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SCE&G®
A SCANA COMPANY

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U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555-0001

ATTN: Document Control Desk

Subject: V. C. Summer Nuclear Station Units 2 and 3
Docket Numbers 52-027 and 52-028
Combined License Application – Environmental Report Audit Information Needs: ACC-5 (Part 2), ALT-2 (Part 1), ALT-2 (Part 3), CR-19, and SW-14

Reference:
1. Letter from S.A. Byrne to Document Control Desk, Submittal of a Combined License Application for V. C. Summer Nuclear Station Units 2 and 3, dated March 27, 2008.
2. Letter from Ronald B. Clary to Document Control Desk, Submittal of Revision 1 to Part 3 (Environmental Report) of the Combined License Application for the V. C. Summer Nuclear Station Units 2 and 3, dated February 13, 2009.

By letter dated March 27, 2008, South Carolina Electric & Gas Company (SCE&G) submitted a combined license application (COLA) for two Westinghouse AP1000 units, designated V.C. Summer Nuclear Station (VCSNS) Units 2 and 3, to be located at the existing VCSNS site in Fairfield County, South Carolina. Subsequently the Environmental Report (ER), Part 3 of the application, was revised and submitted to the NRC (reference 2).

During the week of March 9, 2009, the NRC conducted an Environmental Audit to gather information to assist in the review of the ER. The purpose of this letter is to submit a portion of the ER Information Needs identified by the NRC including: ACC-5 (Part 2), ALT-2 (Part 1), ALT-2 (Part 3), CR-19, and SW-14.

Please address any questions to Mr. Alfred M. Paglia, Manager, Nuclear Licensing, New Nuclear Deployment, P. O. Box 88, Jenkinsville, S.C. 29065; by telephone at 803-345-4191; or by email at apaglia@scana.com.

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NRO

I declare under penalty of perjury that the foregoing is true and correct.

Executed on this 8th day of June 2009

Ronald B. Clary
General Manager
New Nuclear Deployment

ARR/RBC/ar

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VCSNS UNITS 2 and 3

Response to NRC Information Needs Item

Information Item Number: ACC-5, Item 2 **Revision:** 0

Statement of the Information Item:

Information Item ACC-5, Item 2:

Provide expert to discuss the SAMAs (both the AP1000 SAMDA review and the Summer site specific SAMDA review that was performed.) Discuss the SAMAs to determine whether there are SAMDAs, procedural modifications, or training activities that can be justified to further reduce the risks of reactor severe accidents.

SCE&G Follow Up Action:

NRC staff is deliberating and will inform SCE&G if more information is required to meet regulatory requirements in this area.

NOTE: Subsequent to the audit, the following additional information was provided for this information need item as discussed between the NRC and SCE&G on 5/18/2009.

Expand discussion of administrative SAMA paragraph at the bottom of page 7.3-4.

Response:

Updating the SAMA analysis after receipt of a COL is not practical because a SAMA analysis is a National Environmental Policy Act (NEPA) action. All NEPA evaluations for the V.C. Summer COL will be completed with NRC's Record of Decision, which will be published before COL issuance. Nevertheless, text could be strengthened to indicate how procedures and training will be addressed after receipt of the COL. FSAR Chapter 18 addresses the human factors engineering aspects of procedure and training development that address risk. A future revision of the ER will contain the text provided below.

COLA Revisions:

The last paragraph of subsection 7.3 (page 7.3-4) will be revised in a future ER revision as follows:

Accordingly, further evaluation of design-related SAMAs is not warranted. SCE&G does not believe that administrative SAMAs, such as those relating to procedures or training, are appropriate for evaluation. The purpose of this analysis is to demonstrate that design changes for an AP1000 at the VCSNS site are not cost beneficial. Evaluation of administrative SAMAs would not be appropriate until a plant design is finalized and plant administrative processes and procedures are being developed. COLA Part 2, Final Safety Analysis Report, Chapter 18, Human Factors Engineering, and the AP1000 Design Control Document (Westinghouse 2008) describe the human factors engineering process that would apply to development of procedures and training. It addresses risk-

important tasks, emergency response guidelines, and interactions with risk-significant systems, structures, and components. Although a SAMA analysis would not be performed at that time (SAMA is a component of National Environmental Policy Act documentation.), risk-informed decision-making techniques would be used, as appropriate, during procedure and training development. ~~At that time, appropriate administrative controls on plant operations would be incorporated into the plants' management systems as part of the baseline.~~

VCSNS UNITS 2 and 3

Response to NRC Information Needs Item

Information Item Number: ALT-2 **Revision:** 0

Statement of the Information Item:

Information Item ALT-2:

Provide an expert on the alternative sites assessment for SCE&G. This expert should be able to describe such issues as:

- How the ROI was clearly identified and screened to provide legitimate candidate sites (e.g., The ER identifies the state as being the ROI; the updated Jan. 2009 siting study focuses only on the SCEG service territory). Has this ever included the service territory of Santee Cooper?
- Derivation of weighting criteria used for potential site screening
- How the exclusionary and avoidance criteria were selected
- If any further analysis was, or should be, included regarding the reconnaissance level information as provided via the ER for either the proposed site or any of the three alternatives

SCE&G Follow Up Action:

1. Provide revised Section 9.3.2 redescribing the ROI and how potential sites were identified

2. Provide analysis of additional alternative site FA-1 as a citable reference.

3. Provide information on the configuration of the proposed action on all of the alternate sites, to include power block, cooling tower(s), transmission line corridors, intake and discharge points, etc.

Response:

Part 1

Section 9.3.2.1 of the Environmental Report currently describes the region of interest as "the area within, or near the SCE&G service area." This description is consistent with the January 2009 siting study as well as the descriptions in the 2005 McCallum-Turner study and the 1974 Dames and Moore study. To clarify the region of interest, ER Section 9.3.2 will be revised in a future revision of the COLA as shown below.

As requested by NRC, SCE&G reviewed the 22 South Carolina counties that are located outside the SCE&G service territory to determine whether the Santee Cooper service territory offers reasonable alternative sites in addition to those the SCE&G identified in its service territory. Attachment 1 presents the results of that review.

COLA Revisions:

9.3.2 Overview of Site Selection Process

The site evaluation process for Units 2 and 3 conforms to ~~Site selection for Units 2 and 3 was conducted in accordance with~~ the overall process outlined in the Electric Power Research Institute (EPRI) *Siting Guide: Site Selection and Evaluation Criteria for an Early Site Permit Application* (EPRI 2002).

The site selection consisted of the following steps:

- Defining the region of interest;
- Identifying potential sites in the region of interest;
- Screening the potential sites to identify candidate sites; and
- Selecting the proposed site from the list of candidate sites and identifying the remaining candidate sites as alternative sites.
- Comparing the potential environmental impacts of a new nuclear generating facility at the alternative and proposed sites to confirm that the alternative sites are not obviously superior to the proposed site.

Evaluations supporting the identification and screening of potential sites were based on publicly available data sources and involved extensive use of Geographical Information Systems (GIS), which provided the needed ability to look at each site in increasing detail as the study progressed.

9.3.2.1 Region of Interest

Draft NUREG-1555 Section 9.3 (Revision 1, July 2007) indicates that the region of interest is typically selected based on geographic boundaries (e.g., the State in which the proposed site is located) or the relevant service area for the proposed plant. ~~NUREG-1555 provides that the region of interest is the relevant service area for the proposed project.~~ SCE&G is a regulated public utility engaged in the generation, transmission, distribution and sale of electricity in 24 counties in the central, southern, and southwestern portions of South Carolina. Consistent with the guidance provided in NUREG-1555, the region of interest, shown in Figure 9.3-1, is defined as ~~the area within, or near~~ the SCE&G service area plus the area within 15 miles of that service area. The region of interest was expanded beyond the service area in order to take advantage of land availability, proximity to transmission lines and transportation facilities, and environmental factors. While there are no legal impediments to SCE&G siting a plant outside its service area, SCE&G determined that the lack of SCE&G transmission lines and support facilities more than 15 miles outside its service territory would make siting a nuclear plant less desirable for the company. At the time of the initial siting study (McCallum-Turner 2005), SCE&G was not in partnership with Santee Cooper and so Santee Cooper's service territory was not included in the region of interest.

The region of interest includes portions of two physiographic provinces: the Coastal Plain and the Piedmont Plateau. Near the coast, the Coastal Plain is flat, often swampy, and broken by many rivers and streams. Further inland, the Coastal Plain has a rolling topography that rises gently up to 500 feet above mean sea level (msl). The Fall Line separates the Coastal Plain from the Piedmont Plateau. On or near this line, rapids occur in all of the major rivers as they pass from the harder metamorphic rock of the upland region to the more easily eroded clays and shales of the Coastal Plain. The Piedmont Plateau is typically hilly country with elevation differences between the hills and valleys of only a few hundred feet. Elevations in the Piedmont Plateau range from 300 to 600 feet above msl near its border with the Coastal Plain to 1,500 feet above msl at the foot of the Blue Ridge Mountains (BLM 2008, SCPRT 2009).

Approximately 10 to 15 earthquakes are recorded annually in South Carolina with 3 to 5 of them felt or noticed by people. About 70 percent of South Carolina earthquakes are located in the Middleton Place-Summerville Seismic Zone (approximately 22 miles northwest of Charleston). The two most significant historical earthquakes to occur in South Carolina were the 1886 Charleston/ Summerville earthquake and the 1913 Union County earthquake. The 1886 earthquake in Charleston was the most damaging earthquake to ever occur in the eastern United States. In terms of lives lost, human suffering, and devastation, this was the most destructive United States earthquake in the 19th century (SCEMD 2008).

The region of interest has abundant surface water resources that include the Atlantic Ocean, reservoirs, and rivers. Four major river basins in the ~~region~~State - the Savannah, ACE (Ashepoo, Combahee and Edisto), Santee and Pee Dee - include 11,000 miles of rivers and streams. The entire ACE basin, and parts of the Savannah basin and the Santee basin are located in the region of interest. There are no large natural lakes in the region of interest, but several reservoirs have been created for hydroelectric power purposes. The state's 12 largest reservoirs impound more than 14 million acre-feet of water. Five of these reservoirs, Lake Thurmond, Lake Marion, Lake Moultrie, Lake Murray, and Monticello Reservoir are located in the region of interest. ~~The three largest reservoirs in the region are Lake Marion, Lake Moultrie, and Lake Murray~~ (SCDOC 2008, ~~SCPRT 2009~~ SCDNR 2004a).

Generally, the region of interest is rural/agricultural with pockets of heavy population near important waterways, such as the Savannah River, or in traditionally populated areas, such as the state capital, university campuses, and manufacturing centers. Predominant land uses in the region include forested lands, agricultural land, wetlands and urban areas. Populated areas in the region include the metropolitan areas of Charleston, Columbia, Beaufort, Aiken, Hilton Head, and Myrtle Beach as well as many other smaller cities and towns. Military facilities in the region of interest include Fort Jackson, McEntire Air National Guard Station, Charleston Air Force Base, Charleston Naval Weapons Station, Marine Corps Air Station Beaufort, Parris Island Marine Corps Recruit Depot, Coast Guard Station Charleston, and the Beaufort Naval Hospital. Federally protected areas within the region of interest include the Congaree Swamp National Park, Fort Sumter National Monument, Fort Moultrie National Monument, Sumter National Forest, Francis Marion National Forest, Cape Romain National Wildlife Refuge (NWR), ACE Basin NWR, Waccamaw NWR, Santee NWR, Savannah NWR, and Pinckney Island NWR.

