3.5 Surface Water – food radionuclide pathway	**4.2 Engineering and Cost: Transportation or Transmission Related Criteria**
1.3.6 Transportation Safety	4.2.1 Railroad Access
2.1 Environmental Criteria: Construction-Related Effects on Aquatic Ecology	4.2.2 Highway Access
2.1.1 Disruption of Important Species/Habitats	4.2.3 Barge Access
2.1.2 Bottom Sediment Disruption Effects	4.2.4 Transmission Access
2.2 Environmental Criteria: Construction-Related Effects on Terrestrial	**4.3 Engineering and Cost- Related Criteria: Related to Socioeconomic & Land Use**
2.2.1 Disruption of Important Species/Habitats and Wetlands	4.3.1 Topography
2.2.2 Dewatering Effects on Adjacent Wetlands	4.3.2 Land Rights
2.3 Environmental Criteria: Operational-Related Effects on Aquatic Ecology	4.3.3 Labor Rates
2.3.1 Thermal Discharge Effects	

Table 5-1 General Site Criteria

Table 5-2 General Site Criterion Ratings

Criteria		Weight Factor	Brunswick		Harris		Marion		Robinson	
			Rating	Score	Rating	Score	Rating	Score	Rating	Score
1.1.1	Geology/Seismology	3.77	3	11.31	4	15.08	2	7.54	2	7.54
1.1.2	Cooling System Requirements	3.27	5	16.35	4	13.08	4	13.08	3	9.81
1.1.3	Flooding	2.4	1	2.4	1	2.4	1	2.4	3	7.2
1.1.4	Nearby Hazardous Land Uses	3.35	1	3.35	2	6.7	2	6.7	2	6.7
1.1.5	Extreme Weather Conditions	2.36	1	2.36	3	7.08	3	7.08	3	7.08
1.2	Accident Effect Related	4.09	3	12.27	3	12.27	4	16.36	4	16.36
1.3.1	Surface Water – Radionuclide Pathway	2.5	5	12.5	4	10	4	10	4	10
1.3.2	Groundwater Radionuclide Pathway	2.55	3	7.65	5	12.75	3.5*	8.925	3	7.65
1.3.3	Air Radionuclide Pathway	2.5	5	12.5	5	12.5	5	12.5	5	12.5
1.3.4	Air-Food Ingestion Pathway	2.5	5	12.5	4	10	3	7.5	2	5
1.3.5	Surface Water-Food Radionuclide Pathway	2.41	5	12.05	3	7.23	5	12.05	5	12.05
1.3.6	Transportation Safety	2.14	5	10.7	5	10.7	5	10.7	5	10.7
2.1.1	Disruption of Important Species/Habitats	2.64	3	7.92	4	10.56	4	10.56	4	10.56
2.1.2	Bottom Sediment Disruption Effects	2.14	4	8.56	4	8.56	2	4.28	2	4.28
2.2.1	Disruption of Important Species/Habitats and Wetlands	3.18	3	9.54	4	12.72	2	6.36	4	12.72
2.2.2	Dewatering Effects on Adjacent Wetlands	2.77	3	8.31	5	13.85	1	2.77	5	13.85
2.3.1	Thermal Discharge Effects	3.64	4	14.56	4	14.56	4	14.56	3	10.92
2.3.2	Entrainment/Impingement Effects	3.23	3	9.69	3	9.69	3	9.69	3	9.69
2.3.3	Dredging/Disposal Effects	2.36	3	7.08	4	9.44	3	7.08	3	7.08
2.4.1	Drift Effects on Surrounding Areas	2.36	3	7.08	4	9.44	4	9.44	4	9.44
3.1	Socioeconomics – Construction – Related Effects	2	5	10	5	10	5	10	5	10
3.3	Environmental Justice	1.95	5	9.75	5	9.75	5	9.75	5	9.75
3.4	Land Use	3.8	5	19	5	19	2	7.6	5	19
4.1.1	Water Supply	3.7	5	18.5	5	18.5	3	11.1	5	18.5
4.1.2	Pumping Distance	3.05	5	15.25	5	15.25	3	9.15	5	15.25

Criteria		Weight Factor	Brunswick		Harris		Marion		Robinson	
			Rating	Score	Rating	Score	Rating	Score	Rating	Score
4.1.3	Flooding	2.9	1	2.9	1	2.9	1	2.9	3	8.7
4.1.5	Civil Works	3.4	3	10.2	3	10.2	2	6.8	3	10.2
4.2.1	Railroad Access	2.6	5	13	5	13	3	7.8	5	13
4.2.2	Highway Access	2.8	5	14	5	14	3	8.4	5	14
4.2.3	Barge Access	2.85	5	14.25	1	2.85	1	2.85	1	2.85
4.2.4	Transmission Access	4.8	1	4.8	5	24	2	9.6	3	14.4
4.3.1	Topography	2.55	4	10.2	4	10.2	4	10.2	4	10.2
4.3.2	Land Rights	2.75	5	13.75	5	13.75	3	8.25	5	13.75
4.3.3	Labor Rates	3.3	5	16.5	5	16.5	5	16.5	5	16.5
	Composite Site Rating		**361**		**389**		**300**		**367**	

* - Not rounded. See text Appendix B, Criterion 1.3.2.

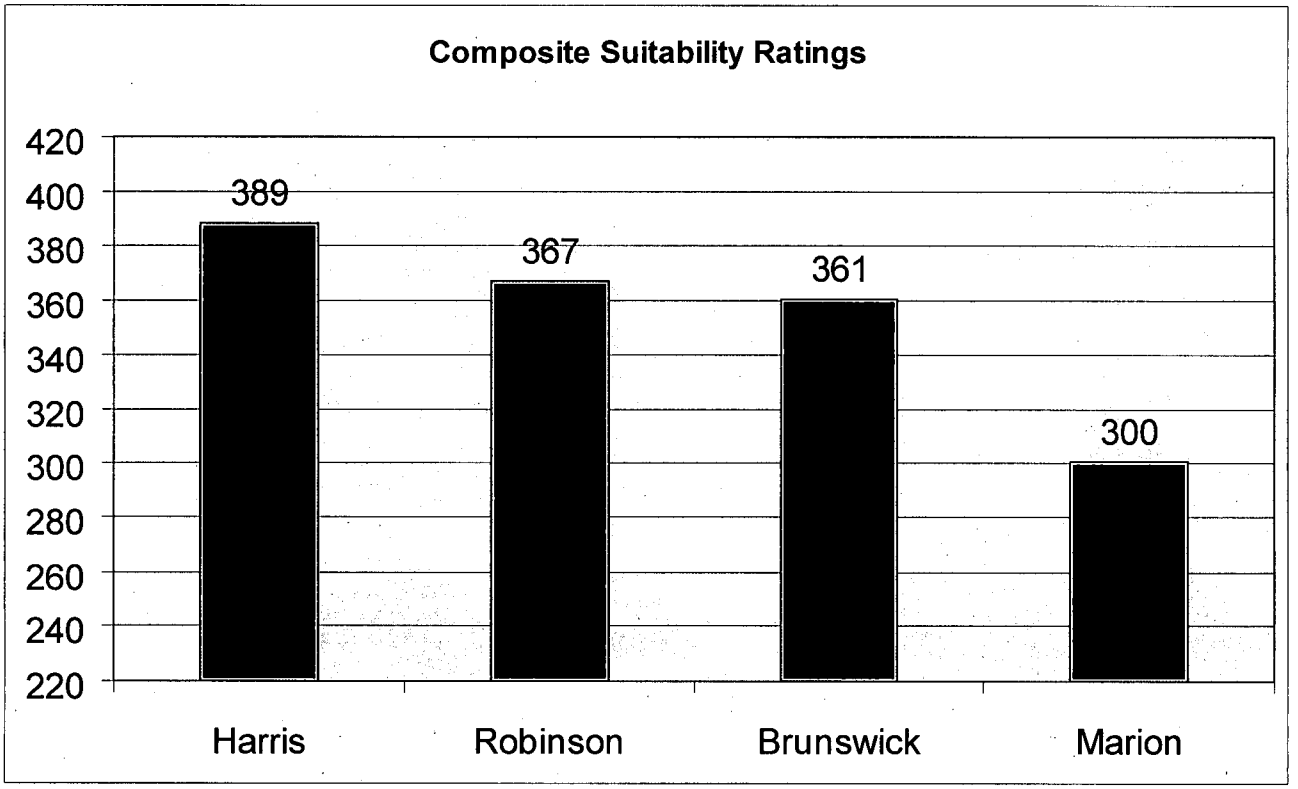


Figure 5-1 – Summary of General Site Criterion Composite Ratings

APPENDIX A

Technical Basis for Screening Criterion Ratings

Criterion P1 – Water Supply		
Site	**Rating**	**Comments and Discussion**
Cape Fear River/Storage Reservoir System		
Harris	4	Water supply is the Shearon Harris storage reservoir system, consisting of a main reservoir on Buckhorn Creek, and an auxiliary reservoir located on Tom Jack Creek. Average reservoir level is at 219.4 feet msl for one-unit operation. Buckhorn Creek has its headwaters in the vicinity of Holly Springs and Apex, NC, and flows on a southwesterly course to its confluence with the Cape Fear River. Buckhorn Creek has five tributaries above the main dam. The conceptual design of the original reservoir system was to support multiple nuclear units at full development of the site with a higher lake elevation at 250 feet. At present, the site contains one 900MW unit with closed cycle cooling. For full development, the reservoir was to be recharged by pumping from the Cape Fear River in addition to the natural recharge from the watershed. This pumping capacity has not been installed, but may be needed for future development. Further analysis is required, but there is sufficient gross flow to support a new plant with closed-cycle cooling. Previous modeling efforts showed that for a two-unit plant, the main reservoir water level would fluctuate from a minimum water level of 217.7 to a maximum level of 221.9 feet msl. Analysis of a 100-year drought in both Buckhorn Creek and Cape Fear River, in conjunction with a 4-unit operation at 100% load factor, resulted in the lowest reservoir level of 205.7 feet msl (at which point plant would shut down – 205.7 feet is minimum operating level). During licensing of Shearon Harris, NRC staff concluded that the water supply was adequate for a two-unit plant operation, including the Cape Fear River makeup system, and is also adequate in the event of a severe drought for both a one- and two–unit operation. Therefore, an adequate water supply and location on an existing reservoir contribute to a favorable rating, although NRC expressed some concerns with multiple unit operation under drought conditions. The site is given an overall rating of 4.

Criterion P1 – Water Supply		
Site	**Rating**	**Comments and Discussion**
	Robinson	
Robinson	3	The cooling water source is Lake Robinson, a 2250-acre impoundment created on Black Creek. Water is pumped at a rate of approximately 506,000 gallons per minute for cooling unit 2 (nuclear unit) and returned to the lake through the discharge canal. The site has 1-710MW nuclear, 1-174MW fossil and 1-15MW combustion turbine. The site appears to be challenged for water supply, based on operational experience at the existing unit, where some restrictions on operations have been required based on thermal effects. Historically, operation of the coal unit at Robinson has been curtailed to avoid exceeding thermal limits for the lake. Robinson was given a rating of 3, based on concerns about operational limitations associated with water supply and thermal issues in Lake Robinson.
	Cape Fear River/Estuary	
Brunswick	5	Due to the nature of the intake and proximity to the Atlantic Ocean, there are no practical flow constraints. The flow at the mouth of the Cape Fear River draws upon a drainage area of 9,140 square miles. Of this, stream flow from about 6,000 square miles is gauged continuously by USGS. Average daily freshwater discharge rate of the river at the mouth is estimated to be between 8,100 and 10,000 cubic feet per second (cfs). Because of the abundant water supply, the site is given a rating of 5.
	Great Pee Dee River	
Marion	4	Based on an analysis conducted by Devine, Tarbell & Associates provided by Progress, the Pee Dee River 7-day, 10-year low flow at the site is 1,450 cfs. Given a plant water makeup requirement in the range of 100 cfs, it appears that adequate cooling water is available to support a two-unit plant for any of the designs under consideration. The rating was reduced slightly (5 to 4) because the site is not on a reservoir or lake, and potential concerns regarding flow during extreme drought conditions.

Criterion P2 – Flooding		
Site	**Rating**	**Comments and Discussion**
Harris	1	Flooding sources evaluated include local flooding from the probable maximum precipitation (PMP) event on Buckhorn Creek and tributaries, dam failures, and hurricane induced wave activity (the site is 115 miles from coast). Because of the 100-foot difference in elevation between the site and the Cape Fear River, there is no concern from flooding from the river. Plant grade elevation is at 260 feet msl, and normal water level in the reservoir is 220 feet MSL. The PMP (based on the conservative assumption that that there would be no loss of water from infiltration, evaporation and a completely blocked drainage system) would result in a flood elevation of 261.27 feet – slightly above plant grade elevation [flood protection features are currently in place to protect safety related structures]. The PMF on streams and rivers showed a maximum stillwater level of 256 feet MSL in the auxiliary reservoir and 238.9 feet MSL for the main dam. Effects of coincident wind wave activities on PMF stillwater levels resulted in a maximum water level of 243.1 feet MSLS in the main reservoir and 258 feet MSL in the auxiliary reservoir. (NRC staff calculated 243.3 and 258.6 feet MSL respectively).
Robinson	3	Grade elevation at the plant site is 225 feet; the site lies on a 2250-acre lake. The PMF was based on PMP conditions (20 inches in 48 hours from a postulated hurricane); modeling showed a resulting flow of 30,000 cfs, but the site would still be above flood elevation in this scenario. The spillway is designed to pass a flow of 40,000 cfs which would result in a lake level of 221.67 feet.
Brunswick	1	The site is located on the Cape Fear River on the North Carolina coast at elevations of 20-25 feet MSL [nominal plant grade is 20 feet MSL). For the PMH (probable maximum hurricane) – surge stillwater level at the site would be 22 feet MSL; peak storm elevation of the Cape Fear River would be 23.3 feet MSL on shore. This peak tide would not reach the site. In the intake canal, the stillwater level is expected to reach 22 feet MSL. The nominal plant grade of 20 feet MSL results in 2 feet of water depth surrounding the plant during the maximum surge conditions. All safety related structures at the current plant are waterproofed to elevation 22 feet MSL.

Criterion P2 – Flooding		
Site	**Rating**	**Comments and Discussion**
Marion	1	The site is generally low in elevation, with considerable onsite and surrounding swamp land. Site elevations appear to be at or even slightly below that of the 100-year floodplain (a PMF elevation has not been determined, but it is assumed that it would be higher than 100-year flood and site grade could be below PMF). This presents the need to address environmental impacts on floodplains as well as the possibility that engineered flood protection features will be required to protect the plant. These factors, combined with the surrounding known swamps and shallow depth to ground water, also indicate the potential for construction dewatering problems.

Criterion P3 – Population

Ratings and the population centers that drive the ratings are presented for each site in the following table; additional detail on population data for each site is provided in the succeeding tables.

Site	Harris	Robinson	Brunswick	Marion
Rating	1	2	2	2

Harris rating based on nearest population center alone would be a 2, but it was further reduced to a 1 given its proximity to two significantly large population centers and the corresponding high population density in the host county and one of the adjacent counties.
Robinson rating based on nearest population center alone would be 1, but it was raised to a 2 given the overall low population density in the host and surrounding counties.
Brunswick rating based on nearest population center (and factoring in seasonal populations) was a 2 and did not warrant further adjustment based on population density in surrounding area.
Marion rating based on nearest population center was a 2 and it also did not change. While surrounding population density was also low, it is in close proximity to two population centers with high population density.

Criterion P3 – Population Data			
Population Center	Population (2000)	Distance from Site	Population Density (Pop/mi^2)
Harris			
Cary	94,536	13-18 miles	n/a
Raleigh	276,093	16-28 miles	n/a
Sanford	23,200	15 miles	n/a
Wake County (host)	627,846	n/a	754.7*
Chatham County	49,320	n/a	72.2
Harnett County	91,024	n/a	153
Durham County	223,314	n/a	769.2*
Orange County	118,227	n/a	295.7
Other large cities within 50 miles: Durham – 187,035 (20-30 miles) Fayetteville – 121,015 (37-43 miles)		Smaller cities within 10 miles Apex – 20,212 Fuquay-Varina - 7898 Holly Springs - 9192	
* Because of the high population densities in Wake (host) and Durham counties, additional population information within 0 to 50 mile radius of Harris is provided in the table below.			
Robinson			
Hartsville	7,556	3 miles	n/a
Florence	30,248	25 miles	n/a
Camden	6,682	26 miles	n/a
Darlington County (Host)	67,394	n/a	120.1
Chesterfield County	42,768	n/a	53.6
Lee County	20,119	n/a	49

Criterion P3 – Population Data			
Population Center	**Population (2000)**	**Distance from Site**	**Population Density (Pop/mi²)**
Sumter County	104,646	n/a	157.3
Kershaw County	52,647	n/a	72.5
Nearest population center to the site: Hartsville/N. Hartsville – 7556 + 3136 Other large cities within 50 miles: Sumter – 39,643 (35 miles) [Columbia – 116,278 (56 miles)]		Smaller cities within 15 miles: McBee – 714 (7 miles) Bishopville – 3670 (12.5 miles) Pine Ridge – 1593 [right next to plant]	
Brunswick			
Wilmington (City)	75,838	16 miles	n/a
Brunswick County (host)	73,143	n/a	85.6
Columbus County	54,749	n/a	58.4
New Hanover County	160,307	n/a	805.8
Horry County (SC)/Myrtle Beach MSA	196,629	n/a	173.4
Nearest population center to site: Wilmington – 75,838 [+ unincorporated 55,600] Other nearby cities: Southport – 2351 (2 miles) Boiling Springs – 3,866 (5 miles) Carolina Beach – 4,701 (7 miles) Kure Beach – 1507 (6 miles) Long Beach/Yaupon Beach/Oak Island – 6571 (5-7 miles) Balk Head Island – 173		Also within 10 miles: Waterborne population (boats, vessels) – 5,546 Seasonal summer population – 13,056 from various nearby attractions Plus beach summer tourists: Pleasure Island (Carolina and Kure Beaches) - 17,000 overnight; 39,000 day; Oak Island (Long Beach, Caswell Beach, Yaupon Beach) - overnight population at 26,000; Bald Head Island – 1509 overnight	
Marion			
Marion	7,042	{ }	n/a
Florence	30,248	{ }	n/a
Marion County	35,466	n/a	72.5
Florence County	125,671	n/a	157.2
Dillon County	30,722	n/a	75.9
Darlington County	67,394	n/a	120.1
Smaller towns { }: Mullins – 5029 {( )} 4 Latta – 1410 ({ }) { }			

Cumulative Population Estimates and Projections and Population Density (persons per square mile) between Zero and Fifty Miles of Harris

Miles from Site	Population (2000)	Population Density (2000)	Population (2020)	Population Density (2020)	Population (2027)	Population Density (2027)
0-1	0	0	0	0	0	0
0-2	54	4.3	93	7.40	112	8.91
0-3	481	17.01	782	27.67	934	33.03
0-4	1,100	21.88	1,774	35.31	2,112	42.02
0-5	2,200	28.01	3,529	44.95	4,203	53.51
0-10	52,860	158.26	88,044	280.39	106,317	338.42
0-20	441,746	351.53	708,548	564.13*	846,877	673.92
0-30	1,099,464	388.86	1,736,454	614.46	2,066,989	731.05
0-40	1,558,369	310.18	2,379,999	473.72	2,806,878	558.69
0-50	2,034,394	259.16	3,025,592	385.42	3,540,592	451.03

*Population density within 20 miles of plant in 2010 estimated to be 455.81 persons/sq mi.
From Updated FSAR based on 2000 US Census Bureau data.

Criterion P4 – Hazardous Land Uses		
Site	**Rating**	**Comments and Discussion.**
Harris	2	No military or industrial facilities were identified within 5 miles, but there is a local concentration of industry 7 miles west in Moncure – mainly in the form of wood products and synthetic fibers plants. Two mining operations and 5 inactive quarries lie within 10 miles of site. A liquefied natural petroleum gas pipeline is nearby (2 miles). Raleigh Executive Airport is 6 miles from site (private); 2 other small general aviation airports are within 10 miles – at Shelba and Luther.
Robinson	2	The site area is rural, with light development. Facilities within 5 miles of the site include: Darlington County Internal Combustion Electric Plan (1 mile) Robinson Unit 1 coal fired power plant. Gas pipeline Hartsville Municipal Airport (2.5 miles) Railroad Specialty steel plant (Talley Metals) adjacent to the existing plant Lee County Airport lies within 15 miles of the site
Brunswick	1	Facilities within 5 miles of the site include: Brunswick County Airport – 4 miles; Cape Fear River/barge traffic – ocean going vessels; Sunny Point Army Terminal The site area in general is characterized as having a high degree of industry; the closest are an ADM industrial plant (principal product is citric acid) and a Co-Gentrix Plant (steam and fossil electricity) The site also adjacent to natural gas pipeline.
Marion	2	{ }

Criterion P5 – Ecology (Disruption of Important Habitat (Terrestrial and Aquatic Ecology combined)					
Site	Rating				Comments and Discussion
	No. of Species	Habitat	Flexibility	Average Score	
Reservoir					
Harris	2	3	4	3	3 listed species
Lake					
Robinson	4	3	5	4	1 listed species
Estuary/Ocean					
Brunswick	1	3	4	3	16 listed species
Pee Dee River					
Marion	5	3	5	4	No listed species

Criterion P6 – Wetlands					
Site	Rating				Comments and Discussion
	Total Acres	Acres of Forested	Flexibility	Average Score	
Harris	5	5	5	5	40.2 acres of wetlands (6000 acre area); 11.5 acres of wetlands (400 acre area)
Robinson	5	5	2	4	105.8 acres of wetlands (6000 acre area); 49.7 acres of wetlands (400 acre are a)
Brunswick	4	3	5	4	400.33 acres of wetlands (6000 acre area); 81 acres of wetlands (400 acre area)
Marion	1	1	2	1	1,034 acres of wetlands (6000 acre area); 246.3 acres of wetlands (400 acre area). Both on and near the site there are significant acreages of freshwater forested wetlands, forested/shrub wetlands, and freshwater emergent wetlands. Much of this wetland area is semi-permanently flooded, consistent with the low lying land in this area. These wetlands are jurisdictional wetlands and a permit from the USACE would be needed prior to disruption or impact. Judging from the low lying nature of the land in this area, dewatering of the site would be necessary which would most likely affect wetlands.

Criterion P7 – Railroad Access		
Site	**Rating**	**Comments and Discussion**
Harris	5	The proposed site is located near the existing Shearon Harris Nuclear Power Plant. As such, on-site railroad access is already provided in the immediate vicinity of the proposed site from the Seaboard line. While some construction/modification is expected to link the new site, a rating of 5 is assigned since rail access already exists at the site. [0.2 mile to existing rail at cost of $600,000]
Robinson	5	The proposed site is located near the existing H.B. Robinson Nuclear Power Plant. As such, on-site railroad access is already provided in the immediate vicinity of the proposed site. While some construction/modification is expected to link the new site, a rating of 5 is assigned since rail access already exists at the site. [0.2 mile to existing rail at cost of $600,000]
Brunswick	5	The proposed site is located near the existing Brunswick Nuclear Power Plant. As such, on-site railroad access is already provided in the immediate vicinity of the proposed site. While some construction/modification is expected to link the new site, a rating of 5 is assigned since rail access already exists at the site. [0.1 mile to existing rail at cost of $300,000]
Marion	3	{ }

Criterion P8 – Transmission Access		
Site	**Rating**	**Comments and Discussion** ***Need to fully reflect results from Navigant studies, when available, in the ratings.***
Harris	5	The proposed site is located near the existing Harris Nuclear Power Plant. As such, transmission lines are located in the immediate vicinity of the proposed site. Transmission system upgrades are estimated by Navigant Consulting as negligible (less than $1 Million) for the addition of a 1100 MW generating unit.
Robinson	3	The proposed site is located near the existing H.B. Robinson Nuclear Power Plant. Transmission system upgrades are estimated by Navigant Consulting at ~ $143 Million for the addition of a 1100 MW generating unit.
Brunswick	1	The proposed site is located near the existing Brunswick Nuclear Power Plant. Required transmission system upgrades are estimated by Navigant Consulting to be the highest for the four alternative sites at ~ $ 309 Million for the addition of a 1100 MW generating unit.
Marion	2	Transmission system upgrades are estimated by Navigant Consulting at ~ $ 205 Million for the addition of a 1100 MW generating unit. Marion is the second most costly site in regards to required transmission system upgrades.

