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November 22, 2011

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

Subject: Duke Energy Carolinas, LLC
William States Lee III Nuclear Station – Docket Nos. 52-018 and 52-019
AP1000 Combined License Application for the
William States Lee III Nuclear Station Units 1 and 2
Supplemental Response to RAI No. 10.04.05-2
Ltr #: WLG2011.11-03

Reference: Letter from Bryan J Dolan (Duke Energy) to Document Control Desk (NRC), *Response to Request for Additional Information Letter No. 003 Related to SRP Section 10.04.05 for the William States Lee III Units 1 and 2 Combined License Application*, dated September 10, 2008 (ML082560247)

This letter provides supplemental information to the Duke Energy response to the Nuclear Regulatory Commission's request for additional information (RAI 10.04.05-2) included in the reference document. Additional supplemental information is provided in this letter associated with enhancements to the site grading and drainage plan and related impacts to various surface flooding analyses.

Supplemental information for the response is addressed in the attached Enclosure 1, which also identifies associated changes, when appropriate, that will be made in a future revision of the Final Safety Analysis Report for the Lee Nuclear Station. Enclosure 2 contains input-output files related to analyses discussed in this supplemental information.

If you have any questions or need any additional information, please contact James R. Thornton, Nuclear Plant Development Licensing Manager (Acting), at (704) 382-2612.

Sincerely,

Ronald A. Jones
Senior Vice President
Nuclear Development

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NRO

Enclosures:

1) Lee Nuclear Station Supplemental Response to Request for Additional Information (RAI),Letter No. 003, RAI 10.04.05-2
2) Input-Output Files Related To Analysis of Site Local Intense Precipitation

AFFIDAVIT OF RONALD A. JONES

Ronald A. Jones, being duly sworn, states that he is Senior Vice President, Nuclear Development, Duke Energy Carolinas, LLC, that he is authorized on the part of said Company to sign and file with the U. S. Nuclear Regulatory Commission this combined license application for the William States Lee III Nuclear Station, and that all the matter and facts set forth herein are true and correct to the best of his knowledge.

Ronald A. Jones, Senior Vice President
Nuclear Development

Subscribed and sworn to me on November 22, 2011

Teresa D. Neely
Notary Public

My commission expires: 9/2/2015

SEAL

TERESA D. NEELY
NOTARY PUBLIC
GASTON COUNTY, NC
MY COMMISSION EXPIRES 09/02/2015

xc (w/o enclosures):

Charles Casto, Deputy Regional Administrator, Region II

xc (w/enclosures):

Brian Hughes, Senior Project Manager, DNRL

Lee Nuclear Station Supplemental Response to Request for Additional Information (RAI)

RAI Letter No. 003

NRC Technical Review Branch: Balance of Plant Branch 1

Reference NRC RAI Number(s): 10.04.05-2 (Tracking Number 484)

NRC Request for Additional Information:

10.04.05-2: In FSAR Section 10.4.5.2.2, the applicant stated that little or no water would reach the plant from a cooling tower basin wall breach due to the remote location of the tower and the grading of the site. However, the staff could not find any further details regarding the location and proximity of the mechanical draft cooling towers with respect to the plant and safety-related equipment. Regarding the circulating water system (CWS), the regulatory basis for acceptance of COL Information Item 10.4-1 (COL Action Item 10.5-3) is established in General Design Criterion (GDC 4), "Environmental and Dynamic Effects Design Bases," as it relates to design provisions to accommodate the effects of discharging water that may result from a failure of a component or piping in the CWS. In addition, Item 1.A of SRP Acceptance Criteria in SRP Section 10.4.5, "Circulating Water System," states that means should be provided to prevent or detect and control flooding of safety-related areas so that the intended safety function of a system or component will not be precluded due to leakage from the CWS.

Therefore, the staff requests additional information regarding the effects of cooling tower failure on safety-related equipment and structures of the plant. Please provide clarification and/or additional information regarding the location of the cooling towers with respect to the plant and confirm that failure of these towers will not affect the structures, systems, or components that perform or support a safety-related function.

Duke Energy Supplemental Response:

Duke Energy provided a response to the subject RAI in Reference 1. This is a supplement to that response and provides updated information to address questions on circulating water system (CWS) related flooding analyses raised by the NRC staff.

The supplemental information provided in this response addresses the following subjects:

1. General Discussion of Enhancements to Site Grading and Drainage Plan
2. Flooding Evaluation of Cooling Tower Basin and CWS Piping Failures
3. Updated Analysis of Local Intense Precipitation (and Related Surface Flooding Considerations)
4. Updated Analysis of Make-Up Pond B Related Flooding
5. Input and Output File Information

Revisions to FSAR Chapter 2 text and tables are provided in Attachment 1.