The region of interest is supported by an extensive state transportation system that provides residents and visitors with a high level of mobility. Five interstate highways provide east-west and north-south access throughout South Carolina, to include the region of interest, and 41,000 miles of state-maintained highways provide additional local access. CSX Transportation, Norfolk Southern, and seven other rail lines offer rail service to the metropolitan areas within the region of interest. The Port of Charleston, one of the busiest container ports on the east coast, has a dual access rail terminal and is located within two miles of interstate highway access. The state's eight commercial airports, seven of which are within the region of interest, provide convenient access to regional and international air service (SCDOC 2008). South Carolina upgrades and adds highways and other transportation infrastructure, as budget constraints allow, in response to population shifts and economic trends.

Chapter 8 addresses electricity demand, transmission network planning, and the need for power within the region of interest.

9.3.2.2 Identification of Potential Sites

In developing a list of potential sites, SCE&G considered multiple types of sites to include a federal nuclear facility site (Savannah River Site, SRS) and an existing nuclear power plant site (VCSNS). Both of these specific sites, SRS and VCSNS, were evaluated in a 2005 nuclear power plant siting study (McCallum-Turner 2005) that was commissioned by SCE&G. The use of an existing nuclear power plant site for new power generation has many environmental and cost benefits. The federal site was considered under the assumption that the site could accommodate new reactor technologies. Additionally, SCE&G considered 18 other ~~candidate~~ potential sites with no existing nuclear facilities. These sites were evaluated in an earlier nuclear SCE&G power plant siting study (Dames & Moore 1974).

...

References:

The following references will be added to Section 9.3. Copies of these references are provided with this response.

SCDNR (South Carolina Department of Natural Resources) 2004a, *South Carolina Water Plan, Second Edition.* January 2004. Available at http://www.keoweefolks.org/reference/scwaterplan.pdf.

The existing Section 9.3 references will be modified as follows:

SCDNR 2004b, *Water Resources Data for South Carolina 2000-2001*. Report 31. Available at www.dnr.sc.gov/water/hydro/HydroPubs/ Abs_dnr_R31.

Attachment 1

Santee Cooper Service Territory Evaluation

Introduction

This evaluation considers whether the Santee Cooper service territory offers reasonable alternative sites in addition to those that SCE&G has identified within its service territory. The proposed COL is a joint project between SCE&G and Santee Cooper but SCE&G began planning the new units before partnering with Santee Cooper and the COL application discussion of alternative sites is limited to those located generally within the SCE&G service territory.

In May 2006, the South Carolina General Assembly authorized Santee Cooper to partner with SCE&G in constructing and operating new nuclear units at the VCSNS site. The enabling legislation limits Santee Cooper's participation to "...existing or future nuclear electric generation units, and related transmission facilities, to be constructed on a site at or near Parr Shoals in Fairfield County ..."(South Carolina Code of Laws Section 58-31-200). Thus, it would take a statutory change to secure Santee Cooper authorization to partner at another site.

Region of Interest

Santee Cooper is South Carolina's state-owned utility, which provides power distributed by various municipalities and electric cooperatives to more than 650,000 customers in all 46 South Carolina counties. The Santee Cooper service territory is intermingled with those of several other utilities (see Figure 8.1-1). This evaluation focuses on the 22 counties in the northern and northwestern portions of South Carolina that lie outside the SCE&G service territory (see Figure 1). This area generally corresponds with the South Carolina service territories for Duke Energy and Progress Energy.

The region of interest includes a portion of the Blue Ridge Mountains in addition to the Coastal Plain and the Piedmont Plateau physiographic provinces that were described in Subsection 9.3.2.1.1. The steep slope that separates the mountains and Piedmont is the Blue Ridge escarpment. The Blue Ridge province, in the northwestern portion of South Carolina, occupies less than two percent of the state's total area. This escarpment is made up of low to high-grade metamorphic rock. The majority of the rocks within the region are metamorphosed Proterozoic or Paleozoic sedimentary rocks and the other portion is composed of metamorphosed igneous rocks. This province consists of a mountainous area of steep ridges, mainly forested, with intermountain basins and valleys that intersect at angles, giving the area a rugged appearance. Sassafras Mountain, which is the highest point in the state, reaches 3,560 feet above sea level in this region (BLM 2008, SCPRT 2009).

Surface water resources in the region include the Atlantic Ocean, reservoirs, and rivers. The Pee Dee basin is in the northeastern part of the region of interest. The Santee basin covers the central-west portion of the region of interest and the Savannah basin is along

the western edge of the region of interest. There are no large natural lakes in the region of interest, but seven of the State's largest reservoirs are located in the region. They are Lakes Hartwell, Jocassee, Russell, and Keowee in the Savannah basin, and Lakes Wateree, Wylie, and Greenwood in the Santee basin. There are no major reservoirs on the rivers of the Pee Dee basin in South Carolina, and surface water availability in the basin during drought periods can be a critical problem that requires multi-state cooperation (SCDNR 2004a, PDRCG undated).

Generally, the region of interest is rural/agricultural with pockets of heavy population in traditionally populated areas, such as university campuses, and manufacturing centers. Predominant land uses in the region include forested lands, agricultural land, wetlands and urban areas. Populated areas in the region include the metropolitan areas of Florence, Camden, Greenville-Spartanburg, Anderson, and Sumter as well as many other smaller cities and towns. Military facilities in the region of interest include Shaw Air Force Base, and Coast Guard Station Georgetown. Federally protected areas within the region of interest include portions of Sumter National Forest, the Carolina Sandhills National Wildlife Refuge, Kings Mountain National Military Park, Historic Camden Revolutionary War Site, Charles Pinckney National Historic Site, Overmountain Victory National Historic Trail, Ninety-Six National Historic Site, and Cowpens National Battlefield.

Five interstate highways provide east-west and north-south access throughout South Carolina and 41,000 miles of state-maintained highways provide additional local access. CSX Transportation, Norfolk Southern, and seven other rail lines offer rail service to the metropolitan areas within the region of interest. The Port of Georgetown also has a rail terminal located within one mile of U.S. Highway 17. The state's eight commercial airports provide convenient access to regional and international air service (SCDOC 2008). South Carolina upgrades and adds highways and other transportation infrastructure, as budget constraints allow, in response to population shifts and economic trends.

Review of Existing Site Selection Reports

To identify potential sites within the Santee Cooper region of interest, SCE&G reviewed nuclear plant siting documentation for Duke Energy's William States Lee III Nuclear Station (DEC 2009) and Progress Energy's Shearon Harris Nuclear Power Plant Units 2 and 3 (PEC 2008). SCE&G also reviewed the siting documentation for Santee Cooper's coal-fired Pee Dee Generating Station (MACTEC 2006).

Duke Energy Assessment

The Duke Energy site selection process considered a total of 18 potential sites that were distributed throughout its service territories in North Carolina and South Carolina and included Duke Energy's three existing nuclear sites in South Carolina; McGuire Nuclear Station, Catawba Nuclear Station, and Oconee Nuclear Station. McGuire Nuclear Station and Catawba Nuclear Station were eliminated due to insufficient land area to accommodate the new units, significant population growth concerns, transmission challenges, and water quality/thermal concerns. The existing Oconee Nuclear Station was also eliminated due to insufficient land area to accommodate the new units (DEC 2009).

Duke Energy identified four candidate sites in its two-state region of interest. One of the candidate sites, the Perkins site, is located in North Carolina which is outside the Santee Cooper region of interest. The three other candidate sites; Lee (the site Duke Energy indentified as the preferred site for its nuclear project), Keowee, and Middleton Shoals are located in the region of interest (DEC 2009). SCE&G reviewed the three Duke Energy candidate sites that are located in South Carolina and determined that they were not reasonable sites for the following reasons:

- **Lee Site:** The Lee site is a former industrial site owned by Duke Energy. Duke Energy identified the Lee site as its preferred site for a two-unit nuclear plant. Duke Energy's need for power would use the capacity of both units currently proposed for the Lee site. In order to develop nuclear capacity at the Lee site SCE&G and Santee Cooper would need to acquire the rights to the property. Although three units were planned for the Lee site in the 1970's, it is unlikely that two additional nuclear units could be located at the Lee site without expansion of the existing reservoirs. The site is located approximately 75 miles from the nearest SCE&G load center, Columbia, South Carolina, about 50 miles from SCE&G's 230-kV transmission system, and about 50 miles from Santee Cooper's 230-kV transmission system. At least 45 miles of new transmission lines would be needed to connect the Lee site to the SCE&G transmission system and 50 miles of new transmission lines would be needed to connect the site to the Santee Cooper transmission system. Substantial upgrades to the transmission systems would be needed as well to provide power to the Columbia, Charleston, and Myrtle Beach load centers.
- **Keowee Site:** The Keowee site is a wooded greenfield site owned by Duke Energy. In order to develop nuclear capacity at the Keowee site SCE&G and Santee Cooper would need to acquire the property. Development of the site would require extensive rough grading that would include the construction of a supplemental water reservoir. Also, there is a high level of residential development at the area where a water intake structure would be constructed. The site is located approximately 120 miles from the nearest SCE&G load center, Columbia, South Carolina, about 85 miles from SCE&G's 230-kV transmission system, and about 30 miles from Santee Cooper's 230-kV transmission system. At least 85 miles of new transmission lines would be needed to connect the Keowee site to the SCE&G transmission system and 30 miles of new transmission lines would be needed to connect the site to the Santee Cooper transmission system. Substantial upgrades to the transmission systems would be needed as well to provide power to the Columbia, Charleston, and Myrtle Beach load centers.
- **Middleton Shoals Site:** The Middleton Shoals site is a wooded greenfield site owned by Duke Energy. In order to develop nuclear capacity at the Middleton Shoals site SCE&G and Santee Cooper would need to acquire the property. Development of the site would require extensive rough grading that would include the construction of a supplemental water reservoir. The site is located approximately 100 miles from the nearest SCE&G load center, Columbia, South Carolina, about 65 miles from SCE&G's 230-kV transmission system, and about 5 miles from Santee Cooper's 230-kV transmission system. At least 65 miles of new transmission lines would be needed to connect the Middleton Shoals site to the SCE&G transmission system and 5 miles of new transmission lines would be needed to connect the site to the Santee Cooper transmission system.

Substantial upgrades to the transmission systems would be needed as well to provide power to the Columbia, Charleston, and Myrtle Beach load centers.

Progress Energy Assessment

The Progress Energy site selection process considered a total of 11 potential sites, six in North Carolina and five in South Carolina. The South Carolina sites included the Robinson Nuclear Plant, Progress Energy's existing nuclear site in South Carolina. Initially, Progress Energy considered the SRS site that SCE&G identified as a candidate site in the pre-partnership siting studies (Progress Energy Site #9). The SRS site was ultimately eliminated by Progress Energy because the site is not close to its service territory and transmission costs would be high; and the need for operational water arrangements with SRS to obtain cooling water was not desirable (PEC 2008).