Criterion P9 – Geology/Seismology Summary Ratings			
Site	Index	Rating	Comments and Discussion
Harris	28	4	See following back-up table
Robinson	55	2	See following back-up table
Brunswick	38	3	See following back-up table
Marion	69	2	See following back-up table

Ratings for Harris				
Feature	**Source**	**Weight**	**Rating**	**Index No.**
Vibratory Ground Motion	PGA 9.46 %g with 2% PE in 50 years (USGS National Seismic Hazards Mapping Project, 2002).	5	4	20
Capable Tectonic Source (Class A)	The Charleston and Georgetown Class A liquefaction features and the Central Virginia Seismic Zone all occur within 100 to 200 miles of SHNP (USGS Fault and Fold Database, 2003. Crone & Wheeler, 2000).	2	2	4
Capable Tectonic Source (Class B)	The Pembroke Faults Class B feature is located approximately 180 miles NW of SHNP, within 100 to 200 miles. It is not rated since it is no closer than the Class A features that are rated (Crone & Wheeler, 2000).	1	0	0
Surface Faulting & Deformation within 25 miles	No surface faulting or deformation has been identified at the site.	1	0	0
Surface Faulting & Deformation within 5 miles	The Jonesboro Fault occurs within 5 miles of the site. During construction numerous minor faults were discovered at the site. All were confirmed to be non-capable (SHNP FSAR).	2	2	4
Geologic Hazards	No areas of volcanic activity, subsidence due to withdrawal of subsurface fluids, potential unstable slope, potential collapse, mined areas, or areas subject to seismic or other induced water waves or floods occur at the site (SHNP FSAR).	1	0	0
Soil Stability	SHNP is a rock site (SHNP FSAR).	2	0	0
		Total Index		**28**

Ratings for Robinson				
Feature	**Source**	**Weight**	**Rating**	**Index No.**
Vibratory Ground Motion	PGA 26.03 %g with 2% PE in 50 years (USGS National Seismic Hazards Mapping Project, 2002).	5	9	45
Capable Tectonic Source (Class A)	The Georgetown Class A liquefaction features occur within 50 to 100 miles of RNP. The Bluffton and Charleston Class A liquefaction features occur within 100 to 200 miles (USGS Fault and Fold Database, 2003. Crone & Wheeler, 2000).	2	3	6
Capable Tectonic Source (Class B)	No Class B features were identified within a 200 mile radius of RNP (Crone & Wheeler, 2000).	1	0	0
Surface Faulting & Deformation within 25 miles	No surface faulting or deformation have been identified at the site.	1	0	0
Surface Faulting & Deformation within 5 miles	No surface faulting or deformation have been identified at the site.	2	0	0
Geologic Hazards	No areas of volcanic activity, subsidence due to withdrawal of subsurface fluids, potential unstable slope, potential collapse, mined areas, or areas subject to seismic or other induced water waves or floods occur at the site (Dominion Energy, Inc. and Bechtel Power Corp. 2002).	1	0	0
Soil Stability	RNP is a deep soil site. Investigations at RNP identified some soils that show a response to oscillation. Because of the possibility for soil liquefaction and/or settlement, any location for new nuclear facilities at RNP would require thorough investigation and testing to determine the presence of any problematic soils (Updated FSAR).	2	2	4
		Total Index		**55**

Ratings for Brunswick				
Feature	**Source**	**Weight**	**Rating**	**Index No.**
Vibratory Ground Motion	PGA 14.13 %g with 2% PE in 50 years (USGS National Seismic Hazards Mapping Project, 2002).	5	5	25
Capable Tectonic Source (Class A)	The Georgetown Class A liquefaction features occur within 50 to 100 miles of BSEP. The Bluffton and Charleston Class A liquefaction features occur within 100 to 200 miles (USGS Fault and Fold Database, 2003. Crone & Wheeler, 2000).	2	3	6
Capable Tectonic Source (Class B)	No Class B features were identified within a 200 mile radius of BSEP (Crone & Wheeler, 2000).	1	0	0
Surface Faulting & Deformation within 25 miles	No surface faulting or deformation have been identified at the site. A subsurface feature occurs as described for the 5-mile radius (below).	1	0	0
Surface Faulting & Deformation within 5 miles	The Cape Fear Arch (Class C) occurs beneath the site. (USGS Fault and Fold Database, 2003; Crone & Wheeler, 2000).	2	2	4
Geologic Hazards	There is a potential for large water waves or flooding to occur at the site.	1	1	1
Soil Stability	BSEP is a deep soil site.	2	1	2
		Total Index		**38**

Ratings for Marion				
Feature	**Source**	**Weight**	**Rating**	**Index No.**
Vibratory Ground Motion	The Marion site has a PGA of 34.98 %g with 2% PE in 50 years (USGS National Seismic Hazards Mapping Project, 2002).	5	12*	60
Capable Tectonic Source (Class A)	The Georgetown Class A liquefaction features occur within 50 to 100 miles of the Marion Site (USGS Fault and Fold Database, 2003. Crone & Wheeler, 2000).	2	3	6
Capable Tectonic Source (Class B)	There are no known Class B features within 200 miles of the Marion Site.	1	0	0
Surface Faulting & Deformation within 25 miles	No surface faulting or deformation have been identified at the site.	1	0	0
Surface Faulting & Deformation within 5 miles	No surface faulting or deformation have been identified at the site.	2	0	0

Ratings for Marion				
Feature	**Source**	**Weight**	**Rating**	**Index No.**
Geologic Hazards	Due to low elevations, there is a potential for flooding at the Marion Site.	1	1	1
Soil Stability	The Marion Site is a deep soil site.	2	1	2
		Total Index		**69**

* - Rating of 12 exceeds nominal ratings range of 1 – 10 because predicted PGA is in excess of certified design PGA of 30 % g; at a minimum this will require additional site investigation and analysis (see text, Appendix B).

Criterion P10 – Land Acquisition		
Site	**Rating**	**Comments and Discussion**
Harris	5	Site property is already owned by Progress; uncertain if additional property would be required for expansion.
Robinson	5	The site property is already owned by Progress; uncertain if additional property would be required for expansion.
Brunswick	5	Site property is already owned by Progress; uncertain if additional property would be required for expansion.
Marion	3	{ }

APPENDIX B

Technical Basis for General Site Criteria Ratings

General siting criteria used in the Progress nuclear power plant siting study were derived from those presented in Chapter 3.0 of the *Siting Guide: Site Selection and Evaluation Criteria for an Early Site Permit Application*, EPRI, Palo Alto, CA: 2002 (Siting Guide).

The following information is provided in this appendix for each criterion:

- Objective – what aspect of site suitability is being measured
- Evaluation approach – technical basis/methodology used to develop site ratings from available data
- Discussion – Data and information available for the four sites under consideration
- Results – Ratings results and rationale

The following candidate sites were evaluated for the Progress Combined Operating License (COL) application in the Carolinas: Brunswick Steam Electric Plant (Brunswick), H. B. Robinson Plant (Robinson), Shearon Harris Nuclear Plant (Harris), and the Marion Site (Marion).

Note that the sites were evaluated with respect to the following siting criteria during the initial screening phase: cooling water supply, flooding, population, hazardous land uses, ecology, wetlands, railroad access, transmission access, geology/seismic, and land acquisition; the evaluation and results of this phase are presented in Appendix B. Appendix C provides a more detailed discussion of the full EPRI general site criteria, including those initially addressed in Appendix B. For several of these criteria (e.g., cooling water), the original evaluation did not change and reference is made to the criterion discussion in Appendix B, with a brief summary and the final ratings presented in Appendix C for completeness. For other screening criteria (i.e., population, ecology and geology/seismic), additional data were evaluated or additional detail provided in Appendix C, as appropriate, to provide a more comprehensive analysis of the full suite of EPRI siting criteria and sub-criteria.

Technical bases for site ratings developed for each of the general site criteria are provided in the following sections. Criterion/section numbering is designed to reflect section numbers in Chapter 3 of the EPRI Siting Guide where the criteria is discussed, e.g., Criterion 1.1.1 - Geology/ Seismology appears in Section 3.1.1.1 of the Siting Guide.

1. HEALTH AND SAFETY CRITERIA

1.1 ACCIDENT CAUSE-RELATED

1.1.1 Geology/Seismology

This criterion was evaluated as part of the initial screening process (Criterion P9, Appendix A). The data, the evaluation and the results have not changed from the initial screening. As such, the complete evaluation and results, including detail on each of the sub-criteria evaluations in support of the final site ratings, are included here.

Objective - The objective of this criterion is to rank the suitability of Brunswick, Marion, Robinson and Harris with respect to the geologic and seismic setting, using to the extent possible the same or similar criteria previously utilized to rank other potential sites.

Evaluation approach - A numerical system of weights and ratings based upon suitability criteria were assigned to each geologic/seismic category, including vibratory ground motion, capable tectonic sources, surface faulting and deformation, geologic hazards, and soil stability (Sections 1.1.1.1 through 1.1.1.5) and used to compute (i.e., rate times weight) an index number for each category. (To enable the comparative evaluation of sites, the weights and rating schemes adopted herein are the same for all four sites. The index numbers for each site were summed to compute a GEOL Index (Tables 1.1-1 through 1.1-4). The range of GEOL indexes was then used to develop a rating system for candidate sites (Section 1.1.1.6). The sites were rated on a scale of 1 to 5, based on the GEOL scale, with the most suitable sites receiving an overall rating of 5. Weights and the basis for deriving correlating site ratings from the GEOL scale are discussed with respect to each of the sub-criteria in the sections below. NOTE: Within the GOEL index sub-criteria an inverse rating basis is used, with lower numbers indicating most suitable and 5 the least suitable; for the composite GEOL index, higher numbers indicate less suitable sites.

Discussion – Site data are presented for each of the sub-criteria in Sections 1.1.1.1 through 1.1.1.5, below.

Results – A discussion of the roll-up of individual criteria to develop overall site ratings for the Geology/Seismology criterion appears in Section 1.1.1.6.

1.1.1.1 Vibratory Ground Motion

Objective – The purpose of this sub-criterion is to rate sites according to the expected magnitude of ground motion that may be expected. As long as expected peak ground accelerations do not exceed that for the certified designs under consideration there are no exclusionary or avoidance components to this sub-criterion.

Evaluation approach – Peak ground acceleration (PGA) is a measure of the maximum force experienced by a small mass located at the surface of the ground during an earthquake and it is an index of hazard for some structures. The units for PGA are in percent of gravity (%g); i.e. an acceleration of 0.30g is expressed as 30%g. PGA provided herein, as for other sites, is for a

probability of exceedance (PE) of 2% in 50 years (once in 2500 years). PGA data for four Progress Carolina sites were obtained from the USGS National Seismic Hazards Mapping Project, 2002 (http://eqint.cr.usgs.gov/eq/html/lookup-2002-interp.html).

Discussion/Results – The locations evaluated for each of the four candidate sites have PGA values as shown in the table below.

Probabilistic ground motion values in %g

Site	PGA (%g) with 2% PE in 50 years
Brunswick	14.13
Harris	9.46
Marion	34.98
Robinson	26.03

The following table shows the assigned weight and rating scheme for vibratory ground motion.

Weight	Range	Rating	Index Range
	PGA (%g)		
5	0 – 3	1	0 - 50
	3 – 6	2	
	6 – 9	3	
	9 – 12	4	
	12 – 15	5	
	15 – 18	6	
	18 – 21	7	
	21 – 24	8	
	24 – 27	9	
	27 – 30	10	

Based upon the information provided in Tables 1.1-1 through 1.1-4, each candidate site receives the following ratings based on the computed index numbers for vibratory ground motion.

Site	Rating	Index No.
Brunswick	5	25
Harris	4	20
Marion	12	60
Robinson	9	45

It should be noted that the rating of 12 for the Marion site is outside the defined ratings range of 1 – 10 for the vibratory ground motion sub-criterion. This rating was applied to reflect the fact that predicted PGA for the Marion site exceeds the design PGA for certified plant designs being considered (34 %g versus 30%g). Because the predicted PGA is only slightly in excess of the design value, it is possible that detailed on-site studies would prove that the site PGA falls within the design limit. Accordingly, the site was not excluded from further consideration for the Progress COL. However, even if detailed on-site investigations confirm its suitability, it is anticipated that considerable additional site characterization and analysis will be required at Marion. The rating of 12 was assigned to numerically reflect these uncertainties, relative to the other sites under consideration.

1.1.1.2 Capable Tectonic Structure or Source

Objective – No absolute exclusionary criteria have been identified. Capable tectonic structures are addressed as avoidance criteria, therefore, the objective of this sub-criterion is to identify the existence of capable or potentially capable tectonic structures within 200 miles of each site. Candidate sites that are furthest from capable or potentially capable tectonic structures are considered more suitable.

Evaluation Approach – A database compiled by USGS (Quaternary Fault and Fold Database, 2003; http://qfaults.cr.usgs.gov/) and Crone and Wheeler (2000) were utilized to identify capable and potentially capable tectonic sources within 200 miles of each of the four candidate sites. It was assumed that capable and potential capable tectonic sources, which are Quaternary features that may generate strong ground motion, fall into two categories as defined by Crone and Wheeler (2000, p5):

> Class A features have good geologic evidence of tectonic origin and are potentially seismogenic; and
>
> Class B features have geologic evidence that supports the existence of a seismogenic fault or suggests Quaternary deformation, but the currently available geologic evidence for Quaternary tectonic activity is less compelling than for a Class A feature.

Discussion/Results – The table below shows a list of Class A and Class B features within a 200 mile radius of each candidate site. There are no known Class B features within 200 miles of Brunswick, Marion, or Robinson sites, and one Class B feature within 200 miles of Harris.

Feature	Class	Site	Distance from site (mi)
Georgetown liquefaction features	A	Brunswick	Greater than 50 to 100
Bluffton liquefaction features	A	Brunswick	Greater than 100 to 200
Charleston liquefaction features	A	Brunswick	Greater than 100 to 200
Central Virginia Seismic Zone	A	Harris	Greater than 100 to 200
Georgetown liquefaction features	A	Harris	Greater than 100 to 200
Charleston liquefaction features	A	Harris	Greater than 100 to 200
Pembroke Faults	B	Harris	Greater than 100 to 200
Georgetown liquefaction features	A	Marion	{ }
Charleston liquefaction features	A	Marion	{ }
Bluffton liquefaction features	A	Marion	{ }
Georgetown liquefaction features	A	Robinson	Greater than 50 to 100
Charleston liquefaction features	A	Robinson	Greater than 100 to 200
Bluffton liquefaction features	A	Robinson	Greater than 100 to 200

The existence of capable tectonic sources can impact the determination of the SSE, especially those near a site. The defining seismic event for the Brunswick, Marion, Robinson, and Harris sites is the Charleston earthquake of 1886. Despite thorough investigation and numerous studies, the causative fault(s) for this earthquake has not been identified. Geophysical studies have indicated the occurrence of faults near the epicenter of the Charleston 1886 earthquake. These studies are continuing, and may affect the determination of capable structures near the four sites. Regardless, thorough and detailed investigation of the latest fault and seismic information will be required for new permitting.

The following table shows the assigned weight and the rating scheme for capable tectonic sources.

Weight	Range (miles)	Rating	Index Range
Class A 2	none within 200 mi radius	0	0 – 10
	greater than 100 to 200 mi	2	
	greater than 50 to 100 mi	3	
	greater than 25 to 50 mi	4	
	0 to 25 mi	5	
Class B 1	none within 200 mi radius	0	0 – 5
	greater than 100 to 200 mi	2	
	greater than 50 to 100 mi	3	
	greater than 25 to 50 mi	4	
	0 to 25 mi	5	

Based on the information provided in Tables 1.1-1 through 1.1-4, each candidate site receives the following ratings and computed index numbers.

Class A

Site	Rating	Index No.
Brunswick	3	6
Harris	2	4
Marion	3	6
Robinson	3	6

Class B

Site	Rating	Index No.
Brunswick	0	0
Harris	0	0
Marion	0	0
Robinson	0	0

Class A Features

There is one Class A feature within 50 to 100 miles of the Brunswick, Marion and Robinson sites, and two Class A features within 100 to 200 miles. All are Quaternary liquefaction features of the type associated with vibratory ground motion, and are believed to be caused by movement along unknown faults. There are three Class A features within 100 to 200 miles of Harris. One is an active seismic zone, and two are Quaternary liquefaction features of the type associated with vibratory ground motion and are believed to be caused by movement along unknown faults.

Georgetown Liquefaction Features (SC) (Class A) – Prehistoric sandblow craters located approximately 75 miles southwest from Brunswick, { } of the Marion site, 90 miles southeast from Robinson, and 150 miles south of Harris in the central coast region of South Carolina. Quaternary faulting indicated by late Holocene liquefaction features (and possibly a few liquefaction features due to the Charleston 1886 earthquake). Source faulting has not been identified (Crone and Wheeler, 2000).

Charleston Liquefaction Features (SC) (Class A) – Soil liquefaction-formed sand fissures, blows and craters located approximately 130 miles southwest from Brunswick, { } of the Marion site, 120 miles south-southeast of Robinson, and 200 miles south of Harris in the central coast region of South Carolina. Quaternary faulting indicated by direct observations of liquefaction during the Charleston 1886 earthquake. Middle to late Holocene liquefaction features produced by prehistoric earthquakes have also been identified. Source faulting has not been identified (Crone and Wheeler, 2000).

Bluffton Liquefaction Features (SC) (Class A) – Prehistoric sandblow craters located approximately 200 miles southwest from Brunswick, { } of the Marion site, and approximately 155 miles south-southwest of Robinson in the southern coast region of South Carolina. Quaternary faulting indicated by late Holocene liquefaction features. Source faulting has not been identified (Crone and Wheeler, 2000). Central Virginia Seismic Zone (VA) (Class A) - The Central Virginia Seismic Zone is situated near the Appalachian foothills northwest of Richmond, VA. It is located approximately 130 to 160 miles north-northeast of Harris. Evidence for Quaternary faulting consists of a few small clastic dikes formed within the last few hundred years at one site, and a few probable dikes of possible early Holocene age at another site. No source faulting has been identified (USGS Fault and Fold Database, 2003).

Harris Nuclear Plant site – Class B Features

Pembroke Faults (VA) (Class B) – The Pembroke Faults are located in western Virginia approximately 180 miles northwest of Harris, near the West Virginia border. Faults are documented in probable Quaternary age terrace deposits. It has not been determined whether the faults are tectonic, or non-tectonic and due to solution collapse (Crone and Wheeler, 2000). This feature is not counted in the rating because it is no closer than the Class A features which are counted.

Crone and Wheeler (2000) and the USGS Fault Database (2003) also identify Class C and D features. Class C features are defined by Crone and Wheeler (2000) as features where:

Geologic evidence is insufficient to demonstrate (1) the existence of a tectonic fault, or (2) Quaternary slip or deformation associated with the feature.

Class C Features

Four Class C features occur within 200 miles of Brunswick; two in North Carolina and two in South Carolina (USGS Fault and Fold Database, 2003). The closest, the Cape Fear Arch, is a broad northwest – southeast trending upwarping of the crystalline basement that extends from the approximate vicinity of the fall line southeastwards to beneath Brunswick County. Class C features are discussed because the occurrence of such features is considered in the ranking scheme adopted in Section 1.1.1.3. These features would require thorough investigation and evaluation for the permitting of new nuclear facilities at Brunswick. No Class D features have been identified within 200 miles of Brunswick. Additional information is provided below with respect to Class C features within 200 miles of Brunswick.

Seven Class C features occur within 200 miles of the Marion and Robinson sites, and eight Class C features occur within 200 miles of Harris. They are discussed because the occurrence of such features is considered in the ranking scheme adopted in Section 1.1.1.3. These features would require thorough investigation and evaluation for the permitting of new nuclear facilities at each of the three sites. No Class D features have been identified within 200 miles of these sites. Additional information is provided below with respect to Class C features within 200 miles of the Marion, Robinson and Harris sites. The following Class C faults are considered non-capable.

Class C Features Common to Brunswick, Harris, Marion and Robinson

Cape Fear Arch (NC) (Class C) – The Cape Fear Arch is a broad northwest trending arch in southeast North Carolina, formed by uplifting of the crystalline basement rocks, that extends southeastwards beneath Brunswick County. It also is located approximately 60 miles south-southeast of Harris, { } of the Marion site, and 80 miles northeast of Robinson. Faults have been suggested, but none have been identified. Some suggested faults have been discounted (USGS Fault Database, 2003; Crone and Wheeler, 2000).

Cooke Fault (SC) (Class C) – The Cooke Fault is located in South Carolina approximately 160 miles southwest of Brunswick, 190 miles south-southwest of Harris, { } of the Marion Site, and 100 miles south of Robinson. It is a subsurface fault identified by seismic profiles. The latest activity (buried deformation) is reported to be Eocene in age. There is no evidence of post-Eocene activity (USGS Fault Database, 2003; Crone and Wheeler, 2000).

Hares Crossroads Fault (NC) (Class C) – The Hares Crossroads Fault is located in eastern North Carolina approximately 120 miles north of Brunswick, { } of the Marion Site, 135 miles northeast of Robinson, and 45 miles east of Harris. This single fault offsets coastal plain sediment of unknown age. The fault may be a landslide rather than tectonic in origin. The available evidence does not indicate a Quaternary age for this fault (USGS Fault Database, 2003; Crone and Wheeler, 2000).

Class C Features Common to Brunswick, Marion and Robinson

Helena Banks Fault Zone (SC) (Class C) – The Helena Banks Fault Zone is located in the Atlantic Ocean offshore of South Carolina, approximately 140 miles southwest of Brunswick, { } of the Marion Site, and 125 miles south-southeast of Robinson. There is no evidence of activity for this feature since Miocene time (USGS Fault Database, 2003; Crone and Wheeler, 2000).

Class C Features Common to Marion and Robinson

Pen Branch Fault (SC) (Class C) – The Pen Branch Fault is located approximately { } from the Marion Site, and 120 miles southwest of Robinson near the Georgia – South Carolina border. The occurrence, orientation and age of this fault are well documented by numerous site geologic and seismic investigations. Other unclassified and non-Quaternary faults also occur at the Marion Site. This fault is considered as non-capable and non-Quaternary due to the absence of evidence of activity since Eocene time (USGS Fault Database, 2003).

Belair Fault Zone (GA) (Class C) – The Belair Fault Zone is located in Georgia approximately { } of the Marion Site and 130 miles southwest of Robinson. Latest movement along the Belair Fault has not been demonstrated to be of

Quaternary age. However, the available evidence does not definitely preclude Quaternary activity (USGS Fault Database, 2003; Crone and Wheeler, 2000).

Class C Features Common to Marion, Robinson, and Harris

Stanleytown – Villa Heights Faults (VA) (Class C) – The Stanleytown – Villa Heights Faults are located in south-central Virginia, approximately { } of the Marion Site, 160 miles north of Robinson, and 105 miles northwest of Harris. They consist of two small north-striking faults situated near Martinsville, Virginia. Both faults may be landslides rather than tectonic faults. The available evidence does not demonstrate a Quaternary age for these features (USGS Fault Database, 2003; Crone and Wheeler, 2000).