Revisions to FSAR Chapter 2 figures are provided in Attachment 2.

Revisions to FSAR Chapter 10 (Subsection 10.4.5.2.2) are provided in Attachment 3.

Revisions to FSAR Chapter 19 (Table 19.58-201) are provided in Attachment 4.

Revisions to FSAR provided in Attachments 1, 2, 3 and 4 will be incorporated in a future revision of the FSAR.

1. General Discussion of Enhancements to Site Grading and Drainage Plan

To improve overall site drainage a number of enhancements have been made to the site grading and drainage plan (see revised FSAR Figure 2.4.2-202 in Attachment 2 to this Enclosure). These site enhancements include revisions, additions, and removal of existing and previously planned grading features. The overall site grading has been revised to incorporate the following changes.

- The ridge to the northwest of Unit 1 and the two cooling tower berms on either side of the units have been removed. The cooling tower design has been revised to include two individual towers per unit.

- Drainage flow paths to the Broad River (east channel on revised FSAR Figure 2.4.2-202) and Make-Up Pond B (northwest and southwest channels on revised FSAR Figure 2.4.2-202) have been revised, and the graded drainage flow path to Make-Up Pond A has been removed.

- The grading in the area of the power block has been redefined in more detail. Site contours have been reshaped to promote drainage away from the nuclear island (refer to new FSAR Figure 2.4.2-204 in Attachment 2 of this Enclosure). The finished floor elevation of the Nuclear Island remains unchanged at 590 ft msl.

- A vehicle barrier system (VBS) trench has been added to the security perimeter. The VBS is primarily a plant security feature but also supports stormwater drainage away from the power block area. However, the updated analysis of site flooding due to local intense precipitation (Section 3 of this response) conservatively ignores stormwater drainage benefits of the VBS.

Revisions to the site grading and drainage plan are important to the assessment of flooding effects related to cooling tower basin and CWS piping failure, addressed in Section 2 of this supplemental response. Because changes in site contours impact other aspects of FSAR Section 2.4, the following supplemental information is included in this response:

- Updated analysis of site flooding due to a local intense precipitation (Section 3 of this response), and

- Updated analysis of coincident wind wave effects and surge/seiche considerations for Make-Up Pond B (Section 4 of this response).

Discussion of changes to the cooling tower design and related changes to the CWS design are addressed in a separate Duke Energy letter to the NRC.

2. Flooding Evaluation of Cooling Tower Basin and CWS Piping Failures

Cooling Tower Basin Failure - In the enhanced site grading and drainage plan, the cooling tower basins are below grade. In the event of a basin failure, water would remain in the basin area and not migrate across the site. Thus, the flooding risk and related impacts to safety-related structures, systems, and components (SSCs) are insignificant.

CWS Piping Failure - This information supplements that provided on CWS piping failures discussed in the earlier response to RAI 10.04.05-2 (Reference 1). An additional evaluation was performed using an estimated flow rate that would result from a CWS piping failure in comparison to drainage flow rates (run-off flows) that are evaluated as part of the on-site local intense precipitation flooding analysis. The flow resulting from a CWS pipe break within the turbine building will discharge through relief panels located on the east side of the turbine building. Potential drainage pathways were identified for the variety of possible on-site flow paths. In each case, the CWS piping failure flow rate was determined to be less than the drainage path flow rates expected during a local intense precipitation event. Thus, the flooding effects of a postulated CWS piping failure are bounded by the effects associated with the analyzed local intense precipitation event.

These evaluations confirm the information presented in Reference 1. A break in the cooling tower basin or associated CWS piping will not have an adverse effect on safety-related SSCs. The grading of the site, combined with the location of the cooling towers and the associated CWS piping, and the sub-grade cooling tower basin elevation will preclude adverse interactions with safety-related SSCs.

FSAR Subsection 10.4.5.2.2 will be revised to reflect the cooling tower basin design and this assessment of flooding effects. Changes to FSAR Subsection 10.4.5.2.2 are provided in Attachment 3.

3. Updated Analysis of Local Intense Precipitation (and Related Surface Flooding Considerations)

Enhancements to the site grading and drainage plan (revised FSAR Figure 2.4.2-202) required updated analysis of local intense precipitation. The updated analysis resulted in a slight increase in the maximum water surface elevation from 589.57 ft. msl to 589.62 ft. msl. The result of this updated analysis provides the maximum flood elevation for water features at the site. Therefore, the maximum flood level at the Lee Nuclear Station is elevation 589.62 ft. msl. The Lee Nuclear Station safety-related structures have a grade elevation of 590 ft. msl.