Progress Energy identified four candidate sites in its two-state region of interest. Two of the candidate sites, the Harris Nuclear site and the Brunswick Nuclear site, are located in North Carolina which is outside the Santee Cooper region of interest. The two other candidate sites; the Robinson Nuclear site and the Marion County site are located in the region of interest (PEC 2008). SCE&G reviewed the two Progress Energy candidate sites that are located in South Carolina and determined that they were not reasonable sites for the following reasons:

- **Robinson Nuclear Plant:** The Robinson Nuclear Plant site is an existing nuclear power plant that is owned by Progress Energy. In order to develop nuclear capacity at the Robinson Nuclear Plant site SCE&G and Santee Cooper would need to acquire the rights to the property. Based on Progress Energy operating experience, the site is challenged for water supply due to thermal limits on the lake (PEC 2008). The Robinson Nuclear Plant site is located approximately 55 miles from the nearest SCE&G load center, Columbia, South Carolina, about 45 miles from SCE&G's 230-kV transmission system, and about 15 miles from Santee Cooper's 230-kV transmission system. At least 45 miles of new transmission lines would be needed to connect the Robinson Nuclear Plant site to the SCE&G transmission system and 15 miles of new transmission lines would be needed to connect the site to the Santee Cooper transmission system. Substantial upgrades to the transmission systems would be needed as well to provide power to the Columbia, Charleston, and Myrtle Beach load centers.
- **Marion County Site:** The Marion County site is not owned by SCE&G or Santee Cooper. In order to develop nuclear capacity at the Marion County site SCE&G and Santee Cooper would need to acquire the property. The Marion County site is a greenfield site that is located in a low-lying area with considerable on-site and surrounding wetlands and swamps. Site elevations appear to be at or even slightly below that of the100-year floodplain. The Marion County site would require the construction of a reservoir to ensure adequate flow during drought conditions. Several potentially significant cultural resources have been identified within the site boundaries that could limit use of certain areas of the site. The Marion County site is located approximately 85 miles from the nearest SCE&G load center, Columbia, South Carolina about 65 miles from SCE&G's 230-kV transmission system, and about 10 miles from Santee Cooper's 230-kV transmission system. At least 65 miles of new transmission lines would be

needed to connect the Marion County site to the SCE&G transmission system and 10 miles of new transmission lines would be needed to connect the site to the Santee Cooper transmission system. Substantial upgrades to the transmission systems would be needed as well to provide power to the Columbia, Charleston, and Myrtle Beach load centers.

Santee Cooper Assessment

The Santee Cooper site selection process considered a total of 11 potential sites in South Carolina, five of which were eliminated based on site reconnaissance and consultations with State and Federal Agencies. Two of the South Carolina sites, Site 1 and Site 3 are located near the Al-1 and Wateree sites that SCE&G considered during the pre-partnership site selection process and were not considered by SCE&G during this review (MACTEC 2006). SCE&G reviewed the four remaining Santee Cooper potential sites and determined that they were not reasonable sites for the following reasons:

- **Site 6:** Site 6 is located on Bull Creek between the Pee Dee and Waccamaw Rivers near the town of Bucksport in Horry County (MACTEC 2006). In order to develop nuclear capacity at the Marion County site SCE&G and Santee Cooper would need to acquire the property. The site is located in a low-lying coastal area which is below the 100-year flood zone elevation and is subject to storm surges. Due to the unconsolidated nature of the underlying coastal plain sediments and the location's proximity to the Charleston earthquake epicenter, the site might not meet seismic requirements for nuclear power reactors. The site is located approximately 80 miles from the nearest SCE&G load center, Charleston, South Carolina, about 65 miles from SCE&G's 230-kV transmission system, and about 10 miles from Santee Cooper's 230-kV transmission system. At least 65 miles of new transmission lines would be needed to connect Site 6 to the SCE&G transmission system and 10 miles of new transmission lines would be needed to connect the site to the Santee Cooper transmission system. Substantial upgrades to the transmission systems would be needed as well to provide power to the Columbia, Charleston, and Myrtle Beach load centers.
- **Site 7:** Santee Cooper identified Site 7 as its preferred site for a proposed two-unit coal-fired power plant (MACTEC 2006). Development of the coal-fired plant would consume nearly all the available land at the site and additional land would need to be acquired to co-locate a nuclear plant at the same site. Development of a nuclear plant at Site 7 would also require the construction of a reservoir to ensure adequate flow during drought conditions. The site is located approximately 85 miles from SCE&G's Columbia and Charleston, South Carolina load, about 65 miles from SCE&G's 230-kV transmission system, and about 10 miles from Santee Cooper's 230-kV transmission system. At least 65 miles of new transmission lines would be needed to connect Site 7 to the SCE&G transmission system and 10 miles of new transmission lines would be needed to connect the site to the Santee Cooper transmission system. Substantial upgrades to the transmission systems would be needed as well to provide power to the Columbia, Charleston, and Myrtle Beach load centers.
- **Site 9:** Site 9 is located in Florence County in a region of the Great Pee Dee River called the Neck (MACTEC 2006). In order to develop nuclear capacity at

Site 9 SCE&G and Santee Cooper would need to acquire the property. Development of a nuclear plant at Site 9 would require the construction of a reservoir to ensure adequate flow during drought conditions. The site is located approximately 80 miles from the nearest SCE&G load center, Charleston, South Carolina, about 65 miles from SCE&G's 230-kV transmission system, and about 10 miles from Santee Cooper's 230-kV transmission system. At least 65 miles of new transmission lines would be needed to connect Site 9 to the SCE&G transmission system and 10 miles of new transmission lines would be needed to connect the site to the Santee Cooper transmission system. Substantial upgrades to the transmission systems would be needed as well to provide power to the Columbia, Charleston, and Myrtle Beach load centers.

- **Site 10:** Site 10 is located on the Great Pee Dee River near the town of Society Hill in Florence County (MACTEC 2006). In order to develop nuclear capacity at Site 10 SCE&G and Santee Cooper would need to acquire the property. Development of a nuclear plant at Site 10 would require the construction of a reservoir to ensure adequate flow during drought conditions. The site is located approximately 75 miles from the nearest SCE&G load center, Columbia, South Carolina, about 65 miles from SCE&G's 230-kV transmission system, and about 17 miles from Santee Cooper's 230-kV transmission system. At least 65 miles of new transmission lines would be needed to connect Site 10 to the SCE&G transmission system and 17 miles of new transmission lines would be needed to connect the site to the Santee Cooper transmission system. Substantial upgrades to the transmission systems would be needed as well to provide power to the Columbia, Charleston, and Myrtle Beach load centers.

Conclusions

Consideration of the Santee Cooper service territory for alternative sites expands the VCSNS region of interest to the north and east of that limited to the SCE&G service territory. Because of how South Carolina service territories are laid out (see Figure 8.1-1), this expansion brings into consideration areas interspersed with service territories for Duke Energy and Progress Energy. Each of these utilities has performed siting studies and has identified alternative nuclear power plant sites. Santee Cooper has also performed siting work. Although the Santee Cooper siting was for fossil-fuel-fired plants, many siting considerations (e.g., cooling water supply, acreage availability, proximity to transmission lines) are common to fossil and nuclear plant siting.

SCE&G has reviewed results of these other studies but has concluded that none offer reasonable alternatives for the SCE&G and Santee Cooper purpose and need, most commonly due to one or more of the following:

- The length of new or expanded transmission line corridors that would be needed to connect to the SCE&G and Santee Cooper load centers
- The lack of available and reliable cooling water even if an existing reservoir is expanded or a new one built
- The lack of sufficient acreage for two additional generating units

Finally, SCE&G cannot predict whether the South Carolina General Assembly would conclude that any site within the Santee Cooper service territory to be a reasonable alternative to the Santee Cooper partnership at the VCSNS site.

References:

The following references apply to this text only. Copies of these references are provided with this response.

DEC (Duke Energy Carolinas) 2009. William States Lee III Nuclear Station COL Application, Part 3, Environmental Report, Revision 1, Section 9.3, Alternative Sites. NRC ADAMS No. ML090990335

MACTEC (MACTEC Engineering & Consulting, Inc.) 2006. *Draft Environmental Assessment Santee Cooper Pee Dee Electrical Generating Station*. October 31, 2006.

PEC (Progress Energy Carolinas, Inc.) 2008. Shearon Harris Nuclear Power Plant Units 2 and 3 COL Application, Part 3, Environmental Report, Revision 0, Section 9.3, Alternative Sites. NRC ADAMS No. ML080600913.

PDRCG (Pee Dee Regional Council of Governments) Undated. *Planning Implications of Alternate Development Patterns on Infrastructure and Existing Planning Policies Pee Dee Region of South Carolina*. Available at http://www.ors2.state.sc.us/tcsp/pdf/peedee_tcsp.pdf.

SCDNR (South Carolina Department of Natural Resources) 2004a, *South Carolina Water Plan, Second Edition.* January 2004. Available at http://www.keoweefolks.org/reference/scwaterplan.pdf.

The following existing Section 9.3 references are also referenced in this text:

BLM (Bureau of Land Management) 2008. South Carolina Reasonably Foreseeable Development Scenario for Fluid Minerals. May. Available at http://www.blm.gov/pgdata/etc/medialib/blm/es/jackson_field_office/planning/planning_pdf_sc_rfds.Par.9099.File.dat/S_Carolina_RFDS_R1.pdf. Accessed January 7, 2009.

SCDOC (South Carolina Department of Commerce) 2008. Transportation and Infrastructure. Available at http://www.sccommerce.com/docdirectory/ResearchFolder/Transportation%20and%20Infrastructure%20in%20South%20Carolina%202008.pdf. Accessed January 7, 2009.

SCPRT (South Carolina Department of Parks, Recreation & Tourism) 2009. South Carolina Geography, Climate, and Economy. Available at http://www.scprt.com/facts-figures/geographyclimateeconomy.aspx?Print=1. Accessed January 6, 2009.