Class C Features for Harris Nuclear Plant Site

Old Hickory Faults (VA) (Class C) – The Old Hickory Faults are located in southeast Virginia, approximately 135 miles northeast of Harris. The faults occur in the Old Hickory Heavy Mineral Deposit situated along the Fall Line that separates the Coastal Plain and Piedmont physiographic provinces. Five small faults were found during mining that moved Piedmont igneous and metamorphic saprolite to a position overlying Pliocene Coastal Plain sediment. The faults are believed to be of Pliocene age. Evidence for Quaternary activity is lacking (USGS Fault Database, 2003; Crone and Wheeler, 2000).

Lebanon Church Fault (VA) (Class C) – The Lebanon Church Fault is located in north central Virginia, approximately 180 miles north of Harris. It is a small reverse fault that is reported to be of possible Quaternary age. The fault transposed old crystalline bedrock to a position above terrace gravels that may be Quaternary in age (USGS Fault Database, 2003; Crone and Wheeler, 2000).

Everona Fault – Mountain Run Fault Zone (VA) (Class C) – The Everona Fault and Mountain Run Fault Zone are located in north central Virginia, approximately 190 miles north of Harris. The Everona Fault is a small fault that cuts and offsets stream gravel and colluvium that is late Cenozoic and possibly Pleistocene in age. This fault is believed to probably be a Quaternary feature, but conclusive evidence has not been demonstrated. The Mountain Run Fault Zone separated the Piedmont and Blue Ridge physiographic provinces in the vicinity. Scarps within the fault zone may be related to faulting, or may be due to erosion. If the features are fault-line scarps, their age is considered to be Cenozoic and possibly Pleistocene. Conclusive evidence for Quaternary movement is lacking (USGS Fault Database, 2003; Crone and Wheeler, 2000).

Lindside Fault Zone (VA) (Class C) – The Lindside Fault Zone is located in Virginia and West Virginia, approximately 190 miles northwest of Harris near the West Virginia border. The fault zone is situated near a local seismic zone, but orientation and depth differ indicating an absence of association. Evidence for Quaternary movement within the fault zone is lacking (USGS Fault Database, 2003; Crone and Wheeler, 2000).

1.1.1.3 Surface Faulting and Deformation

Objective – Develop site ratings for site suitability relative to surface faulting and deformation in the site vicinity.

Evaluation approach – No absolute exclusionary criteria have been identified with regard to surface faulting and deformation. Suitability criteria have been established based on the occurrence of surface faulting and tectonic and non-tectonic structures within a 25-mi and 5-mi radius of candidate sites, as follows (EPRI 2000, p.3-7):

Within 25 miles
- No such structures altogether (Most Suitable)
- Potential non-capable structures
- Potential capable structures (Least Suitable)

Within 5 miles
- No such structures altogether (Most Suitable)
- Potential non-capable structures
- Potential capable structures
- Fault exceeding 1,000 feet in length (Least Suitable)

The potential for surface faulting or deformation primarily concerns plant design, therefore features identified within 5 miles of a candidate site receive a higher weight. Following are the assigned weights and ratings for surface faulting and deformation.

Weight	Range	Rating	GEOL Index Range
Five miles to within 25 mi–1	No structures Potential non-capable structures Potential capable structures	0 1 5	0–5
within 5 mi–2	No structures Potential non-capable structures Potential capable structures Fault exceeding 1,000 feet in length Capable fault exceeding 1,000 feet in length	0 2 3 4 5	0–10

Discussion/Results

Based upon the information presented in Tables 1.1-1 through 1.1-4, the four candidate sites receive the following ratings and computed index numbers for surface faulting and deformation.

Within 25 miles

Site	Rating	Index No.
Brunswick	0	0
Harris	0	0
Marion	0	0
Robinson	0	0

Within 5 miles

Site	Rating	Index No.
Brunswick	2	4
Harris	2	4
Marion	0	0
Robinson	0	0

1.1.1.4 Geologic Hazards

Objective – Based on EPRI guidance (2000, p. 3-7) sites having the following geologic and man-made conditions should be avoided:

- Areas of active (and dormant) volcanic activity,
- Subsidence areas caused by withdrawal of subsurface fluids such as oil or groundwater, including areas which may be affected by future withdrawals,
- Potential unstable slope areas, including areas demonstrating paleolandslide characteristics,
- Areas of potential collapse (e.g. karst areas, salt, or other soluble formations),
- Mined areas, such as near-surface coal mined-out areas, as well as areas where resources are present and may be exploited in the future,
- Areas subject to seismic and other induced water waves and floods.

Evaluation approach – Sites furthest away from these features would be considered the most suitable sites; sites were rated in accordance with the presence of and distance from these features. Following are the assigned weight and rating used for geologic hazards:

Weight	Range	Rating	GEOL Index Range
1	Geologic hazard(s) present	1	0–1

Discussion/Results

As shown on Tables 1.1-1 through 1.1-4, design specifications for a new nuclear facility must address the possibility of large water waves and floods. Brunswick and Marion receive the following computed rating and index number for geologic hazards.

Site	Rating	Index No.
Brunswick	1	1
Harris	0	0
Marion	1	1
Robinson	0	0

1.1.1.5 Soil Stability

Objective – Evaluate the sites with respect to the difficulty of soil conditions expected at each site.

Evaluation approach – No absolute exclusionary criteria have been identified with respect to soil stability. Soil stability is addressed as an avoidance criterion. Certain soil properties have unfavorable characteristics in association with vibratory ground motion. These soil properties include poor mineralogy, low density soil (lack of compaction), and high water content (or high water table). Sites with the highest values of PGA in combination with deleterious site soils would receive a relatively lower rating. Sites having rock foundations or more suitable soil conditions are considered to be better sites.

Following are the assigned weights and ratings for soil stability:

Weight	Range	Rating	Index Range
2	Rock site	0	0 – 4
	Deep soil site, no known deleterious soil conditions	1	
	Deep soil site with potential stability issues, or insufficient information available to assign a rating of 1	2	

Discussion/Results – Based upon the information presented in Tables 1.1-1 through 1.1-4, the four candidate sites receive the following rating and computed index number for soil stability. Harris is a rock site.

Site	Rating	Index No.
Brunswick	1	2
Harris	0	0
Marion	1	2
Robinson	2	4

1.1.1.6 Overall Rating for Geology/Seismology

The index numbers for this ranking scheme range from 5 to 85. This range of indexes was used to develop a ranking system to compare the suitability of sites as follows.

Index Range	Rating
5 - 21	5
22 - 37	4
38 - 53	3
54 - 69	2
70 - 85	1

The index numbers for each site were summed. The resulting index was compared to the index ranges in the above table to determine the overall rating for each site. Based upon this evaluation, the candidate sites are ranked as follows.

Site	Index Number	Rating
Brunswick	38	3
Harris	28	4
Marion	69	2
Robinson	55	2

Table 1.1-1 Ratings for Brunswick

Feature	Source	Weight	Rating	Index No.
Vibratory Ground Motion	PGA 14.13 %g with 2% PE in 50 years (USGS National Seismic Hazards Mapping Project, 2002).	5	5	25
Capable Tectonic Source (Class A)	The Georgetown Class A liquefaction features occur within 50 to 100 miles of BSEP. The Bluffton and Charleston Class A liquefaction features occur within 100 to 200 miles (USGS Fault and Fold Database, 2003. Crone & Wheeler, 2000).	2	3	6
Capable Tectonic Source (Class B)	No Class B features were identified within a 200 mile radius of BSEP (Crone & Wheeler, 2000).	1	0	0
Surface Faulting & Deformation within 25 miles	No surface faulting or deformation has been identified at the site. A subsurface feature occurs as described for the 5-mile radius (below).	1	0	0
Surface Faulting & Deformation within 5 miles	The Cape Fear Arch (Class C) occurs beneath the site. (USGS Fault and Fold Database, 2003; Crone & Wheeler, 2000).	2	2	4
Geologic Hazards	There is a potential for large water waves or flooding to occur at the site.	1	1	1
Soil Stability	BSEP is a deep soil site.	2	1	2
			Total Index	**38**

Table 1.1-2 Ratings for Harris

Feature	Source	Weight	Rating	Index No.
Vibratory Ground Motion	PGA 9.46 %g with 2% PE in 50 years (USGS National Seismic Hazards Mapping Project, 2002).	5	4	20
Capable Tectonic Source (Class A)	The Charleston and Georgetown Class A liquefaction features and the Central Virginia Seismic Zone all occur within 100 to 200 miles of SHNP (USGS Fault and Fold Database, 2003. Crone & Wheeler, 2000).	2	2	4
Capable Tectonic Source (Class B)	The Pembroke Faults Class B feature is located approximately 180 miles NW of SHNP, within 100 to 200 miles. It is not rated since it is no closer than the Class A features that are rated (Crone & Wheeler, 2000).	1	0	0

Table 1.1-2 Ratings for Harris

Feature	Source	Weight	Rating	Index No.
Surface Faulting & Deformation within 25 miles	No surface faulting or deformation has been identified at the site.	1	0	0
Surface Faulting & Deformation within 5 miles	The Jonesboro Fault occurs within 5 miles of the site. During construction numerous minor faults were discovered at the site. All were confirmed to be non-capable (SHNP FSAR).	2	2	4
Geologic Hazards	No areas of volcanic activity, subsidence due to withdrawal of subsurface fluids, potential unstable slope, potential collapse, mined areas, or areas subject to seismic or other induced water waves or floods occur at the site (SHNP FSAR).	1	0	0
Soil Stability	SHNP is a rock site (SHNP FSAR).	2	0	0
			Total Index	**28**

Table 1.1-3 Ratings for the Marion site

Feature	Source	Weight	Rating	Index No.
Vibratory Ground Motion	The Marion site has a PGA of 34.98 %g with 2% PE in 50 years (USGS National Seismic Hazards Mapping Project, 2002).	5	12	60
Capable Tectonic Source (Class A)	The Georgetown Class A liquefaction features occur within 50 to 100 miles of the Marion Site (USGS Fault and Fold Database, 2003. Crone & Wheeler, 2000).	2	3	6
Capable Tectonic Source (Class B)	There are no known Class B features within 200 miles of the Marion Site.	1	0	0
Surface Faulting & Deformation within 25 miles	No surface faulting or deformation has been identified at the site.	1	0	0
Surface Faulting & Deformation within 5 miles	No surface faulting or deformation has been identified at the site.	2	0	0
Geologic Hazards	Due to low elevations, there is a potential for flooding at the Marion Site.	1	1	1
Soil Stability	The Marion Site is a deep soil site.	2	1	2
			Total Index	**69**

Table 1.1-4 Ratings for Robinson

Feature	Source	Weight	Rating	Index No.
Vibratory Ground Motion	PGA 26.03 %g with 2% PE in 50 years (USGS National Seismic Hazards Mapping Project, 2002).	5	9	45
Capable Tectonic Source (Class A)	The Georgetown Class A liquefaction features occur within 50 to 100 miles of RNP. The Bluffton and Charleston Class A liquefaction features occur within 100 to 200 miles (USGS Fault and Fold Database, 2003. Crone & Wheeler, 2000).	2	3	6
Capable Tectonic Source (Class B)	No Class B features were identified within a 200 mile radius of RNP (Crone & Wheeler, 2000).	1	0	0
Surface Faulting & Deformation within 25 miles	No surface faulting or deformation has been identified at the site.	1	0	0
Surface Faulting & Deformation within 5 miles	No surface faulting or deformation has been identified at the site.	2	0	0
Geologic Hazards	No areas of volcanic activity, subsidence due to withdrawal of subsurface fluids, potential unstable slope, potential collapse, mined areas, or areas subject to seismic or other induced water waves or floods occur at the site (Dominion Energy, Inc. and Bechtel Power Corp. 2002).	1	0	0
Soil Stability	RNP is a deep soil site. Investigations at RNP identified some soils that show a response to oscillation. Because of the possibility for soil liquefaction and/or settlement, any location for new nuclear facilities at RNP would require thorough investigation and testing to determine the presence of any problematic soils (Updated FSAR).	2	2	4
			Total Index	**55**

References

Atlanta Testing & Engineering, Phase I Environmental Assessment, Job No. 1480, Report No. 93290, 1993.

CP&L Updated FSAR, Chapter 2, Revision 18c.

Crone, A.J. and Wheeler, R.L. 2000. Data for Quaternary faults, liquefaction features, and possible tectonic features in the Central and Eastern United States, east of the Rocky Mountain front. USGS Open File Report 00-260.

Dominion Energy, Inc. and Bechtel Power Corporation 2002. Evaluation of the INEEL, Portsmouth and Savannah River Sites.

Environmental Report, Brunswick Steam Electric Plant.

Environmental Report, Robinson Steam Electric Plant, Unit No. 2.

EPRI. 2001. Siting Guide: Site Selection and Evaluation Criteria for an Early Site Permit Application. Electric Power Research Institute, August 2001.

Frankel, A. et. al. 1996. National Seismic Hazard Maps, Documentation. USGS Open File Report 96-532. June 1996.

NRC. 1997. Identification and Characterization of Seismic Sources and Determination of Safe Shutdown Earthquake Ground Motion Regulatory Guide 1.165.

NUREG-1437, Supplement 25, 2005.

NUREG-1437, Supplement 13, Robinson Steam Electric Plant, 2003

Professional Service Industries, Inc., Soils Exploration and Foundation Recommendations, 1993.

S&ME, Preliminary Wetland Location Approximation/Cultural Resource Literature Review, 2001.

SHNP FSAR

Stephenson, D. and Stieve, A. 1992. Structural Model of the Basement in the Central Savannah River Area, South Carolina and Georgia.

Updated FSAR, H.B. Robinson site.

USGS Earthquakes Hazards Program. National Seismic Hazard Mapping Project. Interpolated Probabilistic Ground Motion for the Conterminous 48 States by Latitude Longitude, 2002 data.

USGS Earthquakes Hazards Program. National Seismic Hazard Mapping Project. Quaternary Fault and Fold Database for the United States, 2005.

U.S. Atomic Energy Commission, SER, 1973.

U.S. Atomic Energy Commission, SER, H.B. Robinson Unit 1, 1970.

1.1.2 Cooling System Requirements

Objective - Cooling system requirements are important siting considerations for new power generating facilities. The objective of this criterion is to rate the candidate sites with respect to specific cooling system requirements, using to the extent possible the same or similar criteria previously utilized to evaluate other potential nuclear power plant sites.

Evaluation approach - The principle requirements of interest are the quantity of cooling water available and the ambient air temperature (EPRI, 2001, Section 3.1.1.2.1). Exclusionary and avoidance conditions apply to the evaluation of candidate sites with respect to these cooling system requirements. AP1000 cooling water supply requirements for units with closed-cycle cooling systems are summarized below.

Cooling System Type	AP1000 Two-Unit Requirement
Closed-cycle	Make up flow rate (gpm) – 42,000
Closed-cycle	Maximum Water Consumption (gpm) – 60,000
Closed-cycle	Monthly Average Water Consumption (gpm) – 42,000

Ambient air temperature characteristics of a potential site affect the design of heat removal systems. The candidate sites were compared to determine which site has the most suitable ambient air characteristics with respect to the PPE values outlined in EPRI 2001, Section 3.1.1.2.2. With the exception of extreme low temperature values, sites with the lowest temperatures are considered to be the most suitable.

Discussion/Results – Site data and results are presented for each of the sub-criteria in Sections 1.1.2.1 and 1.1.2.2, below. Overall ratings for the Cooling System Requirements criterion are provided in Section 1.1.2.3.

1.1.2.1 Cooling Water

The four sites were evaluated with respect to the cooling water criterion during the initial screening phase (P1 criterion) and were found to have an adequate flow or reservoir volume to support the requirements of a closed cycle cooling water system. The rating approach used in this evaluation is described in Table 4-2 and site data are presented in Appendix A of this report (Criterion P1).

To summarize:

- Brunswick – Due to the nature of the intake and proximity to the Atlantic Ocean, there are no practical flow constraints. The flow at the mouth of the Cape Fear River draws upon a drainage area of 9,140 square miles. Of this, stream flow from about 6,000 square miles is gauged continuously by USGS. Average daily freshwater discharge rate

of the river at the mouth is estimated to be between 8,100 and 10,000 cubic feet per second (cfs). Because of the abundant water supply, the site is given a rating of 5.

- Harris – Water supply is the Harris storage reservoir system, consisting of a main reservoir on Buckhorn Creek, and an auxiliary reservoir located on Tom Jack Creek. The conceptual design of the original reservoir system was to support multiple nuclear units at full development of the site with a higher lake elevation at 250 feet. At present, the site contains one 900MW unit with closed cycle cooling. For full development, the reservoir was to be recharged by pumping from the Cape Fear River in addition to the natural recharge from the watershed. This pumping capacity has not been installed, but may be needed for future development. Further analysis is required, but there is sufficient gross flow to support a new plant with closed-cycle cooling. During licensing of Harris, NRC staff concluded that the water supply was adequate for a two-unit plant operation, including the Cape Fear River makeup system, and is also adequate in the event of a severe drought for both a one- and two–unit operation. Therefore, an adequate water supply and location on an existing reservoir contribute to a favorable rating, although NRC expressed some concerns with multiple unit operation under drought conditions. The site is given an overall rating of 4.

- Marion – Based on an analysis conducted by Devine, Tarbell & Associates provided by Progress, the Great Pee Dee River's 7-day, 10-year low flow at the site is 1,450 cfs. Given a plant water makeup requirement in the range of 100 cfs per unit, it appears that adequate cooling water is available to support a two-unit plant for any of the designs under consideration. The rating was reduced slightly (5 to 4) because the site is not on a reservoir or lake, and potential concerns regarding flow during extreme drought conditions.

- Robinson – The cooling water source is Lake Robinson, a 2250-acre impoundment created on Black Creek. Water is pumped at a rate of approximately 506,000 gallons per minute for cooling unit 2 (nuclear unit) and returned to the lake through the discharge canal. The site has 1-710MW nuclear, 1-174MW fossil and 1-15MW combustion turbine. The site appears to be challenged for water supply, based on operational experience at the existing unit, where some restrictions on operations have been required based on thermal effects. Historically, operation of the coal unit at Robinson has been curtailed to avoid exceeding thermal limits for the lake. Robinson was given a rating of 3, based on concerns about operational limitations associated with water supply and thermal issues in Lake Robinson.

Criteria	Brunswick	Harris	Marion	Robinson
Cooling water	**5**	**4**	**4**	**3**

References

NRC 1983. Safety Evaluation Report, Harris Nuclear Plant Units 1 and 2, Docket Nos. STN 50-400 and STN 50-401. U.S. Nuclear Regulatory Commission, November 1983.

Updated Final Safety Analysis Report [*date*]. Chapter 2 Site Characteristics. Harris Unit 1

CPL 1970. Phase II Site Study: Whiteoak Creek, Carolina Power & Light. Ebasco Services Incorporated, October 1970.

US NRC 1986. Safety Evaluation Report related to the Operation of Harris Nuclear Power Plant, Unit No. 1 Docket No. STN 50-400. Carolina Power and Light Company and North Carolina Eastern Municipal Power Agency.

U.S. Nuclear Regulatory Commission Office of Nuclear Reactor Regulation. NUREG-1038 Supplement No. 4. October

US AEC 1973. Safety Evaluation by the Directorate of Licensing, US Atomic Energy Commission, in the matter of Carolina Power and Light Brunswick Steam Electric Plant Units 1 and 2 Docket Nos. 50-324 and 50-325. November.

USAEC 1970. Evaluation by the Division of Reactor U.S. Atomic Energy Commission in the matter of Carolina Power and Light Company H.B. Robinson Unit No. 2 Docket No. 50-261. May 18.

Updated Final Safety Analysis Report [*date*]. Chapter 2 Site Characteristics. H. B. Robinson Nuclear Power Plant

Devine Tarbell & Associates, Inc., October 11, 2005 Memorandum: 7Q10 Low Flow Statistics for the Pee Dee River at the USGS Pee Dee Gage.

1.1.2.2 Ambient Temperature Requirements

Temperature data were obtained from local weather stations as compiled by the Southeast Regional Climate Center – historical climate summaries and normals – which is part of the National Oceanic and Atmospheric Administration's National Climate Data Center. Closest daily weather stations with a reasonable period of record (e.g., more than 20 years) were selected for each site. Data indicate that each site meets the ambient temperature exclusionary and avoidance criteria addressed in EPRI 2001 (Section 3.1.1.2.2). Maximum and minimum annual temperature values (dry bulb), as well as the highest and lowest average monthly temperatures values were compared between sites. Actual meteorological conditions at the four sites, however, may vary from the data collected and evaluated for the closest reporting (representative) weather stations: Southport, NC for Brunswick; Raleigh-Durham airport (NC) for Harris; and Florence airport (SC) for Marion and Robinson sites (period of record for all sites is1948-2004).

Ambient Temperatures (degrees F)	Highest temperature of record	Highest monthly average	Lowest temperature of record	Lowest monthly average	Rating
Brunswick	103 (6/26/52)	87.6 (July)	-3 (12/25/89)	34.6 (January)	**4**
Harris	105 (7/23/52)	88.8 (July)	-9 (1/21/85)	29.8 (January)	**4**
Marion	108 (6/27/54)	90.8 (July)	0 (1/21/85)	34.4 (December)	**3**
Robinson	108 (6/27/54)	90.8 (July)	0 (1/21/85)	34.4 (December)	**3**

Source: www.dnr.sc.gov/climate/sercc/climateinfo/historical/historical.html
NOAA National Climatic Data Center, Ashville, NC: 2004 Local Climatological Data, Annual Summary with Comparative Data for Columbia, SC.
NOAA National Climatic Data Center, Ashville, NC: 2004 Local Climatological Data, Annual Summary with Comparative Data for Augusta, GA.

Discussion/Results – The candidate sites were compared to one another to assess their relative suitability with respect to selected temperature extremes and frequency values.

With the exception of extreme low temperature values, sites with the lowest dry bulb temperatures are considered to be the most suitable. Based only on a comparison of highest and lowest temperature (daily extremes) and average high and temperature records, and consideration of general climate conditions at the sites, Brunswick and Harris sites are slightly favored over Marion and Robinson. Because the maximum temperature for all sites was in excess of 100 F, a deduction of one point was also made to each site.

1.1.2.3 Cooling System Summary Rating

The sites were assigned relative ratings for the suitability of the cooling system based on the average of the ratings for cooling water supply and the ambient air temperature characteristics. For Brunswick and Marion, where the average rating was a fraction, the rating was rounded up to reflect the cooling water supply rating since it is a better site differentiator than ambient temperature.

Criteria	Cooling Water Supply	Ambient Temperature	Composite Rating
Brunswick	5	4	**5**
Harris	4	4	**4**
Marion	4	3	**4**
Robinson	3	3	**3**

1.1.3 Flooding

Objective – The objective of this criterion is to evaluate the suitability of the four candidate sites with respect to potential flooding. Potential sites appear to meet the exclusionary and avoidance siting criteria outlined in EPRI 2001 (Section 3.1.1.3). These criteria exclude potential sites within major wetlands, areas less than one foot above the maximum flood elevation.

Evaluation approach – The relative suitability of Brunswick, Harris, Marion and Robinson with respect to probable maximum flood (PMF) elevations was evaluated during the initial screening phase (Criterion P2, Appendix A). The evaluation relied on existing documents and recommended plant layout locations. Primary emphasis was on PMF elevations for the main water bodies (rivers and reservoirs) and their major tributaries where flood elevations were identified.

Discussion/Results – A summary of site data presented previously is provided below; site ratings, which did not change, are also included.