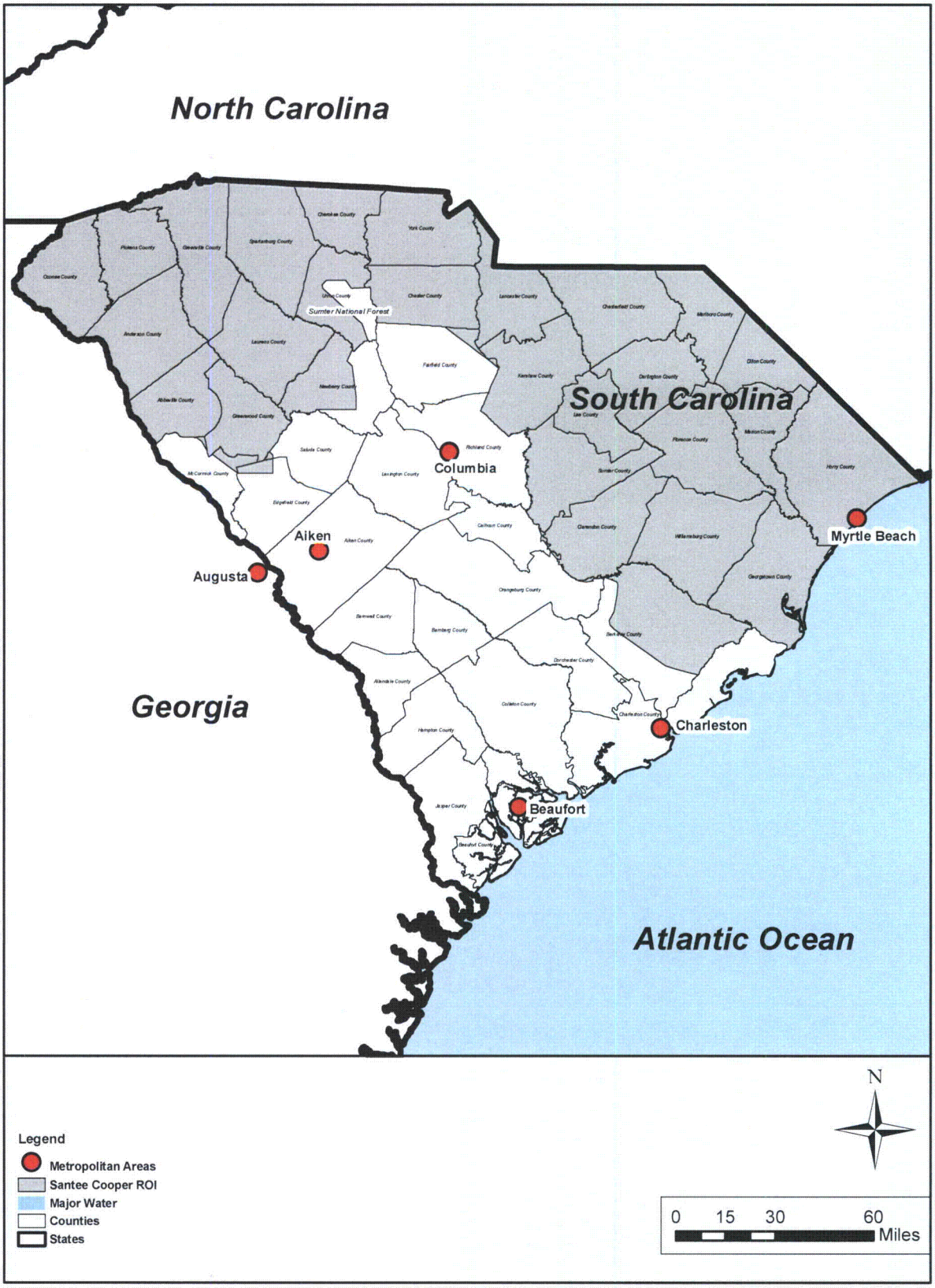


Figure 1 Santee Cooper Region of Interest

VCSNS UNITS 2 and 3

Response to NRC Information Needs Item

Information Item Number: ALT-2 **Revision:** 0

Statement of the Information Item:

Information Item ALT-2:

Provide an expert on the alternative sites assessment for SCE&G. This expert should be able to describe such issues as:

- How the ROI was clearly identified and screened to provide legitimate candidate sites (e.g., The ER identifies the state as being the ROI; the updated Jan. 2009 siting study focuses only on the SCEG service territory). Has this ever included the service territory of Santee Cooper?
- derivation of weighting criteria used for potential site screening
- How the exclusionary and avoidance criteria were selected.
- If any further analysis was, or should be, included regarding the reconnaissance level information as provided via the ER for either the proposed site or any of the three alternatives.

SCE&G Follow Up Action

1. Provide revised Section 9.3.2 redescribing the ROI and how potential sites were identified

2. Provide analysis of additional alternative site FA-1 as a citable reference.

3. Provide information on the configuration of the proposed action on all of the alternate sites, to include power block, cooling tower(s), transmission line corridors, intake and discharge points, etc.

Response:

Number 3

SCE&G developed representative figures (attached) to show how the proposed action could be configured at each of the four alternate sites. The figures were developed using reconnaissance level information (i.e., information or analyses that can be retrieved or generated without performing site-specific investigations). If SCE&G or some other entity chose to construct a new nuclear generation facility at one of the alternate sites, a number of site-specific investigations (e.g., cultural resources survey, threatened and endangered species surveys, geotechnical investigations, etc.) would be required before the ultimate site configuration could be determined.

Figures ALT-2-1 and ALT-2-2 show a potential plant configuration and transmission corridors for the Fa-1 site.

VCSNS UNITS 2 and 3

Response to NRC Information Needs Item

Figures ALT-2-3 and ALT-2-4 show a potential plant configuration and transmission corridors for the Cope Generating Station site.

Figures ALT-2-5 and ALT-2-6 show a potential plant configuration and transmission corridors for the Saluda site.

Figures ALT-2-7 and ALT-2-8 show a potential plant configuration and transmission corridors for the SRS site.

Figures ALT-2-7 and ALT-2-8 were developed for the site that SCE&G evaluated in Section 9.3.3.1 of the Environmental Report. SCE&G determined that the SRS site visited by NRC on March 26, 2009 was a different site than the one that was analyzed in Section 9.3.3.1 of the Environmental Report. The SRS site that SCE&G evaluated in Section 9.3.3.1 of the Environmental Report was previously reviewed by NRC in Section 8.7 of NUREG-1811, *Final Environmental Impact Statement for an Early Site Permit (ESP) at the North Anna ESP Site* (NRC ADAMS No. ML063480261). The SRS site was also evaluated by DOE in the *Draft Global Nuclear Energy Partnership Programmatic Environmental Impact Statement* (available at http://www.ne.doe.gov/peis.html) and in the *Study of Potential Sites for the Deployment of New Nuclear Plants in the United States* (available at http://www.ne.doe.gov/np2010/espStudy/espStudyDominion.pdf).

The site that was visited on March 26, 2009 is a site that the U.S. Department of Energy (DOE) is currently promoting as a potential energy park.

The characteristics (e.g. ecology, hydrology, land use/land cover, air quality, and socioeconomics) of both sites at SRS are very similar.

COLA Revisions:

No COLA revision is required as a result of the response to this Information Needs item.

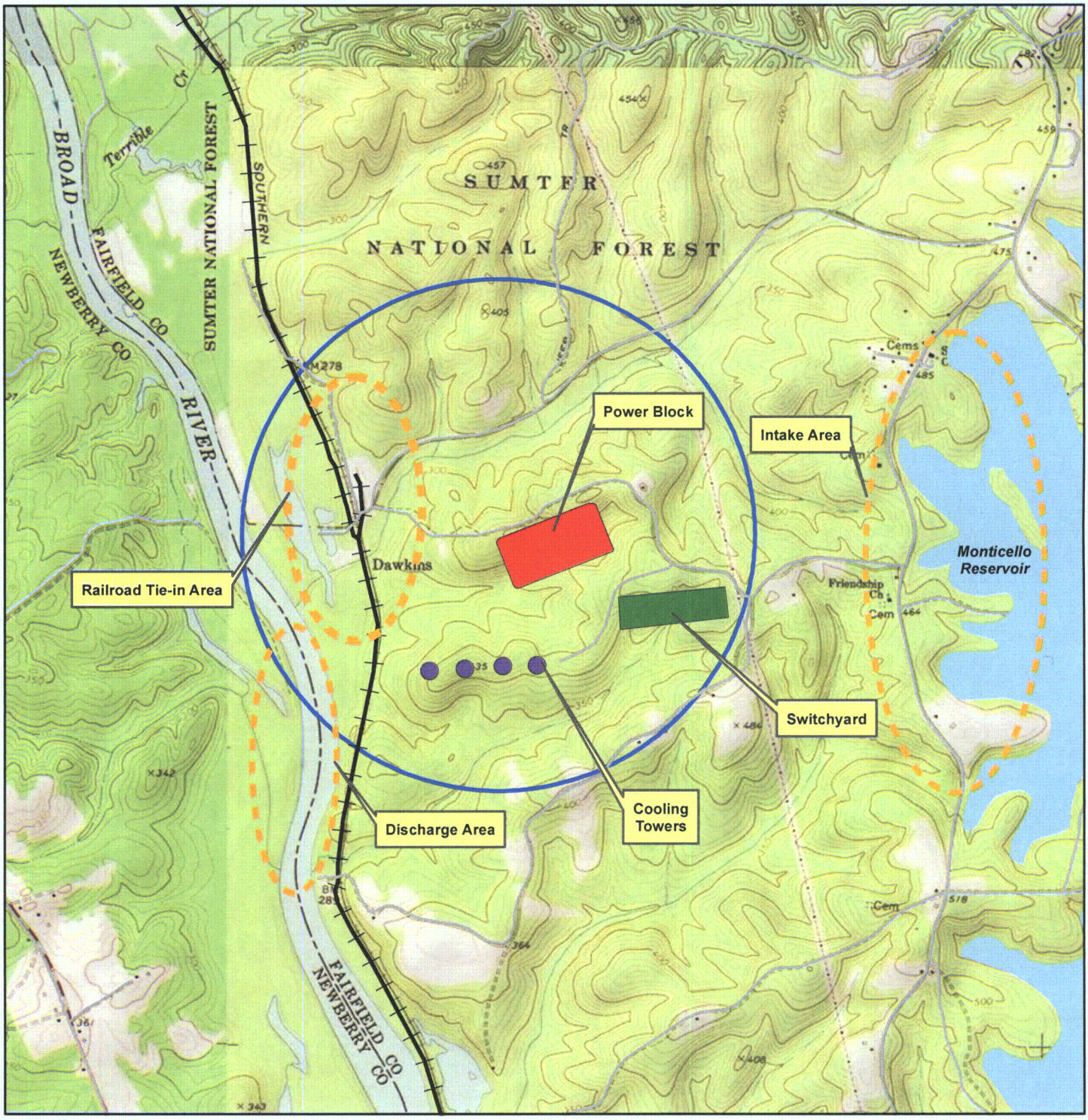


Figure ALT-2-1 Possible Site Configuration for Fa-1 Site

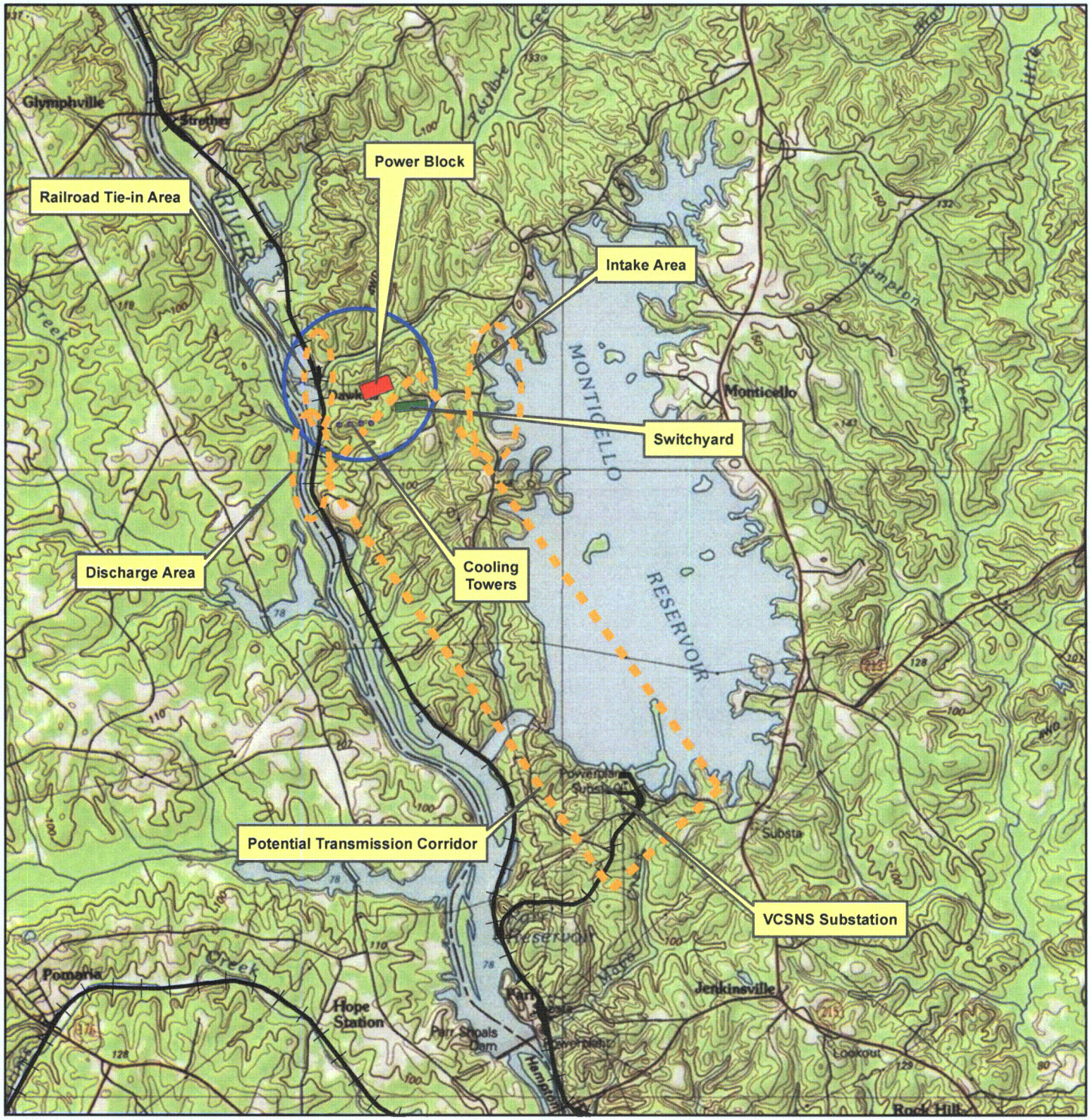
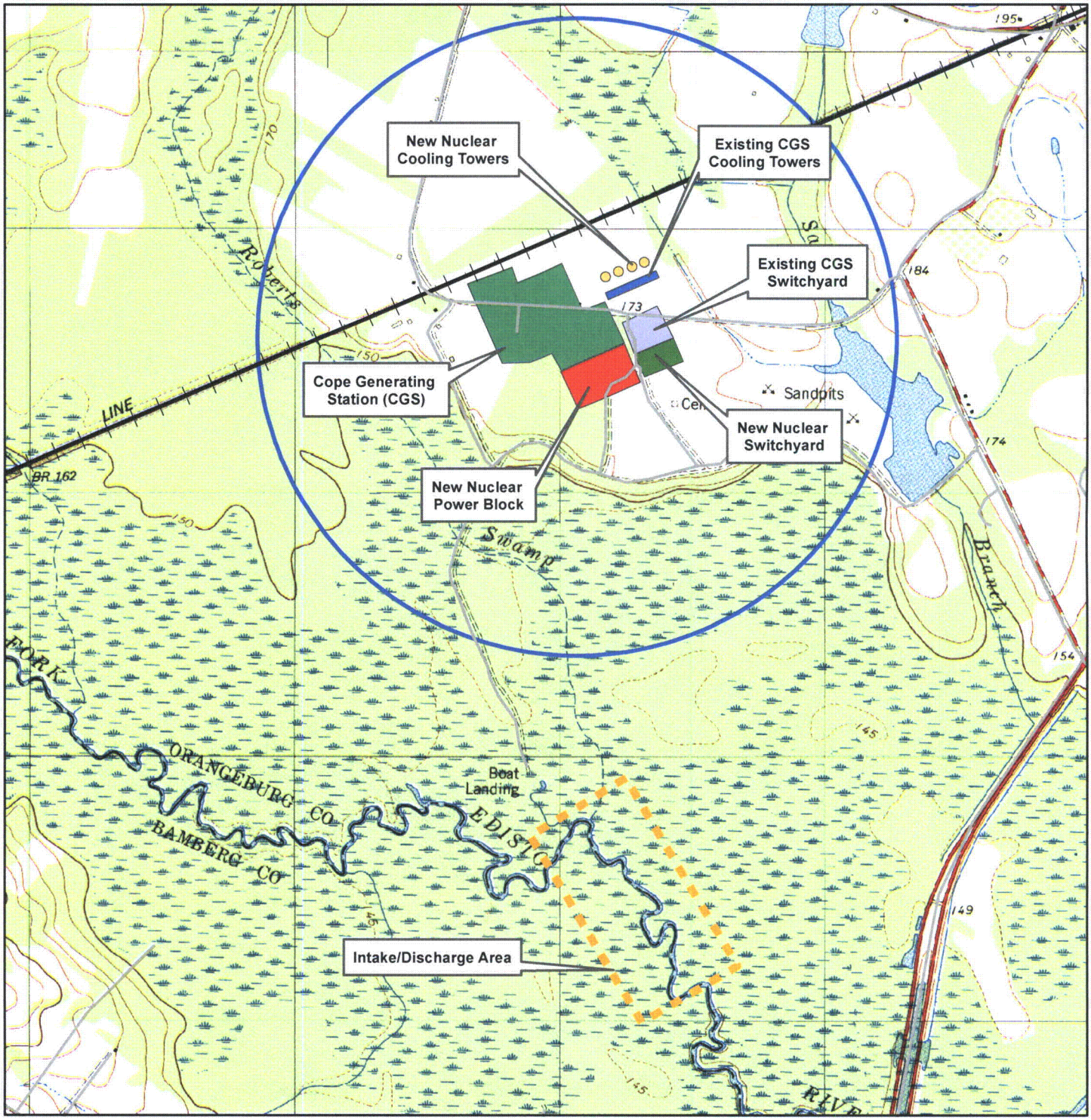


Figure ALT-2-2 Potential Transmission Corridor for Fa-1 Site



0 0.15 0.3 0.6 Miles

N
W E
S

- Roads
- Railroad
- New Nuclear Cooling Towers
- New Nuclear Switchyard
- New Nuclear Power Block
- CGS Existing Switchyard
- CGS Existing Cooling Towers
- Cope Generating Station (CGS)
- Alternate Sites 3/4 Mile (1130 Acres) Buffer