Brunswick – The site is located on the Cape Fear River on the North Carolina coast at elevations of 20-25 feet MSL [nominal plant grade is 20 feet MSL). For the PMH (probable maximum hurricane) – surge stillwater level at the site would be 22 feet MSL; peak storm elevation of the Cape Fear River would be 23.3 feet MSL on shore. This peak tide would not reach the site. In the intake canal, the stillwater level is expected to reach 22 feet MSL. The nominal plant grade of 20 feet MSL results in 2 feet of water depth surrounding the plant during the maximum surge conditions. All safety related structures at the current plant are waterproofed to elevation 22 feet MSL.

Harris – Flooding sources evaluated include local flooding from the probable maximum precipitation (PMP) event on Buckhorn Creek and tributaries, dam failures, and hurricane induced wave activity (the site is 115 miles from coast). Because of the 100-foot difference in elevation between the site and the Cape Fear River, there is no concern from flooding from the river.

Plant grade elevation is at 260 feet msl, and normal water level in the reservoir is currently 220 feet MSL, although it should be noted that a higher lake elevation of 250 feet was calculated for the original 4 unit design (original dam design accommodates this higher elevation). This higher reservoir elevation would likely result if a second plant was added, lowering the difference (between plant grade of new plant and reservoir elevation) to ten feet. The PMP (based on the conservative assumption that that there would be no loss of water from infiltration, evaporation and a completely blocked drainage system) would result in a flood elevation of 261.27 feet – slightly above plant grade elevation [flood protection features are currently in place to protect safety related structures].

The PMF on streams and rivers showed a maximum stillwater level of 256 feet MSL in the auxiliary reservoir and 238.9 feet MSL for the main dam. Effects of coincident wind wave activities on PMF stillwater levels resulted in a maximum water level of 243.1 feet MSLS in the

main reservoir and 258 feet MSL in the auxiliary reservoir. (NRC staff calculated 243.3 and 258.6 feet MSL respectively).

Marion – The site is generally low in elevation, with considerable onsite and surrounding swamp land. Site elevations appear to be at or even slightly below that of the 100-year floodplain (a PMF elevation has not been determined, but it is assumed that it would be higher than 100-year flood and site grade could be below PMF). This presents the need to address environmental impacts on floodplains as well as the possibility that engineered flood protection features will be required to protect the plant. These factors, combined with the surrounding known swamps and shallow depth to ground water, also indicate the potential for construction dewatering problems.

Robinson – Grade elevation at the plant site is 225 feet; the site lies on a 2250-acre lake. The PMF was based on PMP conditions (20 inches in 48 hours from a postulated hurricane); modeling showed a resulting flow of 30,000 cfs, but the site would still be above flood elevation in this scenario. The spillway is designed to pass a flow of 40,000 cfs which would result in a lake level of 221.67 feet.

The site ratings and background on relative suitability of the candidate sites with respect to flooding are summarized below. No other flooding concerns (e.g., downstream ice jam flooding concerns, seismically induced flooding, or upstream dam failure concerns) were identified for the four sites, but the conservative ratings would address additional concerns if identified in the future.

Criteria	Brunswick	Harris	Marion	Robinson
Flooding	**1**	**1**	**1**	**3**

1.1.4 Nearby Hazardous Land Uses

1.1.4.1 Existing Facilities

1.1.4.2 Projected Facilities

Objective – The objective of this criterion is to include NRC guidance on considerations regarding the nature and proximity of man-related hazards (dams, airports, transportation routes, and military and chemical manufacturing and storage facilities).

Evaluation approach – For the purpose of this evaluation, it was assumed that all four sites can be developed to meet the exclusionary criteria outlined in 10 CFR 100. The suitability of the candidate sites was, therefore, evaluated based on the relative number and distance of the following off-site man-made hazards that could be identified on USGS topographic maps, supplemented by information found in existing environmental reports for each site. The evaluation was limited to only existing hazards within a 5- to 10-mile radius of each site, to the extent such information was available. This included primarily airports, pipelines, and rail. Note that information relating to projected man-made hazards was not readily available and could not be evaluated during this phase of the siting process.

The relative suitability of the four sites with respect to nearby hazardous land uses was evaluated during the previous screening phase (Criterion P4, Appendix A).

Discussion – To summarize from the previous screening evaluation:

Brunswick – Facilities within 5 miles of the site include: Brunswick County Airport; Cape Fear River/barge traffic – ocean going vessels; and Sunny Point Army Terminal. The site area in general is characterized as having a high degree of industry; the closest are an ADM industrial plant (principal product is citric acid) and a Co-Gentrix Plant (steam and fossil electricity). The site also is adjacent to natural gas pipeline.

Harris – No military or industrial facilities were identified within 5 miles, but there is a local concentration of industry 7 miles west in Moncure – mainly in the form of wood products and synthetic fibers plants. Two mining operations and 5 inactive quarries lie within 10 miles of site. A liquefied natural petroleum gas pipeline is located within 2 miles of the site, and the Raleigh Executive Airport (private airport 6 miles from the site) and two other small general aviation airports are within 10 miles of the site (at Shelba and Luther).

Marion – {

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Robinson – The site area is rural, with light development. Facilities within 5 miles of the site include: Darlington County Internal Combustion Electric Plan (1 mile), Robinson Unit 1 coal fired power plant, a gas pipeline, Hartsville Municipal Airport (2.5 miles), a railroad, a specialty steels plant (Talley Metals) and Lee County Airport (within 15 miles of the site).

Results – All sites had at least one potentially hazardous land use less than 5 miles from the site and received a minimum rating of 2. Brunswick had the most potentially hazardous facilities and received the lowest rating.

Criteria	Brunswick	Harris	Marion	Robinson
Nearby Hazardous Land Uses	1	2	2	2

1.1.5 Extreme Weather Conditions

1.1.5.1 Winds
1.1.5.2 Precipitation

Objective – The objective of this criterion is to rate the suitability of the four candidate sites with respect to extreme weather conditions. Extreme weather conditions of interest are related to specific PPE criteria regarding tornado design, wind and precipitation (EPRI Siting Guide, Section 3.1.1.5).

Evaluation approach – During the review of available meteorological information on the sites, no information was found that indicated the four sites could not meet the exclusionary and avoidance criteria specified for the PPE values. Extreme weather readily available for the four sites included peak wind gusts (available for selected cities – Wilmington and Raleigh-Durham, North Carolina, and Myrtle Beach and Florence, South Carolina); number of tornadoes and violent tornadoes per 10,000 square miles (state average); and maximum 24-hour precipitation values. The number of hurricanes making landfall in NC and SC was also considered, given the proximity of the Brunswick site to the coast. Available extreme weather data were obtained from government sources (National Climate Data Center and Southeast Regional Climate Center), including NCDC Climatic Wind Data for US [ncdc.noaa.gov/documentlibrary. pdf/wind1996.pdf.]. Other sources included the NCDC Asheville Continental US Landfalling Hurricanes.

Discussion/Results – Rating of the sites was performed based on a comparison of recorded extreme wind (fastest-mile) values, projected extreme winds at various return frequencies, and severe storm records. This information is summarized below.

Site	Peak Gust (mph) 1930-1996	Tornado Frequency Average per 10,000 sq mi	Strong violent tornadoes Average per 10,000 sq mi Tornado Frequency	No. Hurricanes in period 1950-2003 (state average)	Maximum 24-hr précis.
Brunswick*	78 (Wilmington) 104 (Myrtle Beach)	2.8 (NC)	0.9 (NC)	16 (NC)	18.30 in
Harris**	67	2.8	0.9	16	5.33 in
Marion***	78	3.4 (SC)	0.7 (SC)	6 (SC)	6.08
Robinson***	78	3.4	0.7	6	6.08

* Representative site is Southport, NC for precipitation, Wilmington and Myrtle Beach for wind speed; period of record is 1948-2004 unless otherwise noted
** Representative site is Raleigh-Durham airport, same period of record as above.
*** Representative site is Florence, SC for precipitation and Columbia, SC for wind speed; same period of record as above

Based on the data above, the following site ratings were assigned. In general, the sites were fairly similar and were assigned equally conservative ratings of 3, with the exception of Brunswick. Given its proximity to the coast and higher potential for extreme storm events (precipitation,

winds, and number of hurricanes) compared to the other sites, it was given a rating of 1. Harris is located at a sufficient distance from the coast such that the threat of hurricanes would be significantly reduced from that at Brunswick.

Criteria	Brunswick	Harris	Marion	Robinson
Extreme Weather Conditions	1	3	3	3

1.2 ACCIDENT EFFECTS-RELATED

Objective – The overall objective of this criterion is to evaluate sites with respect to the evaluation of design-related accident evaluations and potential effects of accidents.

Evaluation approach – Site ratings for this criterion are developed as a composite of three sub-criteria that address site characteristics relevant to consideration of accidents: Population, Emergency Planning Considerations, and Atmospheric Dispersion.

Discussion/Results – A discussion of each of the sub-criteria appears in the following sections 1.2.1, 1.2.2, and 1.2.3. A discussion of the roll-up of the sub-criterion ratings into a single rating for the Accident-Effects-Related criterion appears in Section 1.2.4.

1.2.1 Population

Objective - The objective of this criterion is to evaluate the relative suitability of the candidate sites with respect to the population density in the vicinity of the sites. For the purposes of this evaluation, it was assumed the existing licensed units at three of the candidate sites meet the population density conditions codified in 10CFR100.21. These conditions are:

- the sites have exclusion area authority,
- a low population zone exists beyond the exclusion area, and
- sufficient distance exists to high population centers.

Evaluation approach - As outlined in Regulatory Guide 4.7, low population areas are preferred and low population zones should have densities less than 500 people per square mile (EPRI 2001) (equivalent to less than 25,000 persons within 4 miles).

All sites meet population density exclusion criteria since population density was a criterion in the regional screening process. Available census data regarding the nearest population centers and area population densities were reviewed for the candidate sites in the previous screening phase (Criterion P3, Appendix A), and confirmed that each met the exclusion criteria. On-line data were obtained from the US Census Bureau.

Discussion/Results

Ratings and the population centers that drive the ratings are presented for each site in the following table; additional detail on population data for each site is provided in the succeeding tables.

Site	Brunswick	Harris	Marion	Robinson
Rating	2	1	2	2

The Brunswick rating based on nearest population center (and factoring in seasonal populations) was a 2 and did not warrant further adjustment based on population density in surrounding area.

The Harris rating based on nearest population center alone would be a 2, but it was further reduced to a 1 given its proximity to two significantly large population centers and the corresponding high population density in the host (Wake) and adjacent (Durham) counties.

The Marion rating {

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The Robinson rating based on nearest population center alone would be 1, but it was raised to a 2 given the overall low population density in the host and surrounding counties.

Nearest Population Center (2000 Population)	Distance (miles)	Population Density (By County)	Notes
Brunswick (Brunswick County)			
Wilmington (75,838)	16	85.6 (Brunswick) 58.4 (Columbus) 805.8 (New Hanover County) 173.4 (Horry County (SC)/Myrtle Beach MSA)	No large population centers within 4 miles of site. Other nearby communities: Southport – 2,351 (2 miles) Boiling Springs – 3,866 (5 miles) Carolina Beach – 4,701 (7 miles) Kure Beach – 1,507 (6 miles) Long Beach/Yaupon Beach/Oak Island – 6,571 (5-7 miles) Balk Head Island – 173 Also within 10 miles: Waterborne population (boats, vessels) – 5,546 Seasonal summer population – 13,056 from various nearby attractions Plus beach summer tourists: Pleasure Island (Carolina and Kure Beaches) - 17,000 overnight; 39,000 day; Oak Island (Long Beach, Caswell Beach, Yaupon Beach) - overnight population at 26,000; Bald Head Island – 1,509 overnight Horry County, SC/Myrtle Beach MSA (196,629) is approximately 50 miles away
Harris (Wake County)			
Cary (94,536) Raleigh (276,093) Sanford (23,200)	15 miles 20 miles 15 miles	754.7 (Wake County) 72.2 (Chatham County) 153 (Harnett County) 769.2 (Durham County) 295.7 (Orange County)	No population centers within 4 miles of site. Other communities within 50 miles: Durham – 187,035 (20-30 miles) Fayetteville – 121,015 (37-43 miles) Smaller cities within 10 miles Apex – 20,212 Fuquay-Varina - 7,898 Holly Springs - 9,192

Nearest Population Center (2000 Population)	Distance (miles)	Population Density (By County)	Notes
Marion (Marion County)			

Marion (7,042)
 	
Florence (30,248)
	{
	
	{
	}
		72.5 (Marion County)
		
		157.2 (Florence County)
		
		75.9 (Dillon County)
		
		120.1 (Darlington County)
			Smaller towns {
			}:
			Mullins – 5,029 {(
			) }
			Latta – 1,410 ({
			})
			
			{
			}

Robinson (Darlington County)			
Hartsville (7,556) Florence (30,248) Camden (6,682)	3 miles 25 miles 26 miles	120.1 (Darlington) 53.6 (Chesterfield) 49 (Lee) 157.3 (Sumter) 72.5 (Kershaw)	One population center within 4 miles of the site (Hartsville). Other communities within 50 miles: Sumter – 39,643 (35 miles) [Columbia – 116,278 (56 miles)] Communities within 15 miles: McBee – 714 (7 miles) Bishopville – 3,670 (12.5 miles) Pine Ridge – 1,593 [right next to plant]

Because of the high population densities near the Harris site, additional population data are included below that break out population density by various mile radii.

Cumulative Population Estimates and Projections and Population Density (persons per square mile) between Zero and Fifty Miles of the Harris Nuclear Plant

Miles from Site	Population (2000)	Population 2010	Population (2020)	Population (2027)	Population (2030)	Population (2040)	Population (2050)
0-5	2,200	2,850	3,529	4,203	4,235	4,828	5,262
0-10	52,860	70,048.	88,044	106,317	107,414	124,600	138,306
0-20	441,746	572,494	708,548	846,877	850,257	969,293	1,056,529
0-30	1,099,464	1,411,897	1,736,454	2,066,989	2,083,745	2,396,307	2,659,900
0-40	1,558,369	1,961,492	2,379,999	2,806,878	2,832,199	3,257,029	3,647,872
0-50	2,034,394	2,520,822	3,025,592	3,540,592	3,570,198	4,070,026	4,517,728.5

*From Updated FSAR based on 2000 US Census Bureau data.

Miles from Site	Pop. Density (2000)	Pop. Density (2010)	Pop. Density (2020)	Pop. Density (2027)	Pop. Density (2030)	Pop. Density (2040)	Pop. Density (2050)
0-5	28.01	36.29	44.93	53.51	53.92	61.47	67
0-10	168.25	222.96	280.24	338.40	341.89	396.60	433.86
0-20	351.53	455.56	563.82	673.90	676.59	771.31	840.73
0-30	388.84	499.33	614.12	731.02	736.95	847.49	940.71
0-40	310.02	390.21	473.47	558.39	563.43	647.94	725.70
0-50	259.02	320.95	385.22	450.79	454.56	518.19	575.19

The Harris UFSAR reports that 20-mile population densities are expected to be about 456, 564, and 674 persons per square mile in 2010, 2020 and 2027, respectively. This compares to NRC Siting guidance that indicates population density, averaged over any radial distance out to 20 miles from the site, should not be "well in excess" of 500 persons per square mile, at the time of initial site approval and within about 5 years thereafter. Interpolation of the Harris UFSAR population projections indicates that 20-mile population would be approximately 500 persons per square mile in the 2010 time frame (approximately 5 years after scheduled issuance of the Progress COL). Accordingly, site 20-mile population density at Harris is not expected to be well in excess of 500 persons per square mile within about 5 years of site approval for the COL.

1.2.2 Emergency Planning

Objective – The purpose of this section is to evaluate the relative suitability of the four candidate sites with respect to emergency planning characteristics of the general area around each site. (No exclusionary or avoidance criteria apply to this issue.) In particular, this evaluation relied on information pertaining to general population in surrounding area, road conditions near site, access to major traffic networks, terrain features, and climatic conditions.

Evaluation approach – Sites with the least constrained evacuation planning issues (low population, good access from site to major traffic networks and no terrain or climate limitations) were considered the most suitable and were assigned a score of 5. Ratings are based on review of county websites (transportation information), USGS topographic maps, and best professional judgment. Ratings relate to extent of development in the general area, the number of roads providing egress from the site area, and proximity to major US highway systems. In general, the areas with lower population are found in more rural areas with less developed traffic networks, so the two factors balanced one another out.

Discussion/Results – A summary of relative information for each site is provided below.

Brunswick – The proposed Brunswick Site is located near the city of Southport, NC. The site is accessed by local roads. State Highways 87, 133, and 211 provide access to the Southport area, and feed into U.S. Highway 17 (Ocean Highway East). The Atlantic Ocean and the Cape Fear River prevent egress to the east and the south, which is the basis for its rating of 2. In addition, the proposed site is located in an area that is prone to hurricane activity. Such a climate condition could further restrict egress, although its location and potential for severe weather has also given Brunswick additional experience in planning and executing emergency response under severe weather conditions.

Harris – The proposed Harris Site is located on the northern side of the Harris Reservoir. U.S. Highway 1 is located immediately north of the site and provides access to the Raleigh, NC area (northeast of the site) and Interstate 40. The location of the site in relation to the Harris Reservoir prevents direct egress to the south. No other limiting climate or terrain conditions were identified.

Marion Site – {

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Robinson – The proposed Robinson Site is located on the southwestern side of Lake Robinson, near the town of Pine Ridge, SC. State Highway 151 provides access to the area and serves as a link to U.S. Highway 1 (northwest) or U.S. Highway 15 (southeast). The location of the site in relation to Lake Robinson prevents direct egress to the east. No other limiting climate or terrain conditions were identified.

Emergency Response	Brunswick	Harris	Marion	Robinson
Rating	2	4	5	4

1.2.3 Atmospheric Dispersion

Objective – The objective of this criterion is to evaluate the suitability of the four candidate sites with respect to short-term atmospheric dispersion characteristics, as a measure of the relative level of concentrations that could occur during accident conditions at the sites.

Evaluation Approach – The efficiency of atmospheric diffusion is primarily dependent on wind speed, wind direction, and the change in air temperature with height which affects atmospheric stability. These factors are used to calculate an atmospheric dispersion function referred to X/Q. The best way to calculate this function is using on-site meteorological data.

Discussion/Results

FSAR reports for the existing sites were consulted for comparison of calculated long-term atmospheric dispersion coefficients (X/Q).

- Brunswick – $4x10^{-6}$ sec/m^3.
- Harris – $3.5x10^{-6}$ sec/m^3
- Robinson – $8x10^{-6}$ sec/m^3.

The Marion Site is expected to have similar atmospheric conditions to the Robinson site. Since X/Qs from on-site data for three of the sites are within the same order of magnitude and the fourth site is expected to be similar (based on its relative proximity to Robinson), equal ratings of 5 were assigned to each site.

Atmospheric Dispersion	Brunswick	Harris	Marion	Robinson
Rating	5	5	5	5

Finally, composite ratings for this criterion (Accident Effects) are a composite of those for sub-criteria 1.2.1, 1.2.2, and 1.2.3; the ratings for these sub-criteria, along with the summary rating for this criterion, are provided in the following table.

Sub-criterion	Brunswick	Harris	Marion	Robinson
Population	2	1	2	2
Emergency Planning	2	4	5	4
Atmospheric Dispersion	5	5	5	5
Overall Rating	**3**	**3**	**4**	**4**

1.3 OPERATIONAL EFFECTS-RELATED

1.3.1 Surface Water – Radionuclide Pathway
1.3.1.1 Dilution Capacity
1.3.1.2 Baseline Loadings
1.3.1.3 Proximity to Consumptive Users

Objective – The purpose of this criterion is to evaluate candidate sites with respect to potential liquid pathway dose consequences. (No site exclusionary or avoidance criteria apply to this issue.) Besides potential source terms, dilution in the receiving surface water body is of primary importance. Three factors considered in evaluating the potential dilution for a receiving water body are dilution capacity, baseline loadings, and proximity to consumptive users.

Evaluation Approach – Site ratings for this criterion are developed as a composite of three sub-criteria that address site characteristics relevant to consideration of operation: Dilution Capacity, Baseline Loadings, and Proximity to consumptive users.

- Dilution Capacity - The purpose of this sub-criterion is to rate sites based on the overall capacity of the receiving water body to dilute effluents from a nuclear power plant. Information on the radioactive source term dilution at a new power plant will be site specific. For siting consideration where such information is not available, however, surrogate parameters, representing the dilution capacity of a stream, can be used. The greater the dilution capacity of the receiving water body, the shorter will be the mixing length downstream defined as the zone within which complete mixing of a discharge contaminant occurs. Sites with higher dilution capacity are rated higher.

- Baseline Loadings – The capacity of a stream to impact health and safety of downstream consumers is related to the existing, or baseline loadings of, radionuclides that are present in the system or can be anticipated in the future. The purpose of this sub-criterion is to characterize sites in accordance with existing levels of radioactive contamination in the receiving water body. Sites are given a rating of 5 for no baseline loadings; proportionally lower ratings are assigned as higher existing levels of radionuclide contamination are identified.

- Proximity to consumptive users - The purpose of this sub-criterion is to rate sites in accordance with the proximity of plant effluent release point to the location(s) public water supply withdrawal(s). More proximal withdrawals present higher potential for dose impacts from the surface water ingestion pathway and can require additional design and licensing efforts. Downstream locations of public water supply withdrawals and recreational contact were identified for each site. Sites with greater pathway lengths to users were more suitable and were assigned a score of 5.

Discussion/Results

A summary of the sub-criterion and overall ratings for the surface water-radionuclide pathway criterion is presented in the following table.

Site	Dilution Capacity	Baseline Loadings	Proximity to Downstream public water supply	Composite Rating
Brunswick	5	4	5	**5**
Harris	4	4	3	**4**
Marion	4	5	4	**4**
Robinson	3	4	4	**4**

Ratings for dilution capacity are directly related to average annual river flow.

Dilution Capacity

- The receiving body of water from the Brunswick Site, the Cape Fear River/Atlantic Ocean, is large enough to efficiently dilute effects from a nuclear power plant.
- The receiving body of water from the Harris Site, the Harris Reservoir, is large enough to efficiently dilute effects from a nuclear power plant.
- The receiving body of water from the Marion Site, the Great Pee Dee River, will dilute effects from a nuclear power plant, but is not as large as the receiving bodies of water at other sites.
- The receiving body of water from the Robinson Site, Lake Robinson, is large enough to efficiently dilute effects from a nuclear power plant. Operational history with the plant (e.g., thermal loading) indicates that dilution in Lake Robinson is likely to be less than that for the other sites

Baseline Loadings

- The Brunswick, Harris, and Robinson Sites are located near existing radiological operations. As such, baseline loadings of radiological contamination are not expected to significantly differ between the three sites.
- The Marion Site is located in an area where no current radiological operations exist. As such, baseline loadings at this location are expected to be smaller than for the other three sites.

Proximity to Consumptive Users

Ratings are based on the distance to the closest downstream public water supply intake structure from each site (based on gross approximations from site to location on water closest to nearest city deriving its water supply from the river); the closer the water intake, the lower the rating. Water intake distances in river miles (downstream from sites) are projected as follows:

- Brunswick – No public water system (surface) was found in the EPA Safe Drinking Water Information System (SWDIS) database (Cape Fear River/Atlantic Ocean in Brunswick County, NC). Nearby/downstream communities of Bald Head Island, Oak Island and Southport purchase their surface water, presumably from another location in the Brunswick County Water System).
- Harris – The town of Lillington has a public (surface) water intake on the Cape Fear River approximately 15 miles downstream of the Harris Plant in Harnett County

- Robinson – No existing public water system (surface) found in EPA SDWIS (Darlington County, SC); however, there is potential for a downstream public water supply to be developed in the future (Progress 2005; personal communication with P. Snead).
- Marion – {

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1.3.2 Groundwater Radionuclide Pathway

Objective – The purpose of this section is to evaluate the candidate sites with respect to the relative vulnerability of shallow groundwater resources to potential contamination.