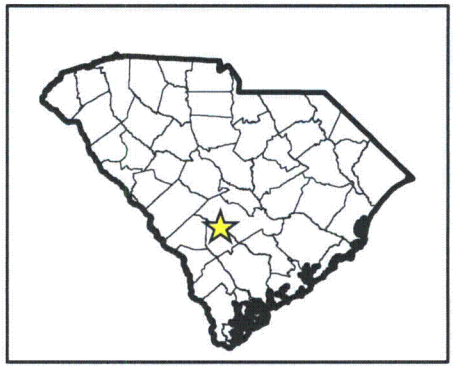


Figure ALT-2-3 Possible Site Configuration for Cope Site

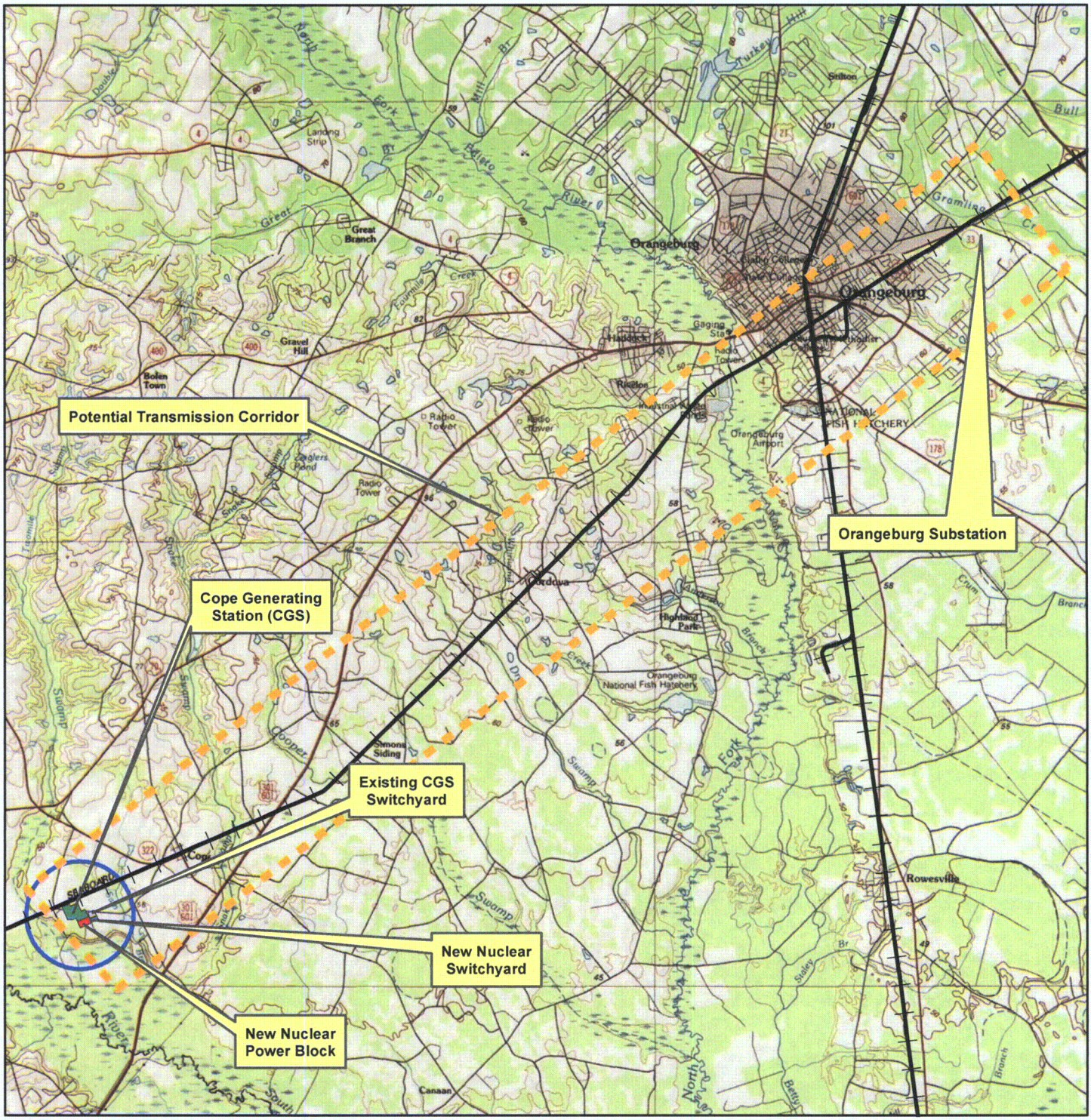


Figure ALT-2-4 Potential Transmission Corridor for Cope Site

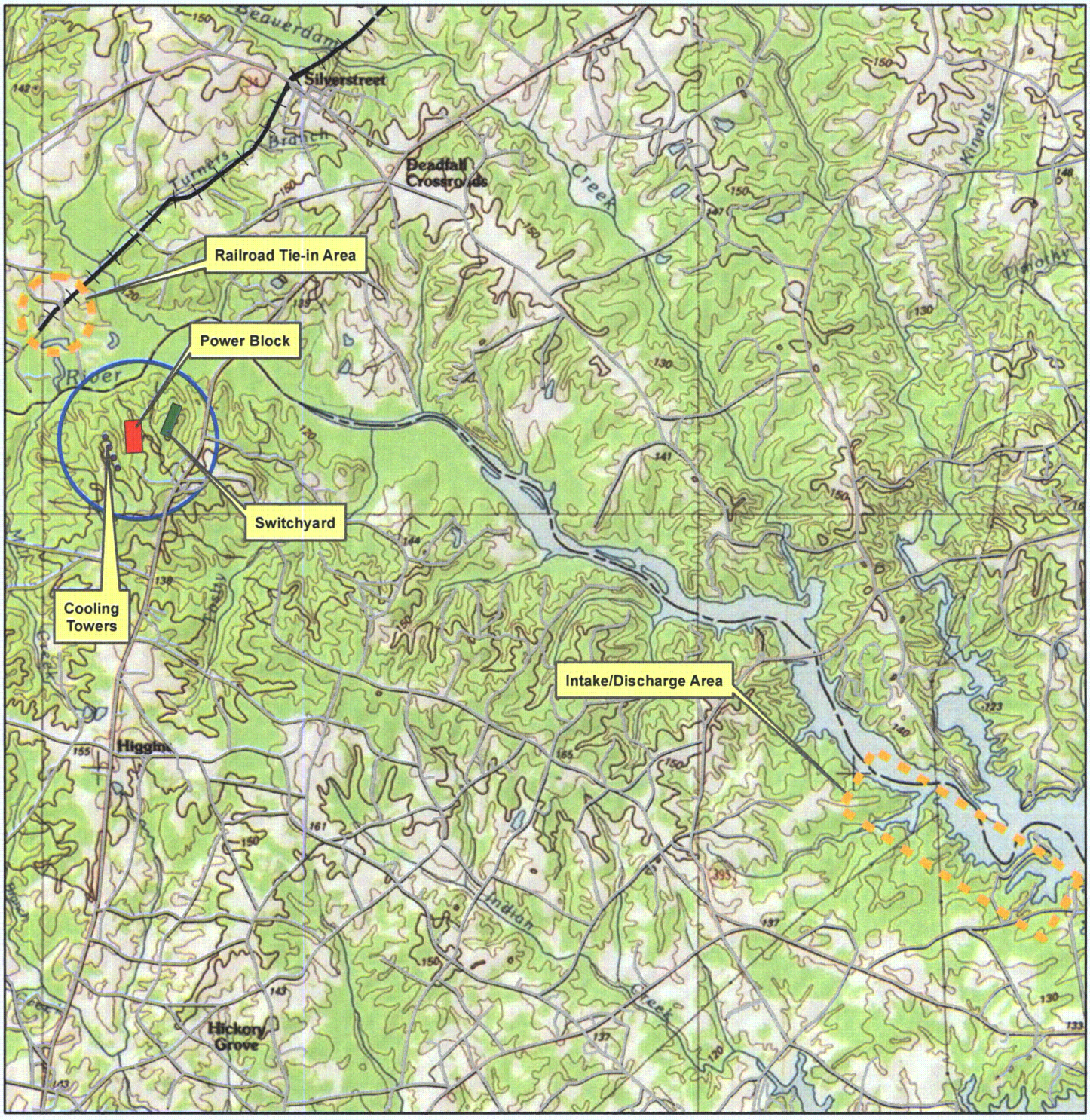
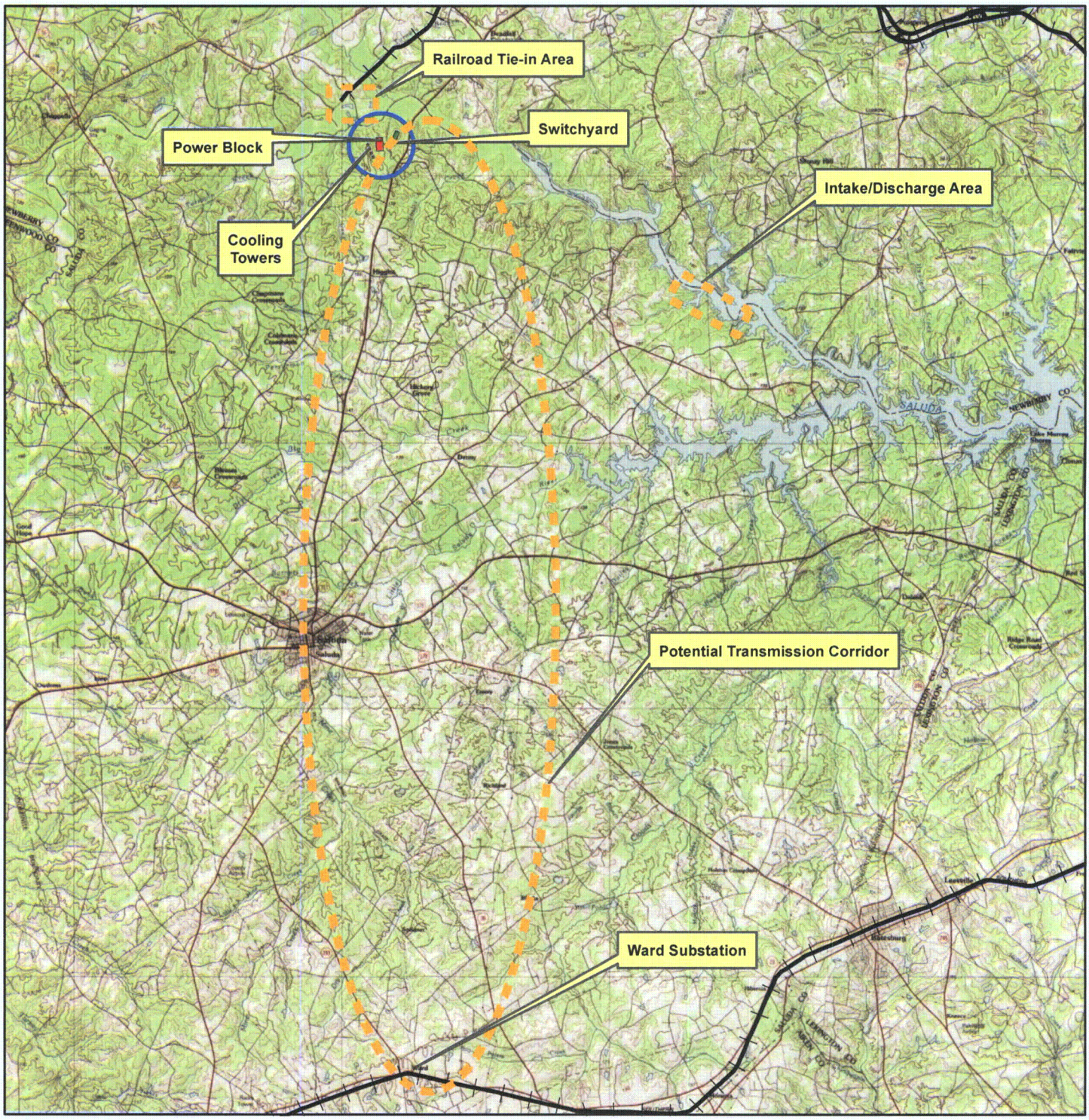


Figure ALT-2-5 Possible Site Configuration for Saluda Site



0 1.5 3 6 Miles

N
W E
S

Railroad
Switchyard
Power Block
Cooling Towers
Alternate Sites 3/4 Mile (1130 Acres) Buffer

Figure ALT-2-6 Potential Transmission Corridor for Saluda Site

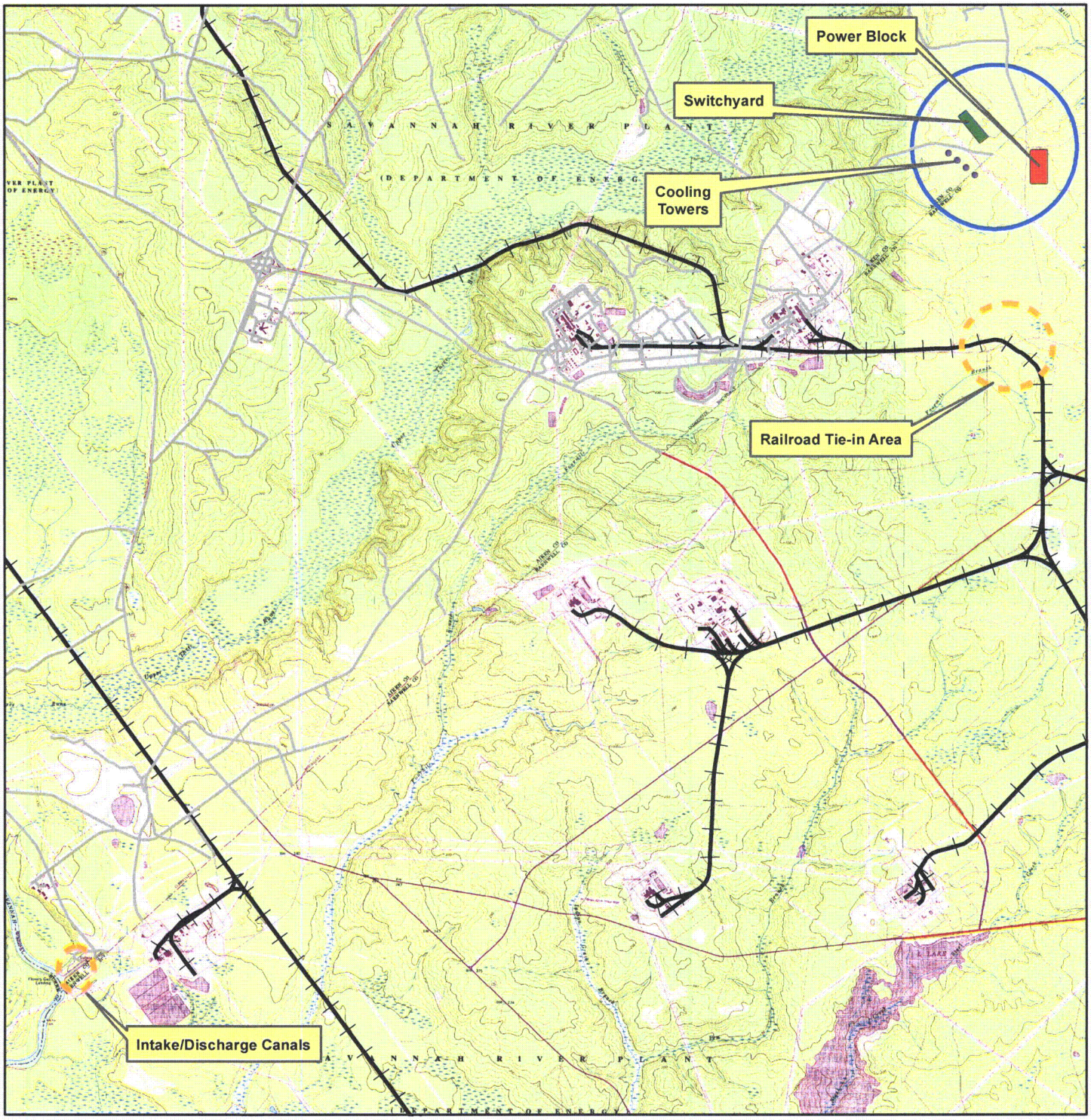


Figure ALT-2-7 Possible Site Configuration for SRS Site

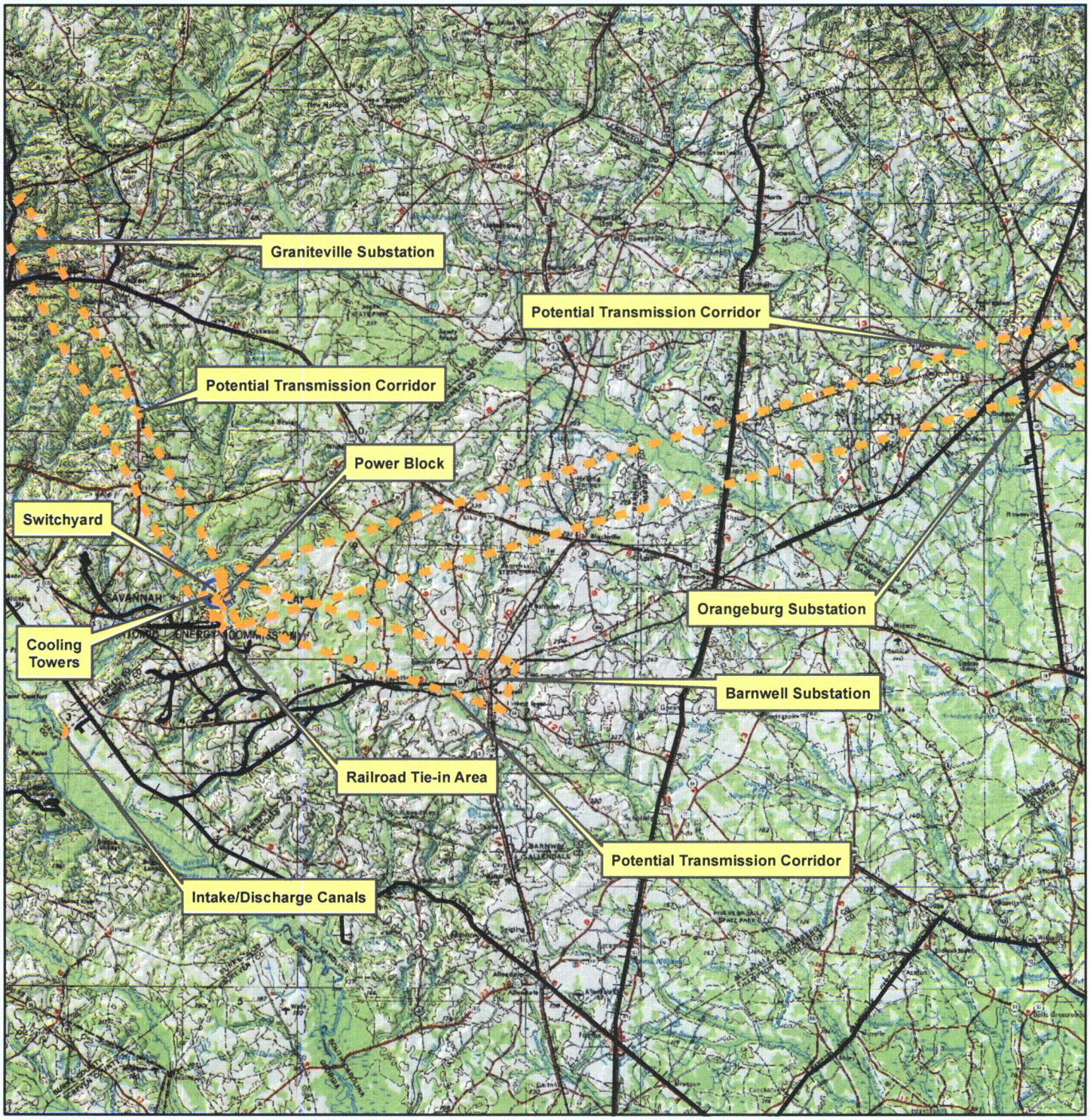


Figure ALT-2-8 Potential Transmission Corridors for SRS Site

VCSNS UNITS 2 and 3

Response to NRC Information Needs Item

Information Item Number: CR-19 **Revision:** 0

Statement of the Information Item:

Information Item CR-19: Make available copies of the two procedures referenced on page 4.1-5 (cultural resources procedures and inadvertent discovery procedures) and provide an expert to describe how they will be implemented.

SCE&G Follow Up Action: Provide existing EMP and provide Unit 1 procedure. Provide a written response on implementation of existing procedures to future Units 2 and 3.

Response: Unit 2 (and then Unit 3) will transition to the Unit 1 station administrative procedures when construction activities for the particular unit are completed. Since the two procedures (SAP-404 and SAP-405) refer to the existing Unit 1 Environmental Protection Plan (Appendix B to the Operating License for VCSNS Unit 1), they will be revised to comply with the respective Environmental Protection Plans for Units 2 & 3.

A copy of the current Unit 2/3 Environmental Management Plan (EMP) and the Unit 1 procedures are in the reading room.

COLA Revisions:

No COLA revision is required as a result of the response to this Information Needs item.

VCSNS UNITS 2 and 3

Response to NRC Information Needs Item

Information Item Number: SW-14 **Revision:** 0

Statement of the Information Item:

Information Item SW-14:

Provide an expert to discuss the level of consumptive water use that would not be considered small under different flow conditions, the status of safe yield analysis and how it supports the determination of its findings related to cumulative water use impacts, and the cumulative impact to water quality as presented in 10.5.1 and Table 10.1-1.

SCE&G Follow Up Action

Revise ER Section 10.5.2 to expand discussion on consumptive water use and address uncertainty in discharge measurements.

Response:

Proposed revisions to the consumptive water use discussion in ER Section 10.5.2 are shown below.

ER analyses of water use impacts use flow data collected and published by the U.S. Geological Survey (USGS). The USGS takes measurements in water bodies across the United States, relying on monitoring equipment at gaging stations. Proper installation and maintenance of gaging stations are critical activities for ensuring quality in stream flow data collection and analysis. The USGS South Carolina District has written policies and procedures designed to ensure data quality and accurate reporting (Cooney 2001).

It is the USGS Office of Surface Water policy that surface-water stage records at stream sites be collected with instruments and procedures that provide sufficient accuracy to support computation of discharge from a stage-discharge relation, unless greater accuracy is required (USGS 1992). In general, operation of gaging stations for the purpose of determining daily discharge includes the goal of collecting stage data at the accuracy of + or - 0.01 foot (USGS 1989). Although stage data are collected for various purposes, the predominant use is for computation of discharge, or streamflow, from a stage-discharge relationship. Stage-discharge relations commonly have slopes of about 3 on logarithmic plots with discharge plotted as a function of effective stage (USGS 1992). This implies that a 1 percent error in the effective stage input would translate into a 3 percent error in the computed discharge. Accuracies of discharge records for individual days are commonly about 5 to 10 percent. Individual discharge measurements are seldom better than 2 percent. (USGS 1992)

Leveling, a procedure by which surveying instruments are used to determine the differences in altitude between points, is used to set the gages and to check them from time to time for vertical movement. Levels are run periodically to all bench marks, reference marks, reference points, and gages at each station for the purpose of determining if any datum changes have occurred. USGS South Carolina District policy requires that levels are run at newly installed gaging stations at the time of construction

and installation of recording devices. Levels are run to established gaging stations every 3 years or when discrepancies between inside and outside gages are observed and must be documented. Gages are reset to agree with levels when field personnel servicing the gaging station identify a deficiency and implement corrective actions to address a discrepancy in the water-surface elevations obtained in the gage pool. Inside reference gages, including the base gage, are reset if they are in error by more than 0.02 ft. Outside gages are reset if they are more than 0.02 ft. in error. When gages are reset, field personnel document the reset by stating clearly on the level note sheet the changes that were made and all gage readings at time of departure. (Cooney 2001)

There are two general types of errors associated with streamflow raw data. Persistent-type data errors are usually associated with some type of equipment failure whether in data collection or transmission, but could also be related to ice effects. Intermittent-type data errors, typically the result of a data transmission error, often show up as either a zero or an unreasonably large value. When deficiencies are identified, the field technician responsible for the gage makes a site visit with spare equipment to repair or replace instrumentation. (Cooney 2001)

Extreme values will be filtered from the real-time internet values available on the station's web page by populating the "very high" threshold in the Automated Data Processing System with the gage height of the instrument shelf and the "very low" threshold in the Automated Data Processing System with the value of 0.01 feet. Then further data validation and quality assurance processes are applied to review data from each station and its use in computations prior to its publication. The QA program for the SC data stations is documented in the *Surface Water Quality-Assurance Plan for the South Carolina District of the U.S. Geological Survey.* (Cooney 2001)

References:

Cooney 2001. T.W. Cooney, *Surface Water Quality-Assurance Plan for the South Carolina District of the U.S. Geological Survey*, Open-File Report 01-121. Available online at http://sc.water.usgs.gov/publications/pdfs/OFR-01-121-QW.pdf.

USGS 1992. C. W. Boning, Chief, Office of Surface Water, *Policy Statement on Stage Accuracy*, Office of Surface Water Memorandum 93.07, December 4, 1992. Available online at http://water.usgs.gov/admin/memo/SW/sw93.07.html

USGS 1989. E. D. Cobb, Acting Chief, Office of Surface Water, *Policy Statement on Stage Accuracy*, Office of Surface Water Memorandum 89.08. Available online at http://water.usgs.gov/admin/memo/SW/sw89.08.html

COLA Revisions:

SCE&G will revise ER Section 10.5.2 in a future ER revision as follows:

10.5.2 CUMULATIVE IMPACTS OF OPERATIONS

Units 2 and 3 would remove water from Monticello Reservoir and return water, minus consumptive loss, to Parr Reservoir. ~~After operations begin, Units 2 and 3 would use~~

~~greater quantities of surface water than during the construction activities.~~ Units 2 and 3 are estimated to consume approximately 27,800 gpm to 31,100 gpm for normal and maximum use operations, respectively (Subsection 5.2.1). The long-term, annual mean of the Broad River flow in the vicinity of the VCSNS site at Alston, South Carolina is 2,829,000 gpm (6,300 cfs). The lowest annual mean flow at Alston is 966,300 gpm (2,150 cfs). Therefore, approximately 1% (normal and maximum use operations) of the average annual flow and 2.9% (normal operations) to 3.2% (maximum use operations) of the lowest annual mean flow of the Broad River at Alston would be lost. As stated in Section 5.2, consumptive losses due to operation of Units 2 and 3 would, under normal circumstances (typical annual flows), be barely discernible on the flow of the Broad River, thus the impact would be SMALL. The additional consumption of water by Unit 1 would not significantly change this assessment. Unit 1 consumes approximately 5,800 gpm of water from the Monticello Reservoir, which is approximately 1.5% of the 7Q10 flow of the Broad River at Alston. The cumulative consumptive water use for Units 1, 2, and 3 using the maximum operations estimate would be approximately 9.6% of the 7Q10 flow.

~~As stated in Section 5.2, consumptive losses due to operation of Units 2 and 3 would, under normal circumstances (typical annual flows), be barely discernible on the flow of the Broad River. The additional consummation of water by Unit 1 would not significantly change this assessment.~~ During low-flow periods, the impact of this consumptive use on the availability of water downstream of the plant would be mitigated by the reservoirs from which SCE&G could remove water instead of directly removing water from the Broad River. As described in Section 2.3, water withdrawals, storage, and flow involves the Parr Hydro Station, Fairfield Pumped Storage Facility (FPSF), and VCSNS. Water flow to support these facilities is as follows: Parr Hydro Station draws water from Parr Reservoir and discharges water to the Broad River. FPSF draws water from Parr Reservoir and discharges it to Monticello Reservoir (pumpback mode) and also discharges water to Parr Reservoir from Monticello Reservoir (generation mode). VCSNS Unit 1 withdraws water from and discharges water back to Monticello Reservoir. Units 2 and 3 would withdraw water from Monticello Reservoir and return water to Parr Reservoir. The usable storage inventory of water transferred by FPSF between the two reservoirs is 29,000 acre-feet. An additional emergency drawdown inventory of 16,000 acre-feet of water is available in the Monticello Reservoir for a total usable storage inventory of 45,000 acre-feet (Section 5.2). Using the stored water to provide cooling water for VCSNS Units 1-3 during low flow periods would allow the downstream flow requirements of the Parr Project Federal Energy Regulatory Commission (FERC) license to be met, ensuring that downstream impacts from the cumulative consumptive water use of the three nuclear units would be SMALL. As discussed in Section 2.3.2, the FERC license stipulates minimum flows from the Parr Shoals Dam into the Broad River stating that the flow shall be maintained at 1,000 cfs or at the average daily natural inflow into Parr Reservoir (less evaporative losses from the Parr and Monticello reservoirs) during the striped bass spawning season in March, April, and May in order to protect the fishery of the Broad River. During the rest of the year, the minimum daily average flow below the dam shall be maintained at 800 cfs or at the average daily natural inflow into Parr Reservoir minus evaporation from the Parr and Monticello Reservoirs. Should adequate water to maintain the minimum operating level of Monticello Reservoir provided by the FERC license not be available through pumpback operation of FPSF (an emergency drawdown level may be applicable), SCE&G would curtail or cease operation of VCSNS until water is available.