Evaluation Approach – All candidate sites overlie aquifers that have not been designated by EPA's (1986) classification scheme. EPA guidelines were, however, used to assign a designation to candidate site aquifers. In addition, the relative vulnerability of these aquifers to groundwater pollution was evaluated using a standard numerical ranking system called DRASTIC (Aller et al. 1987). Sites considered most suitable are those that are least vulnerable to groundwater contamination within a 2-mile radius of a site.

Discussion/Results – Class I groundwater is addressed as an avoidance criteria (EPRI 2000). This classification includes groundwater resources of unusually high value. They are highly vulnerable to contamination and are irreplaceable sources of drinking water and or ecologically vital. Groundwater resources underlying the candidate sites are either currently used or are potential sources of drinking water, hence, they would be considered Class II aquifers according to the EPA classification guidelines. There are no sole source aquifers at the four Progress sites.

The DRASTIC evaluation was completed using site-specific data, where available, or data from published sources. The most important variables that control the groundwater pollution potential are:

- D–Depth to water,
- R–Recharge (net),
- A–Aquifer media,
- S–Soil media,
- T–Topography (slope),
- I–Impact of the vadose zone,
- C–Conductivity (hydraulic) of the groundwater flow system.

DRASTIC assigns a weighted numeric value to each characteristic, depending on its relative contribution to risk of groundwater contamination. This results in a numeric ranking for each site, allowing the sites to then be ranked in order of suitability. The higher an area scores on the DRASTIC index, the more susceptible a site is to groundwater contamination. Following is a summary of the DRASTIC evaluations.

Brunswick				
DRASTIC Variable	**Range and Source of Information**	**Weight**	**Rating**	**Number**
Depth to water	10–20 ft bgs (BSEP Updated FSAR)	5	9	45
Net Recharge	10^{+} in/yr (DRASTIC EPA Manual, 1987)	4	9	36
Aquifer Media	Fine sands over clayey silts and silty clays (BSEP ER; BSEP Updated FSAR)	3	6	18
Soil Media	Sandy Loam (BSEP ER, BSEP Updated FSAR)	2	6	12
Topography	10% in northwest and 18% in southeast (USGS site topographic maps)	1	10	10
Impact Vadose Zone	Fine sands over clayey silts and silty clays (BSEP ER; BSEP Updated FSAR)	5	6	30
Hydraulic Conductivity	1-10 gpd/ft^2 (Driscoll, 1986; DRASTIC, 1987)	3	1	3
			INDEX	**154**

Harris				
DRASTIC Variable	**Range and Source of Information**	**Weight**	**Rating**	**Number**
Depth to water	30 – 90 ft bgs (SHNP FSAR).	5	2 - 5	10 - 25
Net Recharge	1 - 3 in/yr (SHNP FSAR).	4	2 - 3	8 - 12
Aquifer Media	Sandstone, siltstone, and claystone (SHNP FSAR).	3	5	15
Soil Media	Clayey loam and silty loam (SHNP FSAR).	2	3 - 4	6 – 8
Topography	4% (USGS site topographic maps)	1	9	9
Impact Vadose Zone	Silt and clay (SHNP FSAR)	5	3	15
Hydraulic Conductivity	10^{-4} gpd/ft^2 (Driscoll, 1986)	3	1	3
			INDEX	**66 – 87**

Marion				
DRASTIC Variable	**Range and Source of Information**	**Weight**	**Rating**	**Number**
Depth to water	{ }	5	7 - 9	35 – 45
Net Recharge	{ }	4	8	32
Aquifer Media	{ }	3	6	18

Marion				
DRASTIC Variable	**Range and Source of Information**	**Weight**	**Rating**	**Number**
Soil Media	{ }	2	4 - 6	8 – 12
Topography	{ }	1	10	10
Impact Vadose Zone	{ }	5	4	20
Hydraulic Conductivity	{ }	3	1	3
			INDEX	**126-140**

Robinson				
DRASTIC Variable	**Range and Source of Information**	**Weight**	**Rating**	**Number**
Depth to water	15–30 ft bgs (RNP UFSAR)	5	7	35
Net Recharge	10^{+} in/yr (DRASTIC EPA Manual, 1987)	4	9	36
Aquifer Media	Sand and gravel with clay (RNP UFSAR; RNP ER).	3	7	21
Soil Media	Sandy Loam (RNP UFSAR; DRASTIC EPA Manual, 1987).	2	6	12
Topography	1% to 3%(USGS site topographic maps)	1	9 - 10	9 - 10
Impact Vadose Zone	Sand and gravel with significant clay (RNP UFSAR; RNP ER).	5	6	30
Hydraulic Conductivity	1 - 10 gpd/ft^2 (Driscoll, 1986)	3	1	3
			INDEX	**146-147**

DRASTIC indexes for all typical hydrogeologic settings range from 65 to 223 (Aller et al. 1987, p. 82). This range of indexes was used to develop a ranking system to compare vulnerability of candidate sites, as follows:

DRASTIC Index Range	Relative Vulnerability	Rating
65–98	Low	5
98–132	Low to Moderate	4
132–166	Moderate	3
166–199	High	2
199–233	Very High	1

Based on these DRASTIC Index Ranges for qualitative vulnerability, candidate sites were ranked as follows:

Candidate Site	DRASTIC Index	Rating
Brunswick	154	**3**
Harris	66 - 87	**5**
Marion site	126 - 140	**3 – 4***
Robinson NP	146 - 147	**3**

* - Because the DRASTIC Index range for the Marion site falls across two of the vulnerability categories (Low-to-moderate – moderate), the site was given a rating of 3.5; this rating was not rounded to reflect its intermediate position on the DRASTIC index scale.

References

Aller, L., Bennett, T., Lehr, J., Petty, R. and G. Hackett. 1987. DRASTIC: A Standardized System for Evaluating Ground Water Pollution Potential Using Hydrogeologic Settings. EPA/600/2-87/035, June 1987.

Atlanta Testing & Engineering, Phase I Environmental Assessment, Marion Co. SC,1993.
Brunswick Steam Electric Plant, Updated Final Safety Analysis Report (FSAR).

Brunswick Steam Electric Plant, Environmental Report (ER).

DRASTIC: A Standardized System for Evaluating Ground Water Pollution Potential Using Hydrogeologic Settings; EPA Manual, 1987.

Driscoll, Fletcher G., Groundwater and Wells, 1986.

EPA. 1986. Guidelines for Groundwater Classification Under the EPA Groundwater Protection Strategy, Office of Groundwater Protection.

Professional Service Industries, Inc., Soil Exploration and Foundation Recommendations, Proposed Industrial Project, Marion SC, 1993.

Robinson Steam Electric Plant Updated FSAR.

Robinson Steam Electric Plant ER.

S&ME, Preliminary Wetland Location Approximation/Cultural Resource Literature Review, Project Marion Site, 2001.

Shearon Harris Nuclear Plant FSAR.

USGS Site Topographic Maps.

1.3.3 Air Radionuclide Pathway

1.3.3.1 Topographic Effects
1.3.3.2 Atmospheric Dispersion

Objective – The purpose of this criterion is to address the relative suitability of sites with respect to the potential for exposure to the public from routine airborne releases from a nuclear power plant.

Evaluation approach – The criterion is comprised of two suitability characteristics:

Topographic Effects – Site ratings are based on whether there are any significant topographic features that would materially affect dispersion of the plume from plant releases (e.g., channeling of releases from a site located low in a high-banked river valley).

Atmospheric Dispersion – Measured in terms of long term (e.g., annual average X/Q) dispersion characteristics. Sites with lower X/Q values are rated higher than those with less favorable dispersion conditions.

Discussion/Results

None of the sites is believed to have significant potential for negative topographic effects on long-term dispersion. Additionally, as noted above, atmospheric dispersion conditions at the proposed sites are not expected to differ significantly. The proposed site ratings with respect to radionuclide exposure via airborne releases are as follows:

Air Radionuclide Pathway	Brunswick	Harris	Marion	Robinson
Rating	5	5	5	5

1.3.4 Air-Food Ingestion Pathway

Objective – The objective of this criterion is to rate candidate sites in terms of the relative potential for exposure of humans to radioactive emissions through deposition of radioactive materials on food crops with subsequent consumption of foodstuffs by exposed individuals.

Evaluation approach – A potential exposure pathway for nuclear power plants is the emission of radionuclides into the food chain on local crops and pastures. Radiological doses and dose commitments resulting from a nuclear plant are well and known and documented. While the operational impacts on the public through food pathway exposures are negligible, sites with lower amounts of crop and pasture land uses are considered to be more suitable. No exclusionary or avoidance criteria apply to this issue. Sites with less crop production nearby are rated higher than those with less nearby agriculture.

Discussion/Results - General information regarding crop lands and pastures near the sites is summarized below. Data is from the National Agricultural Statistics Service (2002 Census of Agriculture – http://151.121.3.33:8080/Census/Create_Census_US_CNTY.jsp).

Brunswick Site (Brunswick County, NC) – In Brunswick County, agriculture (farmland) represents 41,077 acres out of 547,200 total acres (855 square miles) (8%). Out of the total farmland, 23,522 acres are planted in crop (57.3%), or 4.3% of total acres in the county in 2002.

Harris Site (Wake County, NC) – In Wake County, agriculture (farmland) represents 92,803 acres out of 532,480 total acres (832 square miles) (17%). Out of the total farmland, 45,826 acres are planted in crop (49.4%), or 8.6% of total acres in the county in 2002.

Marion Site (Marion County, SC) – In Marion County, agriculture (farmland) represents 93,262 acres out of 312,960 total acres (489 square miles) (30%). Out of the total farmland, 57,783 acres are planted in crop (62.0%), or 18.5% of total acres in the county in 2002.

Robinson Site (Darlington County, SC) – In Darlington County, agriculture (farmland) represents 161,443 acres out of 359,040 total acres (561 square miles) (45%). Out of the total farmland, 96,968 acres are planted in crop (60.1%), or 27% of total acres in the county in 2002.

Note that the Harris and Robinson sites are located in a corner of their respective host counties. Adjacent counties (Chatham County for Harris and Chesterfield County for Robinson) were also evaluated with respect to percentage and acreage of land planted in crop. When factored in with the host county, the total percentage of both counties planted in crop is similar for Harris and slightly lower for Robinson (60.1% versus 50.8%); Robinson totals exceed the other sites with respect to total land planted in crop (acreage and percentage) in both cases.

Based on a comparison of total farmland planted in crop with total farmland and with total acreage in the county (comparing both acreage and percent) using 2002 data, the Brunswick site appears to be the most suitable site, and Robinson is the least suitable. Site ratings are provided below.

Air-Food Ingestion Pathway	Brunswick	Harris	Marion	Robinson
Rating	5	4	3	2

1.3.5 Surface Water – Food Radionuclide Pathway

Objective – The purpose of this criterion is to evaluate the relative suitability of sites in terms of the specific use of irrigation water by downstream locations as a potential pathway for potential exposure.

Evaluation approach – Sites with the fewest number of downstream irrigation uses are more suitable and are rated higher than sites with a large number of downstream irrigation withdrawals. No exclusionary or avoidance criteria apply to this issue (EPRI 2001).

Discussion/Results - Based on data from the National Agricultural Statistics Service (2002 Census of Agriculture – http://151.121.3.33:8080/Census/Create_Census_US_CNTY.jsp), a smaller percentage of cropland is irrigated in South Carolina than in North Carolina.

- Brunswick Site – Brunswick County, NC – 2,655 acres (11.3%)
- Harris Site – Wake County, NC – 4,616 acres (10.1%)
- Marion Site – { }
- Robinson Site – Darlington County, SC – 948 acres (1.0%)

The Marion and Robinson sites are each given a rating of 5 given the small percentages of irrigated cropland in their respective host counties. The Brunswick site is located in the extreme southeastern portion of Brunswick County, and no irrigation pathways in the vicinity of the Brunswick site are known or expected. Therefore, despite the higher percentage of irrigated cropland for Brunswick County as a whole, the site is given a rating of 5 based on its location relative to irrigation withdrawals. Harris is the lowest rated site with a conservative rating of 3.

Surface Water-Food Radionuclide Pathway	Brunswick	Harris	Marion	Robinson
Rating	5	3	5	5

1.3.6 Transportation Safety

Objective - The objective of this criterion is to evaluate the suitability of the four candidate sites with respect to potential to create fog and ice hazards to local transportation. No exclusionary or avoidance criteria apply to this issue.

Evaluation approach – Potential impacts from plant operations on transportation safety could occur as a result of increased hazards from cooling towers. Both natural draft and mechanical cooling towers can increase area fogging conditions ice formation on local roads and highways. Sites with high frequencies of naturally-occurring fog and ice events will likely be more adversely affected by cooling tower operations.

Discussion/Results – Relative information regarding existing fog and ice conditions at the sites is summarized in the table below. Given the incidence of fog and ice along with the relative isolation of each of the sites, a rating of 5 has been assigned to each site.

	Fog Conditions	Ice Conditions	Relative Score
Brunswick	Mean number of days with heavy fog is 25.0 for the past 53 years. No off-site fogging conditions from cooling tower are likely.	Closest secondary highway located ~1 mile West. Very low probability of cooling tower fogging or icing effects on off-site locations.	**5**
Harris	Mean number of days with heavy fog is 32.6 for the past 55 years. No off-site fogging conditions from cooling tower are likely.	Closest primary highway located ~1 mile North. Very low probability of cooling tower fogging or icing effects on off-site locations.	**5**
Marion	Mean number of days with heavy fog is 29 for 16 years. No off-site fogging conditions from cooling tower are likely.	{ }	**5**
Robinson	Mean number of days with heavy fog is 25.9 for the past 56 years. No off-site fogging conditions from cooling tower are likely.	Closest primary highway located ~0.5 mile West. Very low probability of cooling tower fogging or icing effects on off-site locations.	**5**

References

NOAA National Climatic Data Center, Ashville, NC: 2004 Local Climatological Data, Annual Summary with Comparative Data for Columbia, SC.

NOAA National Climatic Data Center, Ashville, NC: 2004 Local Climatological Data, Annual Summary with Comparative Data for Wilmington, NC.

NOAA National Climatic Data Center, Ashville, NC: 2004 Local Climatological Data, Annual Summary with Comparative Data for Florence, SC.

NOAA National Climatic Data Center, Ashville, NC: 2004 Local Climatological Data, Annual Summary with Comparative Data for Raleigh/Durham, NC.

2. ENVIRONMENTAL CRITERIA

2.1 CONSTRUCTION-RELATED EFFECTS ON AQUATIC ECOLOGY

2.1.1 Disruption of Important Species/Habitats

Objective – The objective of this criterion is to evaluate the candidate sites with respect to potential construction related impacts on aquatic or marine ecology. Regulatory Guide 4.7 defines important plant and animal species if one or more of the following conditions apply.

- the species is commercially or recreationally valuable,
- the species is officially listed as endangered or threatened,
- the species effects the well being of another species within (1) or (2) above,
- the species is a critical component of the structure and function of a valuable ecosystem, or
- the species is a biological indicator of radionuclides in the environment.

Of particular concern are potential impacts to habitat areas used by important species. These areas include those used for:

- breeding and nursery,
- nesting and spawning,
- wintering, and
- feeding.

Evaluation approach – The following siting criteria were used to evaluate the four candidate sites.

- Exclusionary – Designated critical habitat of endangered species
- Avoidance – Areas where threatened and endangered species are known to occur.
- Suitability – Areas where limited potential impact is expected

No information was obtained which would indicate that any of the sites under consideration would exceed the exclusionary or avoidance criteria relative to ecology. Therefore, the evaluation focused on the relative suitability of the site based on the number of areas where limited potential impact is expected. The number of potential impact areas was directly correlated to the number of rare, threatened and endangered (RTE) aquatic species that may occur at the Site (within 400 acres), their habitat (based on existing reports and professional judgment of the amount and quality of habitat available for species), and flexibility (professional judgment of the amount of space within the site circle to avoid known locations of protected species during construction of the facility). Note that the evaluation was limited to the plant site and not existing or potential (future) transmission corridors.

The suitability of the candidate sites with respect to ecology (rare, threatened and endangered aquatic and terrestrial species, and critical habitat) was initially evaluated during the candidate site screening phase (Criterion P5, Appendix A). Additional site ecological information specific to aquatic resources at each site is included in the full discussion below. In the context of this discussion, vicinity refers to the USGS Quadrangle in which the candidate site is located (e.g., Kure Beach for Brunswick, New Hill for Harris, { } for Marion, and Lake Robinson for Robinson).

Discussion

Brunswick

Seven Federally listed protected terrestrial species (table below) have the potential to occur in the vicinity of the Brunswick site (Kure Beach Quadrangle). The Federally listed species are identified in the table below. The data source is the North Carolina Natural Heritage Program (NC NHP), 2005: Listing of rare plant and animal species. NC NHP database updated: July 2005; accessed at http://207.4.179.38/nhp/quad.html on October 25, 2005.

Scientific Name	Common Name	Federal Status
Litsea aestivalis	Pondspice	Federal Species of Concern (FSC)
Myriophyllum laxum	Loose Watermilfoil	FSC
Rhynchospora pleiantha	Coastal Beaksedge	FSC
Alligator mississippiensis	American Alligator	Threatened
Caretta caretta	Loggerhead	Threatened
Chelonia mydas	Green Turtle	Threatened
Trichechus manatus	West Indian Manatee	Endangered

Based upon more site-specific information included in the Generic Environmental Impact Statement for License Renewal of Nuclear Plants Regarding Brunswick Steam Electric Plant, Units 1 and 2 (NUREG-1437, Supplement 25, Draft Report for Comment) there are 14 Federally listed endangered or threatened aquatic species and 18 Federal species of concern potentially occurring in the vicinity of the Brunswick site. This evaluation focuses on the Federally listed endangered and threatened aquatic species. Three of these species have been found on the Brunswick site: the loggerhead *(Caretta caretta),* green *(Chelonia mydas),* and Kemp's ridley *(Lepidochelys kempi,)* turtles [note that the Kemp's ridley turtle is considered a terrestrial species but is included here with the other turtle species].

Two other sea turtle species have been observed in Brunswick County. The hawksbill *(Eretmochelys imbricata)* and leatherback *(Dermochelys coriacea)* turtles have been observed on rare occasions in Brunswick County, but have not been documented at the site. Brunswick maintains a diversion structure at the mouth of the cooling water intake canal that supports 3/8-in. mesh screens and specially designed turtle-blocker plastic mesh panels, designed to prevent sea turtles from entering the intake canal. The screens on the diversion structure are cleaned daily, and the canal is patrolled during the primary turtle season to reduce the possibility of a sea turtle being harmed as a result of plant operation. The existing Brunswick plant has undergone Section 7 consultation with the NMFS and has been issued an incidental take statement by that agency. The plant also maintains an endangered species permit, issued by the North Carolina Wildlife Resources Commission, that allows them to capture and transport live and dead sea turtles for the purpose of releasing them to the ocean, transporting them to a rehabilitation facility, or disposing of them. Brunswick is required to report all incidental takes, turtle stranding events and handling activities to these agencies.

The West Indian manatee *(Trichechus manatus)* and short nose sturgeon *(Acipenser brevirostrum)* are Federal endangered species that have been documented in the Cape Fear

Estuary on rare occasions but have never been documented at the Brunswick site. The sei whale *(Balaenoptera borealis),* blue whale *(Balaenoptera musculus),* fin whale *(Balaenoptera physalus),* right whale *(Eubalaena glacialis),* humpback whale *(Megaptera novaeangliae),* and sperm whale *(Physeter macrocephalus)* are also Federal endangered species, but they generally inhabit deeper offshore waters and are not expected to occur at the Brunswick site (NMFS 2005e). The Federally threatened Waccamaw silverside *(Menidia extensa)* is known only from Lake Waccamaw in Columbus County and is therefore not expected to occur at the Brunswick site (FWS 2005b).

NRC staff concluded during the Brunswick plant relicensing process that 1) continued operation of the plant and associated transmission line rights-of-way maintenance during the license renewal term is not likely to adversely affect any Federally listed aquatic species and 2) Any impact on threatened and endangered species from an additional 20 years of operation would be small and no additional mitigation is warranted. Similarly, operation of a second plant at the Brunswick site is not expected to adversely affect any Federally listed aquatic species.

Harris

There are no aquatic species in the site vicinity that are included on Federal or state lists of endangered or threatened species. The Cape Fear shiner (*Notropis mekistochalas*) has been identified as being of "special concern" in proceedings of a North Carolina endangered species symposium. More recently, the species has also received national attention through its designation as a species of special concern by the endangered species "Committee of the American Fisheries Society. The present threat to the species noted is destruction of habitat.

This species is endemic to several tributaries of the Haw, Deep, and Cape Fear Rivers, but only one specimen has been found in the site vicinity over the sampling period, 1972 to 1980. The specimen was found in the Cape Fear River where its habitat would not be affected by impoundment or normal plant operation. Under certain conditions (drought), makeup water from the Cape Fear River may be required at Harris for operating additional units. Pumping from the Cape Fear River in such situations could potentially impact the shiner habitat.

Marion

No site-specific reports on protected species were available for Marion. {

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Robinson

Eleven State and Federally protected aquatic species with potential to occur in the region surrounding the Robinson site were identified through review of the South Carolina Heritage Trust database, and through correspondence with the SCDHEC, the U.S. Fish and Wildlife Service (FWS), and the National Marine Fisheries Service (NMFS) [now National Oceanic and

Atmospheric Administration Fisheries (NOAA Fisheries)]. None of the fish or benthic invertebrate species identified were ever recorded during CP&L environmental monitoring surveys conducted from 1974 to 1998 (CP&L 1999a) and are not considered to exist on or near the Robinson site.

Of the eleven protected species identified, only the Carolina heelsplitter *(Lasmigona decorata)* and shortnose sturgeon *(Acipenser brevirostrum)* are on the Federal list of endangered species. One species, the Atlantic sturgeon (*Acipenser oxyrinchus*), is a candidate for Federal listing. Prior to a 1987 FWS survey (FWS 1993), the Carolina heelsplitter had not been found since the mid-19th century. This Federally endangered freshwater mussel was historically found in South Carolina in the Pee Dee River system. The FWS conducted intensive surveys between 1987 and 1990 and found only two surviving populations of the Carolina heelsplitter in the Pee Dee River system – the Goose Creek and Lynches River/Flat Creek populations. The population nearest the plant was found in the Lynches River (downstream from the Black Creek/Pee Dee River junction) along the western boundary of Chesterfield County (FWS 1993). During the FWS surveys, a total of only 12 live individuals were found in Flat Creek (1987 to 1990) and two individuals were found in the Lynches River (both found in 1990).

Shortnose sturgeon occur in most major river systems along the eastern seaboard of the United States. They inhabit the main stems of natal rivers, migrating between freshwater and mesohaline river reaches. Spawning occurs in upper, freshwater areas, while feeding and overwintering activities may occur in both fresh and saline habitats (NMFS 1998). In South Carolina they are found in the river systems that empty into Winyah Bay (including the Pee Dee River). Shortnose sturgeon were documented in the Winyah Bay system during the late 1970s and early 1980s (Dadswell et al. 1984) and over 100 collections of juveniles and adults were collected (NMFS 1998).

In a letter dated June 7, 2001, the FWS office in Charleston indicated that the shortnose sturgeon possibly occurs in Darlington County. Additionally, the shortnose sturgeon is listed in Chesterfield, Darlington, Florence, and Sumter Counties by the FWS Southeast Regional Office on their website (FWS 1999); however, the species is not known to occur in the site vicinity in Black Creek (Lake Robinson Quadrangle).

Results

While there are many protected species with the potential to occur in the region surrounding the candidate sites, no protected species were found to occur on-site or in the immediate vicinity of any of the sites except for three listed turtle species at Brunswick and the Cape Fear shiner (special concern) that is endemic to the tributaries of the Cape Fear River in the vicinity of the Harris plant. This species is not expected to be directly affected by new plant operation at the same Storage Reservoir System (of the Cape Fear River), however, because pumping of makeup water from the Cape Fear River to Lake Harris will be required for new plants at the site, conditions may pose a potential concern for this species, the Harris site was assigned a rating of 4. While no listed species are found at Robinson, it is given a conservative rating of 4 based on the number of listed species (11) in the general site vicinity. Marion {

}

{ } Brunswick is given the lowest rating because of the number of listed species found at the site (3) and in the site vicinity (14). Composite site ratings are provided below for each site.

Site	Brunswick	Harris	Marion	Robinson
T&E Species (aquatic)	2	4	4	4
Habitat	2	3	3	3
Flexibility	4	4	4	4
Overall rating	**3**	**4**	**4**	**4**

References

Carolina Power and Light Company (CP&L). 1999a. *H.B. Robinson Steam Electric Plant 1998 Environmental Monitoring Report.* CI-0017. Environmental Services Section of the Carolina Power and Light Company. New Hill, North Carolina.

South Carolina Department of Natural Resources (SCDNR). 2003. South Carolina Rare, Threatened & Endangered Species Inventory. Accessed at http://www.dnr.state.sc.us/heritage/owa/species.login on October 25, 2005. Note: This is a protected website that is accessible only through SCDNR authorization.

North Carolina Natural Heritage Program, 2005. Listing of rare plant and animal species. NC NHP database updated: July 2005. Accessed at http://207.4.179.38/nhp/quad.html on October 25, 2005.

NRC, 2003. NUREG-1437 Generic Environmental Impact Statement for License Renewal of Nuclear Plants Supplement 13 Regarding H.B. Robinson Steam Electric Plant, Unit No. 2

Information from: NRC, 1983. Final Environmental Statement related to the Operation of Shearon Harris Nuclear Power Plant, Units 1 and 2. NUREG – 0972. U.S. Nuclear Regulatory Commission.

2.1.2 Bottom Sediment Disruption Effects
2.1.2.1 Contamination
2.1.2.2 Grain Size

Objective – The objective of the criterion is to evaluate the potential short-term impacts to aquatic/marine resources resulting from construction related dredging activities at the candidate sites.

Evaluation approach – The evaluation sought available data on the amount of contaminated sediments near the candidate sites and the grain size of sediments in the area. In general, sites with the lowest concentration of heavy metals and toxic organic compounds and the highest sediment grain size are considered to be the most suitable.

Little information exists regarding the site specific level of sediment contamination that exists in water bodies near the candidate sites. The majority of the available information was obtained from the EPA's National Sediment Quality Survey (2001 and 2004). Information in the EPA report addresses sediment contamination levels as Tier I (adverse impacts to aquatic life are probable) and Tier II (adverse impacts to aquatic life are possible but infrequent). Using best professional judgment, the following evaluation considered the results of the EPA's Tier I/Tier II study results to determine the relative contamination potential for the candidate sites.

No information regarding sediment grain size was obtained for this evaluation. Because sediment grain size is highly variable, even within a small area of coastline or river reach, the following evaluation of potential bottom sediment disruption effects was limited to available information regarding sediment contamination levels in principle water bodies at the four sites.

Discussion/Results

An updated EPA study (EPA 2004) evaluated 2,874 sampling stations in the Southeast, and identified 12 waterbodies as having the most significant sediment contamination in EPA Region 4. No water bodies on which the Progress candidate sites are located were identified in the EPA study. Coastal South Carolina was identified as a general area of potential concern (APC) – around Lake Washington - however this is not likely to be a problem at Brunswick.

In addition, the State of North Carolina and South Carolina's 2004 Listings of Impaired Waters (Clean Water Act Section 303(d)) were reviewed. No waterbodies near the North Carolina sites within the Cape Fear River Basin were identified as impaired with respect to heavy metals or toxic organic compounds, although fish advisories for mercury poisoning were noted for the Cape Fear River Basin at the Atlantic Ocean (in vicinity of the Brunswick Site). For the South Carolina sites, the Pee Dee River, { } and Lake Robinson and Black Creek (Robinson site) were identified as impaired from mercury poisoning (fish). Other locations along the Pee Dee River upstream and downstream of the candidate sites were also listed as impaired from mercury and copper.

Because dredging is not one of the parameters considered for this particular evaluation, and information on grain size was not readily available for most of the sites, the estimated potential

for contaminated sediments to affect the cost and schedule of any construction related dredging operations was based on the limited information available and professional judgment. Based on the EPA study and State 303(d) water quality impaired lists (which raise some concern regarding the Pee Dee River and its tributaries), and because the presence of contaminated sediments in the immediate vicinity of the candidate sites including any onsite streams cannot be confirmed, the following conservative ratings are given to the candidate sites:

Criterion	Brunswick	Harris	Marion	Robinson
Rating	4	4	2	2

References

The Incidence and Severity of Sediment Contamination in Surface Waters of the United States. National Sediment Quality Survey. Office of Science and Technology. EPA 823-R-04-007. November.

South Carolina 20000 Section 303(d) List of Priority Ranked Waterbodies Targeted for Water Quality Management Action.

North Carolina Water Quality Assessment Impaired Waters List, 2004 Integrated 305(b) and 303(d) Report.

2.2 CONSTRUCTION-RELATED EFFECTS ON TERRESTRIAL ECOLOGY

2.2.1 Disruption of Important Species/Habitats and Wetlands

2.2.1.1 Important Species/Habitats
2.2.1.2 Groundcover/Habitat
2.2.1.3 Wetlands

Objective – The objective of this criterion is to evaluate the candidate sites with respect to potential construction related impacts on important species and terrestrial ecology. Regulatory Guide 4.7 defines important plant and animal species if one or more of the following conditions apply.

- the species is commercially or recreationally valuable,
- the species is officially listed as endangered or threatened,
- the species effects the well being of another species within (1) or (2) above,
- the species is a critical component of the structure and function of a valuable ecosystem, or
- the species is a biological indicator of radionuclides in the environment.

Of particular concern are potential impacts to habitat areas used by important species. These areas include those used for:

- breeding and nursery,
- nesting and spawning,
- wintering, and
- feeding.

Evaluation approach – The following siting criteria were used to evaluate the four candidate sites.

- Exclusionary – Designated critical habitat of endangered species
- Avoidance – Areas where threatened and endangered species are known to occur.
- Suitability – Areas where limited potential impact is expected

No information was obtained which would indicate that any of the sites under consideration would exceed the exclusionary or avoidance criteria relative to ecology. Therefore, the evaluation focused on the relative suitability of the site based on the number of areas where limited potential impact is expected. The number of potential impact areas was directly correlated to the number of rare, threatened, and endangered terrestrial species that may occur at the Site (within 400 acres), their habitat (based on existing reports and professional judgment of the amount and quality of habitat available for species), and flexibility (professional judgment of the amount of space within the site circle to avoid known locations of protected species during construction of the facility). Note that the evaluation was limited to the plant site and not existing or potential (future) transmission corridors.

Another sub-criteria evaluated was the total acreage of wetland within the 6000 acres, not including the lake or reservoir that would be the primary source of cooling water. This was also broken out into three components: total wetlands (acres), total acreage of higher quality wetlands, and flexibility, or the ability to avoid wetlands during construction.

The relative suitability of the candidate sites with respect to ecology (rare, threatened and endangered aquatic and terrestrial species, and critical habitat) and wetlands was evaluated during the candidate site screening phase (Criterion P5 and P6, Appendix A). Additional site ecological information specific to terrestrial resources at each site is included in the full discussion below.

Discussion/Results

Brunswick

Nine Federally listed and 15 State listed protected terrestrial species have the potential to occur in the vicinity of the Brunswick site (Kure Beach Quadrangle). The Federally listed species are identified in the table below. Data source is the NC NHP, 2005. Listing of rare plant and animal species. NC NHP database updated: July 2005. Accessed at http://207.4.179.38/nhp/quad.html on October 25, 2005.

Scientific Name	Common Name	Federal Status
Triodopsis soelneri	Cape Fear Threetooth	Federal Species of Concern (FSC)
Amaranthus pumilus	Seabeach Amaranth	Threatened
Lysimachia asperulifolia	Rough-leaf Loosestrife	Endangered
Sideroxylon tenax	Tough Bumelia	FSC
Trichostema sp. 1	Dune Bluecurls	FSC
Charadrius melodus	Piping Plover	Threatened
*Lepidochelys kempii**	Kemp (Atlantic) Ridley	Endangered
Passerina ciris ciris	Eastern Painted Bunting	FSC
Rana capito	Carolina Gopher Frog	FSC

* Addressed under aquatic species

During relicensing of the Brunswick plant, NRC staff reviewed information provided by CP&L (2004) and obtained from the FWS and the North Carolina Natural Heritage Program. Based on the site audit, review of CP&L's ER, other reports, and information from FWS and the North Carolina Natural Heritage Program, the staff concludes that the impacts on terrestrial endangered, threatened, proposed, or candidate species of an additional 20 years of operation and maintenance of Brunswick would be small, and no additional mitigation is warranted. Similarly, operation of a second plant at the Brunswick site is not expected to adversely affect any Federally listed terrestrial species. However, it is given a conservative rating based on the high number of protected species in the site vicinity

Harris

The following site-specific information on the Harris site was derived from information being developed for the Shearon Harris license extension environmental report (Snead, 2005).

In 1998 CP&L conducted a self assessment that evaluated more than 50 sensitive plant and animal species that could occur in the vicinity of HNP (based on studies prepared by Pacific

Northwest National Laboratories for NRC, and lists prepared by USFWS and North Carolina Natural Heritage Program) and evaluated potential threats to these species from activities at Harris (CP&L 1998b)

The self-assessment identified three potentially occurring Federally listed species in the vicinity of the Harris plant, one of which could potentially be affected by Harris operations, future facility expansion, or other activities: the red-cockaded woodpecker (*picoides borealis*). Red-cockaded woodpeckers, federally listed as endangered, are found in mature pine forests (generally longleaf pine) with sparse understory vegetation. Birds are historically known from near the plant site but have not been seen since 1987. The other two species include the Federally-threatened bald eagles (*Haliaeetus leucocephalus*) and an experimental population of Michaux's sumac (*rhus michauxii*). This is consistent with information provided by the NC HNP, 2005. Listing of rare plant and animal species, NC NHP database updated July 2005, accessed at http://207.4.179.38/nhp/quad.html on October 25, 2005.

Bald eagles are occasionally seen at Harris Reservoir, one active bald eagle nest identified in winter 2005, however, Harris operations, future expansions, or other activities are not expected to affect them. Red-cockaded woodpeckers and bold eagles were also identified as occurring in the vicinity of the site in the FES for operation of Harris (NRC 1983, pp 4-29 and 4-30). The staff does not believe that the Harris site itself provided adequate nesting for foraging habitat for the red-cockaded woodpecker. Although the site provide some pine forest of the density reported to provide adequate habitat for woodpecker colonies, the trees generally are not large enough for the consecution of nest cavities. Most pine stands on the site also are quite dense and contain various hardwood species. Red-cockaded woodpeckers are most successful in maintaining populations in open pine stands with mature trees. Because of the lack of mature pine trees on the site and the invasion of pine stands by various hardwoods, the staff concludes that red-cockaded woodpeckers will not establish reproducing colonies on the site in the near future. Station operation is not expected to adversely affect and individuals that may occasionally visit the site.

In addition, an experimental population of Michaux's sumac (*rhus michauxii*), which is federally and state-lised as endangered, was transplanted in the Harris Research Tract near Harris in 2001, and is being monitored by biologists from North Carolina State University. No other federally or state-listed threatened or endangered species are known to occur at the Harris site. Progress energy has procedures in place to protect endangered or threatened species, if they are encountered at the plant site (or along the transmission corridors), and provides training for employees on these procedures (Progress Energy 2002; Progress Energy 2003b).

Sightings of five bald eagles have occurred since 1972, for along the Cape Fear River southwest of the main reservoir and one in 1981 at the main reservoir. The bald eagle may be beneficially impact by station operation. The presence of the main reservoir at the Harris site and two other large reservoirs within 50 km (31 miles) of the site (B. Everett Jordan reservoir and Falls of the Neuse Reservoir) may tend to attract bald eagles. The main reservoir will provide additional foraging habitat for migrant individuals.

Marion

No site-specific reports on protected species were available for Marion. {

} However, in the absence of any site-specific survey data for Marion, and given that is located near the Robinson site and has similar habitat, Marion was given the same rating as Robinson.

Robinson

One Federally listed and three State listed protected terrestrial species have the potential to occur in the vicinity of the Robinson site (Lake Robinson Quadrangle), although all records are from the northwestern portion of the Lake Robinson Quadrangle. No RTE species occur in the immediate vicinity of the site. The Federal protected species, which is also one of the state-protected species, is the endangered red-cockaded woodpecker (*Picoides borealis*). The data source is the South Carolina Department of Natural Resources (SCDNR). 2003. South Carolina Rare, Threatened & Endangered Species Inventory, accessed at http://www.dnr.state.sc.us/heritage/owa/species.login on October 25, 2005. Note: This is a protected website that is accessible only through SCDNR authorization.

No areas designated by the FWS as critical habitat for endangered species exist on the candidate or adjacent to associated transmission lines.

Overall site rankings are provided below and are based on professional judgment of the comparison of sites; the site rating is the numerical average of sub-criterion ratings, rounded to the nearest whole number.

Ratings with respect to wetlands are carried forward from the previous candidate site screening evaluation (Appendix A) and are essentially unchanged. They are based on the following wetland acreages estimated at each site:

Brunswick – 400.33 acres of wetlands (6000 acre area); 81 acres of wetlands (400 acre area).

Harris – 40.2 acres of wetlands (6000 acre area); 11.5 acres of wetlands (400 acre area).

Marion – 1,034 acres of wetlands (6000 acre area); 246.3 acres of wetlands (400 acre area). Both on and near the site there are significant acreages of freshwater forested wetlands, forested/shrub wetlands, and freshwater emergent wetlands. Much of this wetland area is semi-permanently flooded, consistent with the low lying land in this area. These wetlands are jurisdictional wetlands and a permit from the USACE would be needed prior to disruption or impact. Judging from the low lying nature of the land in this area, dewatering of the site would be necessary which would most likely affect wetlands.

Robinson – 105.8 acres of wetlands (6000 acre area); 49.7 acres of wetlands (400 acre area).

Site ratings based on Important Terrestrial Species/Habitat

Site	Brunswick	Harris	Marion	Robinson
T&E species (terrestrial)	2	4	4	4
Habitat	3	3	3	3
Flexibility	4	4	4	4
Overall Rating	**3**	**4**	**4**	**4**

Site ratings based on Wetlands

Site	Brunswick	Harris	Marion	Robinson
Total Acres	3	5	1	5
Acres of Forested	3	5	1	5
Flexibility	4	5	2	2
Overall Rating	**3**	**5**	**1**	**4**

Taking into account the above terrestrial species and wetland ratings, the sites were given the following composite ratings:

Composite Site Ratings

	Brunswick	Harris	Marion	Robinson
Species	3	4	4	4
Wetlands	3	5	1	4
Avg. Score	**3**	**4**	**2**	**4**

References

NRC 2003. NUREG-1437 Generic Environmental Impact Statement for License Renewal of Nuclear Plants Supplement 13 Regarding H.B. Robinson Steam Electric Plant, Unit No. 2

South Carolina Department of Natural Resources (SCDNR). 2003. South Carolina Rare, Threatened & Endangered Species Inventory. Accessed at http://www.dnr.state.sc.us /heritage/owa/species.login on October 25, 2005. Note: This is a protected website that is accessible only through SCDNR authorization.

North Carolina Natural Heritage Program, 2005. Listing of rare plant and animal species. NC NHP database updated: July 2005. Accessed at http://207.4.179.38/nhp/quad.html on October 25, 2005.

South Carolina Department of Natural Resources (SCDNR). 2001a. *Geographic Database of Rare and Endangered Species*. Accessed at http://www.dnr.state.sc.us/heritage/owa/species.auth on March 7, 2001.

South Carolina Department of Natural Resources (SCDNR). 2001b. *Resources* Accessed at http://www.dnr.state.sc.us/etc/conservation.html on April 3, 2001.

NRC 2005. NUREG-1437 Generic Environmental Impact Statement for License Renewal of

Nuclear Plants Supplement 25 Regarding Brunswick Steam Electric Plant, Units 1 and 2 Draft Report for Comment. August

Information from: NRC, 1983. Final Environmental Statement related to the Operation of Shearon Harris Nuclear Power Plant, Units 1 and 2. NUREG – 0972. U.S. Nuclear Regulatory Commission.

Snead, Paul B., Progress Energy, Personal Communication, Unpublished Draft License Renewal Environmental Report, December 2005.

2.2.2 Dewatering Effects on Adjacent Wetlands
2.2.2.1 Depth to Water Table
2.2.2.2 Proximal Wetlands

Objective – The objective of this criterion is to evaluate the sites with respect to potential impacts from construction related dewatering activities on area wetlands.

Evaluation approach – The evaluation included a review of information related to the depth of the water table and the distance to nearby wetlands. A determination of the extent of wetland acreage within the study area was limited. National Wetland Inventory maps were used for some sites as the basis for determining wetland acreage. Those maps include numerous areas that do not represent jurisdictional wetlands under Section 404 of the Clean Water Act, which contributed to the difficulty in making an estimate of wetland acreage. Moreover, those maps were based primarily on interpretation of aerial photography, and the amount of field validation that was performed varies according to region of the country and local terrain. Site Environmental Reports and other documents developed during the early stages of site licensing were also reviewed. These documents may not necessarily reflect existing wetland conditions at the sites.

Discussion/Results – Wetlands have been evaluated previously (Section B.2.1 of this appendix); depth to groundwater also was identified previously for each site (Section A.3.2 of this appendix) and is summarized as follows: Brunswick 10-20 feet; Harris – 30-90 feet; Marion – { }; and Robinson – 15-30 feet. Potential hydraulic connections among wetlands via groundwater are not known, however.

In light of the previous ratings and groundwater information, the site ratings are as follows:

Site	Brunswick	Harris	Marion	Robinson
Total wetland acreage	3	5	1	5
Acreage of Forested wetlands	3	5	1	5
Depth to Groundwater	3	5	2	4
Overall Rating	**3**	**5**	**1**	**5**

2.3 OPERATIONAL-RELATED EFFECTS ON AQUATIC ECOLOGY

2.3.1 Thermal Discharge Effects
2.3.1.1 Migratory Species Effects
2.3.1.2 Disruption of Important Species/Habitats
2.3.1.3 Water Quality

Objective – No exclusionary or avoidance criteria apply to condenser cooling water system thermal discharges on receiving water bodies (EPRI 2001, Section 3.2.3.1). The objective of this criterion is to address the relative suitability of the four candidate sites with respect to potential thermal impacts. Two specific thermal impact issues were considered:

- disruption of important species and habitats, and
- impact on water quality of the receiving water body.

Information on migratory species (also identified in EPRI criteria) was not collected at each site and therefore is not evaluated as part of this criterion.

Evaluation approach – In December 2001, the EPA published a final regulation, which affects the location, design, construction, and capacity of intake structures for new power plants (EPA 2001). The EPA rule will strongly encourage the use of closed-cycle designs to reduce adverse cooling water system impacts, and it is assumed that new nuclear reactors at the four candidate sites would include closed cooling water systems.

In addition, an important consideration in evaluating the suitability of the sites was the design of condenser cooling system used by the existing unit at each site.

Discussion/Results – Information on the disruption of important species and habitats (aquatic) was provided previously in Section B.1.1 of this appendix. Relative information on existing cooling systems is summarized for each site below.

Brunswick

Thermal effluent from Brunswick is currently discharged through two 13-ft diameter, 2000-ft long submerged pipes that extend into the Atlantic Ocean (AEC 1974). Water depth at the point of discharge is approximately 10 ft. The ocean floor in the vicinity of the discharge pipes is sandy, with no natural hard bottom outcroppings that attract fish (CP&L 1979). The bottom is devoid of attached vegetation and there is a strong westerly tidal and longshore flow in this region. While a number of aquatic species may use the nearshore area surrounding the discharge, the slightly increased temperature above ambient ocean temperature is not enough to cause heat shock in an organism upon the start-up of one or both Brunswick units. Most aquatic organisms, including fish and shellfish, are highly mobile and can avoid the discharge area.

The NPDES permit for Brunswick contains a requirement for semi-annual monitoring of water temperatures at the ocean discharge. Temperature monitoring is to be conducted once during the months of April and November, and once during the months of December and March when both

reactor power levels are 85 percent or greater. Brunswick is able to operate at or near full power in the once-through mode while still meeting State water temperature standards.

Harris

The principle source of water for Harris is a storage reservoir system, which consists of two reservoirs. The Main Reservoir, situated on Buckhorn Creek, is impounded by an earthen dam located just below the confluence of Whiteoak Creek and Buckhorn Creek, while the Auxiliary Reservoir, located on Tom Jack Creek, is formed by an earthen dam situated to the west of the plant island. There are two creeks adjacent to the plant site; Tom Jack Creek to the west and Thomas Creek to the east. No pre-existing ponds or impoundments were located within the boundary of the plant island.

Carolina Power & Light Company has constructed a dam on Buckhorn Creek about 2.5 mi. north of its confluence with the Cape Fear River. This dam has created an approximately 4000-acre reservoir which is used for cooling tower makeup requirements.

Because the Harris site is located on a large reservoir system which would likely provide sufficient heat rejection capacity for a new unit (appropriately located, using a closed cooling water system), plant operation should not have significant thermal impacts to aquatic/marine ecology and water quality. No information was discovered during the evaluation which revealed any concerns with significant thermal impacts at the candidate site locations.

Robinson

The Robinson Steam Electric Plant (Robinson) is located on approximately 2435 ha (6020 ac) of CP&L property in northwestern Darlington and southwestern Chesterfield Counties, including the 911-ha (2250-ac) Lake Robinson. The Darlington County Internal Combustion Turbine Electric Plant is also located on the CP&L property, slightly more than 1.6 km (1 mi) north of Robinson.

The upper 448 km2 (173 mi2) of the Black Creek drainage was impounded in 1958 to create Lake Robinson. The 11-km (7-mi) long lake was designed to accommodate a total plant capacity of approximately 1200 megawatts-electric (MW[e]) (NRC 1975). RNP shares the 6.4 km (4 mi) cooling water discharge canal with Unit 1. In addition to functioning as a cooling pond, the lake supports recreational use and modest fishing.

Because Black Creek was impounded for the purpose of providing cooling water to the Robinson plants, the NRC considers the lake a "cooling pond" by definition. Units 1 and 2 share the cooling water discharge canal that extends approximately 6.4 km (4 mi) to the north of the plant along the western edge of the lake (CP&L 2002). The canal was designed to allow the discharge water to cool somewhat before entering the lake.

Impacts from the thermal effluent to Lake Robinson are apparent near the discharge area, however, the impacts are limited in their extent and do not threaten the continued existence of a balanced and indigenous community of fish and wildlife in and around the lake. The NRC staff

concluded that the potential heat shock impacts resulting from operation of the plant's cooling water discharge system to the aquatic environment on or in the vicinity of the site are small, and mitigation is not warranted. However, because Lake Robinson is the smallest of the three reservoir/ocean sites and potential thermal concerns have been identified with expanded operations at the site, it is given a lower rating, with respect to water quality, than the other sites.

Marion

No site specific data are available for Marion. Ratings are based on limited flow and water quality data for the Pee Dee River, and above-described Marion ratings for cooling water supply (i.e., relates to flow) and disruption of aquatic species/habitat.