Therefore, the flow requirements downstream would be met under all scenarios and the cumulative impact would remain SMALL.

SCE&G identified one other planned significant water consumer, Duke Energy's proposed Lee Nuclear Station (Section 2.8 and Figure 2.8-1), which would be upstream of Units 2 and 3. Lee Nuclear is proposed to consist of two AP1000 units with 2,200 MW capacity that would be operational by 2016 (~~Duke Energy 2007a~~). Lee Nuclear would be comparable to Units 2 and 3 in design, capacity, and construction and operational timeframes. Duke Energy estimated the Lee Nuclear maximum consumption rate of Broad River water at 64 cfs (28,723 gpm), approximately 2.5 percent of the average annual flow of the Broad River at the Gaffney station. Duke Energy conducted analyses for downstream impacts to the Broad River. The analyses factored in the operating requirements for the Ninety-Nine Islands Hydroelectric Station FERC license, historic low-flow conditions, as well as the consumptive use of the Lee Nuclear proposed units. The minimum flow limit in the FERC license for the Ninety-Nine Islands Hydroelectric Station (July through November) is 483 cfs. Duke Energy concluded that flow conditions of the FERC license could be met by operational controls at the proposed nuclear plants involving its water impoundments with only an estimated need to curtail operations at Lee Nuclear once every 16.6 years. Therefore, Duke Energy characterized the impact of Lee Nuclear operations to downstream users as SMALL. (Duke Energy 2009)~~Duke Energy has conducted a water supply study for the entire Broad River Basin (Duke Energy 2007b).. The study included analyses for the Upper Broad River Basin, where the proposed Lee Nuclear would be located, and the Lower Broad River Basin. The analysis of the Lower Broad River Basin includes the Monticello and Parr Reservoirs and the projected water usage by VCSNS Unit 1 and the proposed Units 2 and 3. The analyses of the long term availability of water in the Broad River Basin would enable Duke Energy to design water supply reserves as necessary to operate Lee Nuclear within safe water yield parameters.~~ Therefore, cumulative impacts of the operation of VCSNS (3 units) and Lee Nuclear with any necessary water supply features and mitigation measures are expected to have a SMALL impact on water usage in the Lower Broad River Basin.

Changes to references:

Delete Duke Energy 2007b

Replace Duke Energy 2007a with:

Duke Energy 2009. William States Lee III Nuclear Station COL Application Part 3, Applicant's Environmental Report – Combined License Stage (Environmental Report) Revision 1. March 30. Available online at http://adamswebsearch2.nrc.gov/idmws/ViewDocByAccession.asp?AccessionNumber=ML090990348

SW-14 References

PROGRAMS AND PLANS--Policy Statement on Stage Accuracy

In Reply Refer To: June 2, 1989
WGS-Mail Stop 415

OFFICE OF SURFACE WATER TECHNICAL MDMORANDUM NO. 89.08

SUBJECT: PROGRAMS AND PLANS--Policy Statement on Stage Accuracy

The U.S. Geological Survey (USGS) collects water-level or stage data for many purposes. A common purpose is to obtain a flow characteristic that can be related directly to discharge. Other uses are to determine stage in estuaries, lakes, reservoirs, streams, and ground-water levels.

This memorandum discusses policy as it relates to the measurement of stage for the purpose of determining stream discharge at regular daily discharge gaging stations.

The USGS has traditionally used a stage-accuracy goal of + or - 0.01 foot (ft). In recent years, many stage-sensing devices have been marketed which are incapable of meeting this accuracy objective. Extensive testing and evaluation of a variety of sensor systems has been carried out at the USGS Hydrologic Instrumentation Facility (HIF), and some pressure-based sensing systems have been identified that offer acceptable alternatives to mercury manometers and stilling wells.

Surface Water Branch Technical Memorandum 85.08 acknowledges the difficulty of obtaining high accuracy stage measurements at sites with unstable channels or other problems and allows for relaxing normal accuracy goals for these stations. Additionally, data needs such as reconnaissance, special studies, and similar activities sometimes may be met with less accurate stage observations. In these cases, District management is responsible for determining acceptable accuracy requirements.

The intent of this memorandum is to reaffirm the present stage accuracy goal of + or - 0.01 ft for daily discharge stations and also allow for cases where lower accuracy is appropriate. HIF's efforts to procure new pressure-sensor systems for stage measurement are a step towards achieving this accuracy goal.

Data may be used for purposes not foreseen at the time of collection, and the possibility of other uses should be considered before modifying the general accuracy criteria.

Ernest D. Cobb
Acting, Chief, Office of Surface Water

WRD Distribution: A, B, S, FO, PO

Policy Statement on Stage Accuracy

In Reply Refer To: December 4, 1992
Mail Stop 415

OFFICE OF SURFACE WATER TECHNICAL MEMORANDUM NO. 93.07

SUBJECT: Policy Statement on Stage Accuracy

The purpose of this memorandum is to generalize and clarify USGS policy on accuracy goals for collection of surface-water stage (water-level) or gage height data. For a number of years, USGS practice in stage data collection has been guided by statements in USGS Water-Supply Paper (WSP) 2175, page 63, and USGS Techniques of Water-Resources Investigations, Book 3, Chapter A-7, (TWRI 3A7), page 24, that an accuracy of 0.01 foot usually is needed for stage records used in computation of discharge. These statements are expressed as an accuracy goal and policy for stage data collection in OSW TM 89.08. In all cases, the accuracy has been expressed as an absolute magnitude of 0.01 ft, independent of the stage being measured. Widespread use of stage sensors other than floats in stilling wells and increased concern for assurance of record quality have led to a need for reassessment, explanation, and generalization of this policy.

Although stage data are collected for various purposes, the predominant use is for computation of discharge from a stage-discharge relation. Because the uses to which stage data may be put cannot be predicted, it is OSW policy that surface water stage records at stream sites be collected using instruments and procedures that provide sufficient accuracy to support computation of discharge from a stage-discharge relation, unless higher accuracy is required. A specific numerical accuracy criterion is given in a following paragraph. At non-stream (reservoir, lake, estuary) sites, the same numerical accuracy goal is to be used unless higher accuracy is required. Higher accuracy may be required for computation of storage changes in reservoirs or for computation of discharge using slope ratings or unsteady-flow models; in such cases, the instruments and procedures needed to achieve the required accuracy should be used. When field conditions such as high velocities, wave action, or channel instability make it impossible to collect accurate stage data or to define an accurate stage-discharge relation, stage data should be collected with the greatest accuracy feasible, using instruments and methods appropriate for the field conditions.

The accuracy of surface water discharge records depends on the accuracy of discharge measurement, the accuracy of rating definition, and the completeness and accuracy of the gage-height record. Accuracies of discharge records for individual days commonly are about 5 to 10 percent. Individual discharge measurements seldom are better than 2 percent. Stage discharge relations commonly have slopes of about 3 on logarithmic plots in which discharge is plotted as a function of effective stage (gage height minus offset, where offset commonly is approximately equal to gage height of zero flow). This implies that a 1 percent error in the effective stage input to the rating would translate into a 3 percent error in the computed discharge.

The total uncertainty in discharge computed from a stage discharge relation is the square root of the sum of squares of this error and other unavoidable errors and approximations in the flow measurement and rating development procedures. Examination of the equation x = \r(z2 + 7y2) shows that improvement in the stage-accuracy component (z) much beyond the combined accuracy of the other error sources (y) will have rapidly diminishing effect on the improvement of the overall accuracy (x). Thus, although 0.01 ft stage accuracy may be needed at low stages and discharges, that degree of accuracy is not essential for accurate determination of discharge at high stages.

An acceptable balance between stage-measurement accuracy and other components of discharge-record accuracy can be achieved by using instruments capable of sensing and recording stage with an accuracy of either 0.01 ft or 0.2 percent of the effective stage being measured, whichever is less restrictive. For example, the required accuracy would be 0.06 ft at 30 ft effective stage, 0.02 ft at 10 ft, and 0.01 ft at all effective stages less than 5 ft. In this context, effective stage is the height of the water surface above the orifice or other point of exposure of the sensor to the water body; the instrument should be installed in the field with the orifice only sightly below the zero-flow stage.

When evaluating instrument accuracy specifications, it should be noted that many instruments are rated in terms of full-scale percentage accuracy. An instrument with 50-ft range and 0.2-percent full-scale accuracy has an absolute error tolerance of 0.10 ft, applicable throughout the range of stage, and thus would not have sufficient accuracy at low stages.

Realistic evaluation of instrument accuracy requires a combination of specialized laboratory testing and field trials under controlled conditions. The laboratory tests evaluate instrument accuracy by comparisons with known measurement standards over a range of specified stages, temperatures, and other conditions; the field tests evaluate the instrument's ability to operate reliably and maintain its accuracy with time under a range of field operating conditions. One of the major functions of the USGS Hydrologic Instrumentation Facility (HIF) is the performance of laboratory and field evaluations, which are carried out through the Test and Evaluation Section. Results of laboratory and field tests of pressure sensor systems for stage measurement regularly are distributed to WRD offices in the HIF newsletter (WRD Instrument News) and in the INSTRUMENTS continuum on the QVARSA node of the USGS DIstributed Information System (DIS). When selecting stage-measurement instrumentation, Districts should refer to the HIF newsletter and the INSTRUMENTS continuum, and should consult with the HIF and other appropriate sources for information on accuracy and field performance of any instruments under consideration.

Accurate stage measurement requires not only accurate instrumentation but also proper installation to ensure that the stage of the water body is accurately transmitted to the sensor. In addition, continual monitoring of the performance of all system components is necessary to ensure that accuracy does not deteriorate with time. The standard methods for stage measurement described in WSP 2175 and TWRI 3A7 were developed for this

purpose; these methods include frequent reading of independent reference gages, comparison of inside and outside gages, observation of high water marks, redundant recording of peaks and troughs by use of max/min indicators, use of crest stage gages, and regular maintenance of gage datums by levels. These checks should be augmented as appropriate for unusual field conditions and instrument types not discussed in the standard references. Hydrographers should notice and keep records of instrument performance, including comparisons of recorded stages with reference gage readings, and any corrections applied. These records should be considered in evaluations of instrument suitability, in maintenance of District quality assurance plans, and in planning of future operations.

Charles W. Boning, Chief
Office of Surface Water

This memorandum supersedes Office of Surface Water Technical Memorandum No. 89.08.

WRD DISTRIBUTION: A, B, S, FO