In summary, the final set of ratings consisted of two composite ratings: the disruption of important species (based on number of Federally protected aquatic species), as brought forward from Section B.1.1 of this appendix; and existing water quality of the receiving water. With respect to water quality, the size of the receiving water body (heat sink) was the primary factor in assigning ratings (highest rating given to the largest heat sink); cooling water supply information (Section 1.1.2) was considered, as it relates to flow and volume, well as water quality information (Section 2.1.2). The presence of an existing nuclear plant in a site area also was taken into account. The resulting ratings are provided below.

Thermal Discharge Effects	Brunswick	Harris	Marion	Robinson
Presence of important aquatic species	2	5	5	5
Water quality	5	4	3	2
Overall rating	**4**	**4**	**4**	**3**

References

NRC, 2005. NUREG-1437 Generic Environmental Impact Statement for License Renewal of Nuclear Plants Supplement 25 Regarding Brunswick Steam Electric Plant, Units 1 and 2 Draft Report for Comment. August

Progress Energy, (no date). Applicant's Environmental Report – Operating License Renewal Stage, Brunswick Steam Electric Plant Progress Energy

NRC, 2003. NUREG-1437 Generic Environmental Impact Statement for License Renewal of Nuclear Plants Supplement 13 Regarding H.B. Robinson Steam Electric Plant, Unit No. 2
Shearon Harris Nuclear Power Plant Final Safety Analysis Report, Chapter 2.0 Site Characteristics.

2.3.2 Entrainment/Impingement Effects
2.3.2.1 Entrainable Organisms
2.3.2.2 Impingable Organisms

Objective – No exclusionary or avoidance criteria apply to entrainment and impingement impacts from the operation of condenser cooling water systems (EPRI 2001, Section 3.2.3.1). The objective of this criterion is to address the relative suitability of the candidate sites with respect to potential entrainment and impingement impacts.

When cooling water is pumped from water bodies, several environmental impacts can occur. Entrainment refers to the removal of small, drifting organisms with the cooling water. Small fish, fish eggs, phytoplankton, zooplankton, and other aquatic/marine organisms experience high mortality rates as they pass through cooling water pumps and heat exchangers. Impingement refers to larger organisms that are screened out of the cooling water at the intake structure. Impinged organisms can include large fish, crustaceans, turtles, and other aquatic/marine organisms that can not avoid high intake velocities near the intake structure and are trapped on the intake screens.

Evaluation approach – Concerns about entrainment and impingement losses are resource dependent and vary on a site-to-site basis. Typically, power plants with once-through cooling water systems have higher entrainment and impingement impacts than power plants with closed-cycle cooling water systems. The EPA issued a final rule in December 2001 affecting the design of intake structures for new power plants (EPA 2001). These rules encourage the use of closed-cycle systems, which is the type of system assumed to be used by Progress at these sites. Developers of new power plants who choose certainty and faster permitting over greater design flexibility, will be encouraged to limit intake water capacities and velocities and incorporate specific intake screen designs to reduce entrainment and impingement losses.

Discussion/Results – The four candidate sites were evaluated with respect to relative potential for entrainment and impingement impacts for the closed-cycle cooling water system. Proposed facilities at each site will include cooling towers that will reduce the amount of cooling water withdrawal required for plant operation. In addition, proper design of the water intake structure would minimize the potential adverse impacts. In NUREG 1437, NRC concludes that, with cooling towers and appropriate intake design, potential adverse impacts due to entrainment or impingement of aquatic organism are minor and do not significantly disrupt existing populations. Assuming a two unit closed-cycle plant at the site, and 100 percent of the local plankton passing through the plant, it appears that there would be no discernible effect on the plankton population in existing rivers and reservoirs at each site. This is due to the very small volume of water used by the plant relative to the total volume in the river or reservoir at the site. Because of the low flow velocities of a closed cycle plant at the site, impingement of adult fish would be expected to be minimal. Use of a deep water intake would have a minimal effect on entrainment of larval fish.

Site specific data in support of the above conclusion are summarized below for the three existing plants. It is assumed that similar conditions would exist at the Marion site.

Brunswick

Based on information in the GEIS, the Commission found that "Entrainment of phytoplankton and zooplankton has not been found to be a problem at operating nuclear power plants and is not expected to be a problem during the license renewal term." The staff has not identified any new and significant information during its independent review of the CP&L ER, the staff's site visit, the scoping process, or its evaluation of other available information for Brunswick. Therefore, the staff concludes that there are no impacts of entrainment of phytoplankton and zooplankton during the license renewal term beyond those discussed in NUREG 1437.

The NPDES permit issued by the NCDENR governs the operational impacts to the aquatic environment. Operation under the NPDES permit should result in the maintenance of a balanced, indigenous population of fish, shellfish, and other aquatic organisms, both in the Cape Fear Estuary and Atlantic Ocean in the vicinity of the discharge structure. Based on a review of the available information relative to potential impacts of the cooling water intake system on the entrainment of fish and shellfish in early life stages and on the success of the mitigative measures already in place at Brunswick, the staff concludes that the potential impacts are SMALL, and no additional mitigation is warranted. In addition, based on a review of the available information relative to potential impacts of the cooling water intake system on the impingement of fish and shellfish, and on the success of mitigative measures already in place at Brunswick that reduce impingement and mortality caused by impingement, the staff concludes that the potential impacts are SMALL, and no additional mitigation is warranted.

Harris

Impingement and entrainment of aquatic biota are not expected to result in detrimental impacts to any species.

The Cape Fear River intake structure for the existing nuclear station incorporates design features to minimize entrapment/impingement of fish, i.e. flush shoreline placement and low approach velocity ($\leq$ 0.5 fps). The species in the vicinity of the river intake that are most susceptible to impingement are the gizzard shad (particularly during winter) and juvenile sunfishes (during summer). Populations of these species will not be impacted by the expected impingement losses because the species are distributed throughout the river and tributary streams. The cooling tower makeup intake in designed wit low approach velocity and, although the design includes an approach channel that could be attractive to some species, the low velocity should minimize entrapment of fish. The anticipated losses, predominantly of gizzard shad, will not impact the species population nor the populations of piscivorous game species that will utilize shad as their reservoir forage base.

On an annual average basis, the Harris plant will use less than 1% of the Cape Fear River flow. Entrainment losses of this relative magnitude on an annual basis should not impact the river biota.

All organisms entrained in the cooling tower makeup flow from the main reservoir are assumed to be killed. Makeup for the two-unit plant will be 2.6m^3 / sec (93cfs), which represents an average daily withdrawal of 0.05 to 0.1% of the total reservoir storage volume. This low level of entrainment loss will not impact aquatic biota of the reservoir.

Robinson

There are no ongoing studies monitoring entrainment of fish or shellfish at Robinson. In the original 316(b) demonstration, entrainment of ichthyoplankton was addressed based on studies conducted on a weekly basis between March 1975 and February 1976. Duplicate samples were collected during day and night using plankton nets. During the study period, no fish eggs were collected, though larval fish were collected during every month but January. Of all the fish collected, 93.8 percent were percids (perch and darters). Other larval fish entrained included 2.6 percent centrarchids (sunfish) and 0.3 percent catastomids (chubsuckers). The remaining fish (3.3 percent) could not be identified to family. None of the species entrained are known to prefer pelagic areas (e.g., near the intake structure) for spawning. However, based on early CP&L ichthyoplankton sampling conducted in the lower impoundment and discharge areas, there is evidence that darters may move into pelagic areas soon after spawning (CP&L 1976a). The continued presence and abundance of darters in the lake during the early studies (4 years after initial Unit 2 operation) suggested that the effects of entrainment on their population were negligible (CP&L 1976a). More recent declines in the darter population are attributed to other habitat changes, non-native species introductions, and competitive interactions that have increased since the 1982 replacement of brass condenser tubes with tubes that reduced copper concentrations in the lake (CP&L 2002).

Based on the results of entrainment studies and operating history of the Robinson intake, the NRC staff has reviewed the available information (in support of recent relicensing) and concludes that the potential impacts of the cooling water intake system's entrainment on fish and shellfish in the early life stages are SMALL, and therefore, no additional mitigation is warranted. Furthermore, Robinson will be required to comply with any future requirements imposed in its NPDES permit by EPA or SCDHEC, thus ensuring that entrainment impacts at Robinson will continue to be SMALL in the future.

A new study monitoring impingement of fish or shellfish at Robinson began in December 2005. Results will not be available for some time, however. Based on earlier studies, there appear to be no significant impacts to the fish population from impingement on the intake screens. In the original 316(b) demonstration, impingement of fish was addressed based on studies conducted on a monthly basis (48-hr samples) between December 1973 and July 1975. Sampling continued on a weekly basis (24-hr samples) from July 1975 through December 1975. An initial screen washing was followed every 12 hr by additional screen washes. Fish washed from the screens were identified, weighed, and measured. Impingement of fish at the Unit 2 intake averaged 866 fish per day in 1974 and 291 fish per day in 1975. Of these, bluegill made up 74 percent and 57 percent of the biomass in 1974 and 1975, respectively. Most bluegill impinged were less than 115 mm (4.5 in.) in length. Chain pickerel *(Esox niger)* were the next most common species impinged, comprising 14 percent and 28 percent of the biomass in 1974 and 1975, respectively. Maximum impingement occurred during the summer, and minimum impingement occurred during the winter. Fewer fish were impinged on Unit 1 intake screens than on those of Unit 2

because Unit 1 draws less water through the intake pumps. The continued abundance of bluegill in the lake indicates that there are no significant impacts to the fish population from impingement on the intake screens.

The NRC staff has reviewed the available information relative to potential impacts of the cooling water intake on the impingement of fish and shellfish and, based on this data, concludes that the potential impacts are small, and no additional mitigation is warranted. Furthermore, Robinson will be required to comply with any future requirements imposed in its NPDES permit, thus ensuring that impingement impacts at Robinson will continue to be small in the future.

Results – Given the above information, all sites are given the same conservative rating of 3.

Entrainment/Impingement Potential Impact (Closed cycle cooling system design)	**Brunswick**	**Harris**	**Marion**	**Robinson**
Rating	**3**	**3**	**3**	**3**

References

NRC, 2003. NUREG-1437 Generic Environmental Impact Statement for License Renewal of Nuclear Plants Supplement 13 Regarding H.B. Robinson Steam Electric Plant, Unit No. 2

NRC, 2005. NUREG-1437 Generic Environmental Impact Statement for License Renewal of Nuclear Plants Supplement 25 Regarding Brunswick Steam Electric Plant, Units 1 and 2 Draft Report for Comment. August

Final Environmental Statement related to the Operation of Shearon Harris Nuclear Power Plant, Units 1 and 2. NUREG – 0972. U.S. Nuclear Regulatory Commission.

2.3.3 Dredging/Disposal Effects
2.3.3.1 Upstream Contamination Sources
2.3.3.2 Sedimentation Rates

Objective – The purpose of the section is to evaluate the sites for potential environmental impacts related to maintenance dredging at the intake structure. No specific exclusionary or avoidance criteria apply to this issue. The following evaluation, therefore, is a summary of available information related to the relative suitability of the sites.

Evaluation approach – Sites with high levels of contaminated sediment deposition at the intake structure will experience higher maintenance costs for the removal and disposal of the dredged material. Two factors were considered in performing the evaluation:

- The level of upstream contamination, and
- The rate of sedimentation at the site.

As addressed in Section B.1.2 (Contaminated Sediments), no site-specific information about the level of sediment contamination at the sites was identified. Results in Section B.1.2 were based on EPA data, which addressed general trends in levels of contamination in the water bodies at the candidate sites, and general water quality information for the major water bodies on which the candidate sites are located. Sedimentation rates are assumed to be the same at each site except Brunswick and were given a conservative rating of 3 based on incomplete information. While Brunswick is assumed to have relatively low fine sediment deposition rates (which are preferred) compared to the other candidate sites given its location near the coastline, it requires routine maintenance dredging to keep the intake structure clear. Such site-specific conditions at Brunswick result in an added penalty on sedimentation rates at the site.

Based on available information, the sites were rated according to the expected levels of contamination and sedimentation rates for the general area of the four sites. Sites with the lowest concentration of heavy metals and toxic organic compounds and the lowest sediment rates are the most suitable and were assigned a score of 5.

Discussion/Results – The results are summarized in the table below.

Dredging/Disposal Effects	Brunswick	Harris	Marion	Robinson
Upstream Contamination Sources	4	4	2	2
Sedimentation Rates	2	3	3	3
Rating	**3**	**4**	**3**	**3**

2.4 OPERATIONAL-RELATED EFFECTS ON TERRESTRIAL ECOLOGY

2.4.1 Drift Effects on Surrounding Areas

2.4.1.1 Important Species/Habitat Areas
2.4.1.2 Source Water Suitability

Objective – The objective of this criterion is to evaluate the relative suitability of the candidate sites with respect to potential concerns with cooling tower drift effects. This evaluation considered the potential effects on surrounding areas and the suitability of the cooling water source (EPRI 2001). This issue does not apply to sites for which once-through cooling water systems are selected.

Cooling Tower Drift

In every cooling tower, there is a loss of water to the environment in the form of pure water, which results from the evaporative cooling process. This evaporated water leaves the tower in a pure vapor state, and thus presents no threat to the environment. Drift, however, is the undesirable loss of liquid water to the environment, via small unevaporated droplets that become entrained in the exhaust air stream of a cooling tower. These water droplets carry with them minerals, debris and microorganisms and water treatment chemicals from the circulating water, thus potentially impacting the environment. High drift losses are typically caused by fouled, inefficient or damaged drift eliminators, excessive exit velocities or imbalances in water chemistry.

Minimizing drift losses in a cooling tower reduces the risk of impacting the environment. The principle environmental concern with cooling tower drift impacts are related to the emission and downwind deposition of cooling water salts (EPA 1987). Salt deposition can adversely affect sensitive plant and animal communities through changes in water and soil chemistry.

Evaluation approach – Sites considered with the most sensitive environments were assigned lower rating values. Sites with highest concentrations of dissolved solids and other potential contaminants in cooling tower makeup were also assigned lower rating values.

Discussion/Results – Information regarding important terrestrial and aquatic plant and animal communities, habitats, and wetlands in the vicinity of the candidate sites were previously addressed in Section B.1.1 (Disruption of Important Species/Habitats) and Section B.2.1 (Disruption of Important Species/Habitats and Wetlands). Cooling water makeup water quality is also taken into account. It is assumed to be similar at three of the sites – and given a conservative sub-rating of 3. However, the fourth site, Brunswick, was given a lower rating due to its proximity to the ocean and greater likelihood of its cooling water being brackish and containing more salt.

In NUREG 1437 NRC concludes potential adverse impacts due to drift from cooling towers to surrounding plants, including crops and ornamental vegetation, natural plant communities, and soils, is expected to be minor. This potential impact can be minimized with the use of drift eliminators on the cooling towers. In addition, from previous evaluations conducted for Harris (NRC 1983), NRC staff do not believe that salt will accumulate in the soil to levels potentially

harmful to vegetation due to the diluting effect of rainfall. Based on the staff's knowledge of drift studies at plants having freshwater natural draft cooling towers, expected drift levels from operation of the new plants are not likely to adversely impact terrestrial biota.

A summary of the rating values are shown in the table below.

Criteria	Brunswick	Harris	Marion	Robinson
Important Species Habitat Areas – aquatic	3	4	4	4
Important Species Habitat Areas – terrestrial	3	4	4	4
Source water suitability	2	3	3	3
Potential for impact based on NUREG 1437	5	5	5	5
Rating	**3**	**4**	**4**	**4**

References

NRC, 1996. Generic Environmental Impact Statement for License Renewal of Nuclear Plants (NUREG-1437 Vol. 1) Division of Regulatory Applications, Office of Nuclear Regulatory Research, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001

NRC, 1983. Final Environmental Statement related to the Operation of Shearon Harris Nuclear Power Plant, Units 1 and 2. NUREG – 0972. U.S. Nuclear Regulatory Commission.

3. SOCIOECONOMICS CRITERIA

3.1. SOCIOECONOMICS - CONSTRUCTION RELATED EFFECTS

Objective – The objective of this criterion is to evaluate the relative suitability of the site with respect to the number of construction workers who will move into the plant site vicinity with their families; and the capacity of the communities surrounding the plant site to absorb this new temporary (in-migrant) population.

Evaluation approach – The number of in-migrant workers is dependent on labor availability within commuting distance of the plant site. If an adequate supply of workers is available within reasonable commuting distance, few, if any workers, would choose to relocate to the site. The capacity of communities to absorb an increase in population depends on the availability of sufficient resources, such as adequate housing and community services to support the influx.

Steps 1 and 2 (Exclusionary and Avoidance criteria) are not applicable to this criterion. The plant construction workforce is likely to be available at any of the sites under consideration. The issue in siting, therefore, is the potential socioeconomic impact associated with any temporary influx of construction workers who live too far away to commute daily from their residence. With respect to suitability of the sites under consideration by Progress, socioeconomic impacts of nuclear power plant construction are directly related to two factors:

- number of construction workers who will move into the plant site vicinity with their families; and
- capacity of the communities surrounding the plant site to absorb this new temporary (in-migrant) population.

The number of in-migrant workers is dependent on labor availability within commuting distance of the plant site. If an adequate supply of workers is available within reasonable commuting distance, few (if any) workers would choose to relocate to the site vicinity. The capacity of communities to absorb an increase in population depends on the availability of sufficient resources, such as adequate housing and community services (e.g., schools, hospitals, police, transportation systems, and fire protection) to support the influx without straining existing services. Impacts to a small community located along the commuter route(s) (e.g., food, lodging, gas, and congestion) can also be significant and should be considered. The information that should be considered in rating sites from the perspective of construction impacts includes labor requirements, location of labor pool, number of immigrants, and the economic structure of affected communities.

Before the data could be compared between sites and the sites rated, certain assumptions were made regarding the construction labor requirements and construction schedule, labor pool, and affected area. Many of these assumptions were made without the benefit of site-specific information and may warrant future revision when site-specific data become available (i.e., full NEPA documentation for original plant construction and operation can be reviewed, and/or site-specific plant personnel can be interviewed regarding actual impacts from original plant construction). For purposes of this report, assumptions are based on professional judgment, the AP 1000 Siting Guide, and information contained in the U.S. Nuclear Regulatory Commission's

Generic Environmental Impact Statement for License Renewal for Nuclear Plants (NUREG 1437) (May 1996).

ASSUMPTIONS

According to AP 1000 Siting Guide, plant workforce (construction) indicates a monthly maximum construction workforce requirement of 1000 persons per unit. Construction of a nuclear power plant is very labor-intensive and for the AP 1000, skilled and unskilled construction workers would likely be needed over a 4 to 5 year period. The following assumptions were used in this analysis.

- **Ratings are based on the assumption that two units would be constructed at a given site.**
- **Construction would require a peak construction work force of 2000 workers (1000 per unit); this estimate is not necessarily the "worst-case" but assumed to be a "realistic" estimate for purposes of site comparison.**
- **Analysis assumes that no other major construction project would occur in the site vicinity concurrently with the plant construction and operation. Thus, sites were rated without consideration of potential cumulative impacts of other potential demands for labor.**

Available population and economic data were obtained from the US Census Bureau for each site. The data were collected by county to determine availability of an adequate labor force within commuting distance (based on an assumed location of the labor pool). Data relating to population and labor force (primarily construction industry) were compared with the construction labor requirement to determine availability of labor.

The study of economic structure examines employment because of its pre-eminent role in determining economic well-being of an area. Specifically, impacts are determined by comparing the number of direct and indirect jobs created by plant's construction with total employment of the local study area at the time of construction. Sites were rated according to economic impacts based on the following criteria: economic effects were considered small if peak construction related employment accounted for less than 5 percent of total study area employment; moderate if it accounted for 5 to 10 percent of total study area employment; and large if it accounted for more than 10 percent of total study area employment.

Discussion.- The available population and work force data are presented in the following tables.

Brunswick Site Population and Work Force

County (Projected Growth 2000-2010)	Total Pop (2000)	Total Pop (2010)	Total Employed Work Force (2000)	Total Construction Workforce (2000)
Brunswick [43.5]	73,143	104,960	32,355	6140
Columbus [10.4]	54,749	60,443	20,957	3183
New Hanover [33.3]	160,307	213,689	81,238	8,682

County (Projected Growth 2000-2010)	Total Pop (2000)	Total Pop (2010)	Total Employed Work Force (2000)	Total Construction Workforce (2000)
Pender [42.4]	41,082	58,500	17,896	2915
Total	**329,281**	**437,592**	**152,446 (1.3%)**	**20,920 (9.5%)**

Source: U.S.Census Bureau, http://quickfacts.census.gov/qfd/ for NC and SC

Harris Site Population and Work Force

County (Projected Growth 2000-2010)	Total Pop (2000)	Total Pop (2010)	Total Employed Work Force (2000)	Total Construction Workforce (2000)
Chatham (26.6)	49,329	62,450	25,095	2,872
Harnett (34.2)	91,025	122,155	39,096	6,058
Durham (22.8)	223,314	274,230	114,375	9,536
Orange (26.2)	118,227	149,202	62,509	4,572
Wake (47.3)	627,846	924,817	343,426	26.846
Total	**1,109,741**	**1,532,854**	**543,500 (0 .3%)**	**49,884 (4%)**

Source: U.S.Census Bureau, http://quickfacts.census.gov/qfd/ for NC and SC

Marion Site Population and Work Force

County (Projected Growth 2000-2010)	Total Pop (2000)	Total Pop (2010)	Total Employed Work Force (2000)	Total Construction Workforce (2000)
Marion (4.6)	35,466	37,100	14,100	1,484
Florence (10)	125,761	138,337	55,619	6,132
Dillon (5.5)	31,289	33,101	12,427	1,459
Darlington (9.0)	67,394	73,460	28,779	3,074
Total	**259,910**	**282,000 (0.6%)**	**110,925**	**12,149 (16%)**

Source: U.S.Census Bureau, http://quickfacts.census.gov/qfd/ for NC and SC

Robinson Site Population and Work Force

County (Projected Growth 2000-2010)	Total Pop (2000)	Total Pop (2010)	Total Employed Work Force (2000)	Total Construction Workforce (2000)
Darlington (9.0)	67,394	73,460	28,779	3,074
Chesterfield (10.9)	42,768	47430	17,691	2,123
Lee (9.1)	20,119	21,950	7,480	880
Kershaw (20.8)	52,647	63,600	25,005	3,073
Sumter (3.3)	104,646	108,100	41,372	4,704
Total	**287,574**	**314,540 (1.7%)**	**120,327**	**13,854 (14.4%)**

Source: U.S.Census Bureau, http://quickfacts.census.gov/qfd/ for NC and SC

Results

Although the results show higher population and workforce numbers available at Harris and Brunswick, the overall population levels for all four sites in 2010 when construction is anticipated to start, are sufficiently large that the impact on study area employment from construction of two new units would be low at each site. This is based on conservative workforce levels using 2000 Census Bureau data (without expected increases in 2010), although such increases might be used to support other large (non-nuclear) construction projects at that time). All sites show a percentage increase less than 5% when compared to total study area workforce (less than 0.2% for Brunswick and Harris sites and less than 2% for Marion and Robinson sites); and Brunswick and Harris show a percentage increase less than 10% when compared to the total 2000 construction workforce, while Marion and Robinson show a 14-16% increase.

Because of the large population projections and available workforce at Brunswick and Harris, it was assumed that 100% of the workforce at each site would commute from within the area and there would be no in-migrant workforce population. As such, there would be no demands on housing and community services. Based on this information alone, both of these sites would receive a rating of 5.

Given the lower general population estimates and the lower (existing) construction workforce to draw from at the Marion and Robinson sites, an additional analysis was conducted for these two sites to consider the impacts of workers in-migrating to these two areas. We have identified the following assumptions to help address potential impacts on local community services and housing:

- 50% of workers will in-migrate (1000 workers) [Note that when comparing the remaining 1000 workers to the existing construction workforce at Marion and Robinson, the increase is less than 10% and no significant worker impacts would be expected.]

- 50% of these workers bring their families (2.5 additional persons per family) (1250)

- Influx of direct workers also brings in influx of indirect workers (0.4 ratio of direct to indirect workers – in absence of site-specific information - pertaining to the Regional Industrial Multiplier System direct/indirect ratios calculated for each plant (as found in NUREG/CR-2749) (400)

- 50% of these indirect workers bring their families (2.5 additional persons per family) (500)

Thus an influx of 1000 workers is predicted to results in a total population influx of 3150 persons.

When this population influx is compared to the total population projections in 2010 for the Marion and Robinson site areas, the increase is only about 1%. Therefore, the impact on housing and community services would be expected to be negligible.

In general, all four sites are within reasonable commuting distance from a large city or metropolitan area. Each study area appears to have sufficient population centers within commuting distance and/or has experienced tremendous growth since 1990 such that its public services sector would be able to absorb the population in-migration associated with plant construction with minimal impact.

Finally, before assigning a final rating, this evaluation also incorporates more recent findings from a study conducted by Dominion Energy Inc., Bechtel Power Corporation, TLG, Inc., and MPR Associates for the US Department of Energy (2004) entitled: *Study of Construction Technologies and Schedules, O&M Staffing and Cost, Decommissioning Costs and Funding Requirements for Advanced Reactor Designs*. This report includes a more accurate and up-to-date assessment of labor availability that takes into account a U.S. labor pool that is aging and diminishing in number and skill level (with retirement of the baby boom generation that constructed the first set of nuclear power plants). It recognizes that attracting craft with the high skill levels and regulatory employment criteria for new nuclear plant construction is expected to be difficult given that the group of craft currently doing nuclear work is significantly smaller than the total construction craft population, and is in higher demand because of the higher skill levels and greater capability to meet strict employment standards (e.g., scrutiny of NRC background check). However, in an effort to reduce or minimize the labor supply concerns associated with new nuclear plant construction projects, a new strategy has been identified that would shift portions of the work force to areas of the country where skills and craft are available in sufficient quantity (national workforce). This would most effectively be done through modularizing portions of the plants to be built, and providing aggressive training of craftsmen before and during the construction phase of the project. Modularization is anticipated to become an important aspect of new nuclear construction.

Therefore, in light of the results above, this latest information and using best professional judgment, a comparison of socioeconomic conditions between the four candidate sites reveals minimal differences such that all are given the same rating.

Socioeconomic - Construction	Brunswick	Harris	Marion	Robinson
Rating	5	5	5	5

3.2 SOCIOECONOMICS – OPERATION

Socioeconomic impacts of operation relate primarily to the benefits afforded to local communities as a result of the plant's presence (e.g., tax plans, local emergency planning support, educational program support). These benefits tend to be a function of negotiations between the plant owner and local government; they are not indicative of inherent site conditions that affect relative suitability between sites. In addition, three of the four sites have previously demonstrated that their local economies can support existing plant operations, and an additional unit will not adversely affect an area that has already shown its ability to support existing units. This criterion is not applicable to a comparison of the four candidate sites, and in accordance with guidance in the Siting Guide, suitability scores were not developed.

3.3 ENVIRONMENTAL JUSTICE

Objective – The objective of this criterion is to ensure that the effects of proposed actions do not result in disproportionate adverse impacts to minority and low-income communities. In comparing sites, this principle is evaluated on the basis of whether any disproportionate impacts to these communities are significantly different when comparing one site to another.

Evaluation approach – The first step in this evaluation is to collect and compare population data for minorities and low-income populations across sites.

However, two additional questions comprising this evaluation also are relevant:
1. Does the proposed action result in significant adverse impacts?
2. Are impacts to minority or low-income populations significantly different between sites?

If the answer to the first question is "no" for all sites (i.e., no significant health and safety impacts are identified), then there would be no environmental justice concerns, regardless of the percentage of minority or low-income populations found within the surrounding communities of a site(s). If the answer to the first question is "yes" (i.e., significant health and safety impacts are expected), environmental justice concerns are relevant to site selection only if the answer to the second question is also "yes" (i.e., disproportionate adverse impacts on minority or low-income populations are identified at one or more sites, thereby resulting in significant differences between sites).

Discussion – With regard to the sites under consideration, related environmental justice information is summarized for each candidate site below:

Brunswick Site Minority and Low Income Population/Percentages

County	Population (2000)	White	Black (%)	Hispanic (%)	Low Income (population)
Brunswick	73,143	82.3% (60200)	14.4	2.7	12.6% (9,216)
Columbus	54,749	63.4 (34,737)	30.9	2.3	22.7% (12,430)
New Hanover	160,307	79.9 (128,098)	17	2.0	13.1% (21,000)
Pender	41,082	72.7 (29,882)	23.6	3.6	13.6% (5,587)
Total	**329,281**	**76.8% (252,887)**	**23.2% minority (76,393)**		**14.6% (48,233)**

Source: U.S.Census Bureau, http://quickfacts.census.gov/qfd/ for NC and SC

Harris Site Minority and Low Income Population/Percentages

County	Population (2000)	White	Black (%)	Hispanic (%)	Low Income
Chatham	49,329	74.9% (36969)	17.1	9.5	9.7% (4,785)
Harnett	91,025	71.1 (64744)	22.5	5.9	14.9 (13,560)
Durham	223,314	50.9 (113698)	39.5	7.6	13.4 (29,920)
Orange	118,227	78.0 (92272)	13.8	4.5	14.1 (16,670)
Wake	627,846	72.4 (454544)	19.7	5.4	7.8 (48,970)
Total	**1,109,741**	**68.7% (762,392)**	**32.3% minority (358,446)**		**10.3 (113,905)**

Source: U.S.Census Bureau, http://quickfacts.census.gov/qfd/ for NC and SC

Marion Site Minority and Low Income Population/Percentages

County	Population (2000)	White	Black (%)	Hispanic (%)	Low Income
Marion	35,466	41.7% (14,787)	56.3	1.8	23.2% (8,228)
Florence	125,761	58.7 (73,760)	39.3	1.1	16.4 (20,625)
Dillon	31,289	50.4 (15,481)	45.3	1.8	24.2 (7,572)
Darlington	67,394	57.0 (38,402)	41.7	1.0	20.3 (13,680)
Total	**259,910**	**54.6 (141,910)**	**45.4% minority (118,000)**		**19.3 (50,105)**

Source: U.S.Census Bureau, http://quickfacts.census.gov/qfd/ for NC and SC

Robinson Site Minority and Low Income Population/Percentages

County	Population (2000)	White	Black (%)	Hispanic (%)	Low Income
Darlington	67,394	57.0% (38,402)	41.7	1.0	20.3% (13,680)
Chesterfield	42,768	64.3 (27,500)	33.2	2.3	20.3 (8,682)
Lee	20,119	35 (7,048)	63.6	1.3	21.8 (4,386)
Kershaw	52,647	71.6 (37,701)	26.3	1.7	12.8 (6,739)
Sumter	104,646	50.1 (52,462)	46.7	1.8	16.2 (16,953)
Total	**287,574**	**56.7 (163,305)**	**43.3% minority (124,520)**		**17.5 (50,440)**

Source: U.S.Census Bureau, http://quickfacts.census.gov/qfd/ for NC and SC

Results

Environmental justice data for the four sites are summarized below.

Site	Population (2000)	White (%)	Minority (%)	Low Income (%)
Brunswick (NC)	329,281	76.8	23.2	14.6
Harris (NC)	1,109,741	68.7	32.3	10.3
Marion (SC)	{ }	{ }	{ }	{ }
Robinson (SC)	287,574	56.7	43.3	17.5

*State Average for SC is 67.2% white [32.8% minority] and 14.1% below poverty line. State Average for NC is 72.1% white [27.9% minority] and 12.3.0% below poverty line.

- Large minority populations (20% or higher) are found at all four sites
- {
  }
- {
  }
- Low income population higher than the state average is found at the Brunswick site; minority population higher than the state average is found at the Harris site.
- No significant health impacts to human populations were identified at any of the sites under consideration.

- Low-income population at Robinson has directly benefited from economic impacts of the existing plant at Robinson. {

}

Based on professional judgment in factoring in the above percentages alone, the site ratings are as follows:

Environmental Justice	Brunswick	Harris	Marion	Robinson
Rating	4	4	2	2

However, given that no significant impacts to any human populations are expected to occur at any of the sites under consideration, there cannot be significant disproportionate impacts to minority or low-income populations; and based on actual employment experience, positive economic benefits have been shown to be available to all members of the population, without regard to income or ethnicity.

While disproportionate adverse impacts could be expected to occur to minority or low-income populations at each site, if significant health and safety impacts were expected from a new nuclear reactor, no significant health and safety impacts are expected to human populations from reactor operations. Therefore, if no significant health and safety impacts are identified from reactor construction and operation, then there would be no environmental justice concerns, regardless of the percentage of minority or low-income populations found within the surrounding communities. Therefore, no significant differences in environmental justice impacts are expected between the candidate sites and each should receive a final comparative rating of 5.

Based on this analysis, there is no basis for differentiation between sites from an environmental justice perspective, despite differences in the percentages of minority and low-income populations found within the surrounding communities of each site. All sites are found to be equally and highly suitable. Therefore, the site ratings are as follows:

Environmental Justice	Brunswick	Harris	Marion	Robinson
Rating	5	5	5	5

3.4 LAND USE

3.4.1 Construction- and Operation-Related Effects

Objective - The objective of this criterion is to evaluate the suitability of the four candidate sites with respect to potential conflicts in existing land uses at each site. No exclusionary or avoidance criteria apply to this issue.

Evaluation Approach – The evaluation is based on the compatibility of a new nuclear station with existing land uses, including any significant historic resources.

Discussion/Results

For Brunswick, Harris, and Robinson, land to be used for new units is already owned by Progress and is already zoned for uses compatible with development of a new unit; existing units are integrated into the surrounding land use patterns.

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Land Use	Brunswick	Harris	Marion	Robinson
Rating	5	5	2	5

4. ENGINEERING AND COST-RELATED CRITERIA

4.1 HEALTH AND SAFETY RELATED CRITERIA

4.1.1 Water Supply

Objective – The purpose of this criterion is to evaluate relative differences in the design and construction cost of developing water supply facilities.

Evaluation approach – Sites with local conditions that would require additional engineering costs to develop water supply capability (e.g., reservoirs to address water supply limitations or reliability issues (e.g., low flow constraints)) are rated lower than sites with no such requirements.

Discussion/Results

Site ratings are based on professional judgment, taking into account major river body flows (average annual and low flow/drought conditions), as well as the size and extent of on-site reservoirs. Sites with no anticipated reservoir requirements received a 5; other ratings relate to anticipated reservoir requirements.

The Brunswick, Harris, and Robinson sites are all located near large bodies of water, and additional water supply may not be required; all three sites are given a 5. In contrast, the Marion site { } Because reservoir construction is more likely at this site, it is given a rating of 3.

Water Supply	Brunswick	Harris	Marion	Robinson
Rating	5	5	3	5

4.1.2 Pumping Distance

Objective – The purpose of this criterion is to evaluate relative differences in the operational costs associated with pumping makeup water from the source water body to the plant.

Evaluation approach – Sites located large distances from their makeup water supply source are rated lower than those located adjacent to the source. In general, the cost differential is expected to be a linear function of distance from the water source.

Discussion/Results - Precise intake and discharge locations have not yet been determined for the proposed sites as final plant locations and reservoir requirements/locations have yet to be determined. The Brunswick, Harris, and Robinson sites are all located near large bodies of water, and pumping distances are expected to be relatively short. In contrast, the Marion Site will likely require construction of a reservoir, and pumping distances may be longer at that site,

depending on reservoir siting. Therefore, the Marion Site is the least desirable site with respect to pumping distance.

Pumping Distance	Brunswick	Harris	Marion	Robinson
Rating	5	5	3	5

4.1.3 Flooding

Objective – The purpose of this criterion is to rate sites with respect to differential costs associated with construction of flood protection structures necessary to address probable maximum floods at the sites under consideration.

Evaluation approach – Sites with the largest differences between site grade elevation and likely flood elevations are rated highest; sites with plant grade at or near flood level are rated lowest.

Discussion/Results

Since final plant layout locations have not been set for any of the sites, a comparison was based on existing plant grade elevations for Brunswick, Harris and Robinson and the probable maximum flood elevation, using existing reports. For Marion, a comparison was based on the highest point at the site and the 100-year floodplain elevation. Three of the candidate sites are located at elevations where flood protection for the new plant would be required. These sites have been rated a 1. One of the sites is not projected to require engineered flood protection and has been assigned a rating of 3.

Brunswick – The site is located on the Cape Fear River on the South Carolina coast at elevations of 20-25 feet MSL [nominal plant grade is 20 feet MSL). The nominal plant grade of 20 feet MSL results in 2 feet of water depth surrounding the plant during the maximum surge conditions. All safety related structures at the current plant are waterproofed to elevation 22 feet MSL and new safety related structures are projected to require protection as well.

Harris – Plant grade elevation is at 260 feet msl. The PMP (based on the conservative assumption that that there would be no loss of water from infiltration, evaporation and a completely blocked drainage system) would result in a flood elevation of 261.27 feet – slightly above plant grade elevation. Flood protection features are currently in place to protect existing safety related structures and are projected to be required for a new plant.

Marion – The site is generally low in elevation, with considerable onsite and surrounding swamp land. The general site elevation appears to be at or even slightly below that of the 100-year floodplain. A PMF elevation has not been determined, but for the purpose of this analysis it can be estimated to be higher than 100-year flood. Based on this conservative assumption, the site grade could be below PMF. In addition to the need for engineered flood protection for the plant, environmental impacts on floodplains may also need to be addressed.

Robinson – Grade elevation at the plant site is 225 feet; the site lies on a 2250-acre lake. The PMF was based on PMP conditions (20 inches in 48 hours from a postulated hurricane); modeling showed a resulting flow of 30,000 cfs, but the site would still be above flood elevation in this scenario. The spillway is designed to pass a flow of 40,000 cfs which would result in a lake level of 221.67 feet. No flood protection is projected for a new plant located at Robinson.

Flooding	Brunswick	Harris	Marion	Robinson
Rating	1	1	1	3

4.1.4 Vibratory Ground Motion – *Deleted from evaluation*

The objective of this criterion is to provide a relative measure of cost associated with designing to different seismic requirements at different sites. Because all of the sites under consideration are expected to meet the site parameters for seismic design of the standardized designs under consideration, this criterion is not applicable to the Progress site selection process. It is noted that regional USGS data on the Marion site indicate that the Peak Ground Acceleration at the site may be near that for which certified plants are designed. Site investigations necessary to verify that the site is suitable for a certified design could result in additional costs of development.

4.1.5 Civil Works

Objective – The objective of this criterion (formerly titled "soil stability") is to rate sites according to differences in the cost of civil works (e.g., non-flood related berms, stabilizing of graded slopes and banks) necessary to prepare the site for nuclear plant development.

Evaluation approach – Sites are rated highest to lowest according to the estimated level of cost of civil works required at each site.

Discussion/Results

The three existing candidate sites (Brunswick, Harris and Robinson) are located at operating plants that have been previously developed and have been shown to be capable of supporting conventional foundation designs. No significant cost variations can be identified at this time due to differences in the requirement for civil works. Accordingly, the three existing sites are assigned a median rating of 3.

The Marion site is a Greenfield site located in a low lying area surrounded by wetlands and swamps. {

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Civil Works	Brunswick	Harris	Marion	Robinson
Rating	3	3	2	3

4.2 TRANSPORTATION OR TRANSMISSION-RELATED CRITERIA

4.2.1 Railroad Access

Objective – The purpose of this criterion is to rate sites according to the relative costs associated with providing rail access.

Evaluation approach – Ratings for this criterion are based on the straight line distances from each site to the closest rail spur or rail line, scaled from those discussed in Appendix A, Criterion P7).

Discussion/Results

Brunswick – The proposed site is located near the existing Brunswick Nuclear Power Plant. As such, on-site railroad access is already provided in the immediate vicinity of the proposed site. While some construction/modification is expected to link the new site, the site is assigned a rating of 5 since rail access already exists at the site [0.1 mile to existing rail at cost of $300,000].

Harris – The proposed site is located near the existing Harris Nuclear Power Plant. As such, on-site railroad access is already provided in the immediate vicinity of the proposed site from the Seaboard line. While some construction/modification is expected to link the new site, the site is assigned a rating of 5 since rail access already exists at the site [0.2 mile to existing rail at cost of $600,000].

Marion – {

} A rating of 3 has been assigned.

Robinson – The proposed site is located near the existing H.B. Robinson Nuclear Power Plant. As such, on-site railroad access is already provided in the immediate vicinity of the proposed site. While some construction/modification is expected to link the new site, the site is assigned a rating of 5 since rail access already exists at the site.[0.2 mile to existing rail at cost of $600,000].

Railroad Access	Brunswick	Harris	Marion	Robinson
Rating	5	5	3	5

4.2.2 Highway Access

Objective – The purpose of this criterion is to rate sites according to the relative costs associated with providing highway access.

Evaluation approach – Sites are rated from highest to lowest in accordance with the length of additional or new highway construction required to provide car and truck access.

Discussion/Results – Brunswick, Harris, and Robinson are all located at operating plants that have been previously developed and will not need significant, if any, highway construction to accommodate construction or operation of a plant. Accordingly, these sites have been assigned a rating of 5.

The Marion site {

} While this is not excessive, the rating has been reduced to a 3 to reflect this activity projected for the site.

Highway Access	Brunswick	Harris	Marion	Robinson
Rating	5	5	3	5

4.2.3 Barge Access

Objective – The purpose of this criterion is to rate sites according to the relative costs associated with providing barge access.

Evaluation approach – Sites are rated from highest to lowest in accordance with estimated cost of facilities construction required to provide barge access.

Discussion/Results – The Brunswick Site is directly accessible by barge from the Atlantic Ocean and the Cape Fear River. The three other sites are not accessible by barge, and is therefore the less desirable site with respect to barge access.

Barge access	Brunswick	Harris	Marion	Robinson
Rating	5	1	1	1

4.2.4 Transmission Cost Differentials

4.2.4.1 Transmission-Construction
4.2.4.2 Electricity Market Price Differentials

Objective – The purpose of this criterion is to rate sites according to the relative costs associated with providing transmission to the site.

Evaluation approach – Ratings for this criterion are based on a transmission requirements study for the four sites conducted by Navigant Consulting, Inc.; this study is reported in Navigant 2006 as discussed in Appendix A, Criterion P8. Because all four sites are located within the Progress Carolinas service area, no electricity market price differentials are expected between the sites, and this sub-criterion was not evaluated.

Discussion/Results

The Brunswick, Harris, and Robinson sites are all near existing nuclear power plants. As such, transmission lines are located in the immediate vicinity of these proposed sites. However, some additional upgrading/modification is expected be required to tie in the new sites. A transmission deliverability analysis completed for Progress Energy by Navigant Consulting indicates there will be transmission overloads with the addition of a 1100 MW generating unit at the Brunswick, Marion, and the Robinson locations. Brunswick has the highest estimated costs for transmission upgrades for a 1100 MW plant at ~ $ 309 Million. Marion follows with an estimated transmission upgrade cost of ~ 205 Million, followed by Robinson at ~ $ 143 Million. Estimated costs for transmission upgrades at Harris are negligible (less than $ 1 Million).

Transmission	Brunswick	Harris	Marion	Robinson
Rating	1	5	2	3

4.3 CRITERIA RELATED TO LAND USE AND SITE PREPARATION

4.3.1 Topography

Objective – The purpose of this criterion is to rate sites according to the relative costs associated with site grading and earth-moving necessary to prepare the site for construction of a nuclear power plant.

Evaluation approach – Ratings are based on the amount of topographic relief currently found at the site, with the most severe relief resulting in the highest estimated grading costs and therefore the poorest rating.

Discussion/Results - All candidate power plant sites were given a rating of 4, based on the expectation that the land area within both the existing site boundaries and within the Marion site do not exhibit severe topographic relief that would result in significant differential grading costs between the sites.

Topography	Brunswick	Harris	Marion	Robinson
Rating	4	4	4	4

4.3.2 Land Rights

Objective – The purpose of this criterion is to rate sites according to the relative costs associated with purchasing land required to construct and operate a nuclear station on the site.

Evaluation approach – Sites are rated from highest to lowest in accordance with estimated local land costs.

Discussion/Results – It is assumed that Progress already owns all the land required for a new plant at Brunswick, Harris and Robinson since these are existing plants. Marion {

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Land Rights	Brunswick	Harris	Marion	Robinson
Rating	5	5	3	5

4.3.3 Labor Rates

Objective – The purpose of this criterion is to rate sites according to the relative costs associated with local labor costs that would be incurred during plant construction.

Evaluation approach – Sites are rated from highest to lowest in accordance with estimated local labor costs, with the lower cost resulting in higher ratings.

Discussion/Results – Economic data are typically available by county, but were found to be provided in a variety of forms (e.g., by hour, by week, by year; by job type) that were not necessarily consistent between counties. For purposes of consistency, this evaluation relied on data from U.S. Department of Labor, Bureau of Labor Statistics – November 2004 Metropolitan Area Occupational Employment and Wage Estimates. Average hourly rates were provided for construction and extraction workers (e.g., structural iron and steel workers; sheet metal workers; and plumbers, pipefitters and steamfitters) for the following representative MSAs:

Raleigh, NC (for Harris): average construction (mean hourly) $14.80; average plumber, pipefitter and steamfitter (mean hourly): $15.90

Wilmington, NC (for Brunswick): average construction (mean hourly) $14.03; average plumber, pipefitter and steamfitter (mean hourly): $16.04

Florence, SC (for Robinson and Marion): average construction (mean hourly) $14.59; average plumber, pipefitter, steamfitter (mean hourly): $18.03

In general, while the construction worker wage for this one particular labor category was found to be higher for the Marion and Robinson sites (based on rates in Florence, SC), the difference was less than 15%. Comparisons of other construction labor category rates, including the

average construction worker roll up rate (across all construction labor categories) as identified above, reveals minimal differences between sites. Also, construction worker rates in other South Carolina cities (e.g., Columbia) were found to be similar to those in Raleigh and Wilmington, NC. Finally, it should be noted that a significant portion of the construction workforce is expected to come from a national workforce of journeymen, whose rates will be set based on supply and demand within the overall nuclear industry, rather than by local workforce rates or skill sets. Given all these factors, identical ratings are given to the four candidate sites.

Labor Rates	Brunswick	Harris	Marion	Robinson
Rating	5	5	5	5

Attachment VI – Navigant Transmission Impact Study

Preface

Navigant Consulting was contracted by Progress Energy to complete a transmission deliverability impact study for the various sites identified in the site selection process. Sites being evaluated by Navigant included the four alternative sites (Harris, Robinson, Brunswick, and the Marion site).

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The Progress Energy Transmission Department provided input to Navigant Consulting for remediation of overloads for compliance with Progress Energy system reliability standards.

Predicted overloads under various contingency scenarios, estimated cost of transmission direct connection costs, and estimated costs for transmission upgrades (remedies) are provided herein for each of the four alternative sites considered.

The Navigant Report follows on the next page.

NAVIGANT
CONSULTING

TRANSMISSION SYSTEM IMPACT STUDY IN SUPPORT OF SITE SELECTION FOR A CAROLINAS NUCLEAR PLANT

Prepared for

January 4, 2006

DRAFT

{The Navigant Transmission Impact Study Report has been redacted in its entirety.}

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{The Navigant Transmission Impact Study Report has been redacted in its entirety.}