Updates to the FSAR related to the updated analysis of local intense precipitation are as follows:

- FSAR Table 2.0-201 will be revised to reflect that the maximum water surface elevation is in compliance with the AP1000 DCD site parameter for "flood level."
- FSAR Subsection 2.4.2.2 will be revised to reflect the results of this updated analysis.
- FSAR Subsection 2.4.2.3 will be revised to provide an updated description of the analysis.
- New FSAR Figure 2.4.2-204 illustrates the modeling approach of the power block area (as described in updated FSAR Subsection 2.4.2.3).
- FSAR Table 2.4.2-204 will be updated to provide revised analysis results.
- FSAR Subsection 2.4.14 will be revised to reflect the results of this updated analysis.
- FSAR Subsection 2.4.16 will be revised to add new references.
- FSAR Table 19.58-201 will be revised to reflect the results of this updated analysis.

FSAR updates are provided in Attachments 1, 2, and 4.

4. Updated Analysis of Make-Up Pond B Related Flooding

Revised site grading (as shown on revised FSAR Figure 2.4.2-202) required updated analysis of coincident wind wave activity related to Make-Up Pond B (MUPB). Based on this updated analysis, the maximum flood level for MUPB with the added effects of wind wave activity increased from 584.8 ft msl to 585.7 ft msl. The Lee Nuclear Station safety-related structures have a grade elevation of 590 ft. msl.

Changes to the FSAR related to the MUPB updated analysis are as follows:

- FSAR Subsections 2.4.1.2.2.6, 2.4.2.2, 2.4.3.6, 2.4.14 and Table 19.58-201 will be revised to reflect the results of this updated analysis.
- FSAR Figure 2.4.3-234 (critical fetch length) will also be revised consistent with this updated analysis.

The revised site grading also required an updated analysis of surge and seiche flooding for MUPB. FSAR Subsection 2.4.5 will be revised to provide the related updates resulting from these analyses. FSAR Figure 2.4.5-202 will also be revised to provide an updated critical fetch length associated with surge flooding.

5. Input and Output File Information

To support NRC review, input and output files related to updated analysis of site local intense precipitation are provided in Enclosure 2 on a CD ROM. The enclosure also provides a listing of files included on the disc.

References:

1. Duke Energy Letter, Ltr. # WLG2008.09-02, dated September 10, 2008, from B.J. Dolan to Document Control Desk, U.S. Nuclear Regulatory Commission, Lee Nuclear Station, Response to Request for Additional Information, RAI Letter No. 003, NRC RAI No. 10.04.05-2, (ML082560247).

Associated Revisions to the Lee Nuclear Station Combined License Application:

1. FSAR Table 2.0-201
2. FSAR Subsection 2.4.1.2.2.6
3. FSAR Subsection 2.4.2.2
4. FSAR Subsection 2.4.2.3
5. FSAR Table 2.4.2-204
6. FSAR Figure 2.4.2-202
7. New FSAR Figure 2.4.2-204
8. FSAR Subsection 2.4.3.6
9. FSAR Figure 2.4.3-234
10. FSAR Subsection 2.4.5
11. FSAR Figure 2.4.5-202
12. FSAR Subsection 2.4.14
13. FSAR Subsection 2.4.16
14. FSAR Subsection 10.4.5.2.2
15. FSAR Table 19.58-201

Attachments:

Attachment 1 to Supplemental Response to RAI 10.04.05-02, Revision to FSAR Chapter 2 Text and Tables

Attachment 2 to Supplemental Response to RAI 10.04.05-02, Revision to FSAR Chapter 2 Figures

Attachment 3 to Supplemental Response to RAI 10.04.05-02, Revision to FSAR Chapter 10

Attachment 4 to Supplemental Response to RAI 10.04.05-02, Revision to FSAR Chapter 19

Lee Nuclear Station

Attachment 1 to Supplemental Response to

Request for Additional Information

RAI 10.04.05-02

FSAR Chapter 2 Text and Table Revisions:

FSAR Table 2.0-201, Sheet 6 of 8
FSAR Subsection 2.4.1.2.2.6
FSAR Subsection 2.4.2.2
FSAR Subsection 2.4.2.3
FSAR Table 2.4.2-204
FSAR Subsection 2.4.3.6
FSAR Subsection 2.4.5
FSAR Subsection 2.4.14
FSAR Subsection 2.4.16

WLS SUP 2.0-1

TABLE 2.0-201 (Sheet 6 of 8)
COMPARISON OF AP1000 DCD SITE PARAMETERS AND LEE NUCLEAR STATION UNITS 1 & 2 SITE CHARACTERISTICS

	AP 1000 DCD Site Parameters	WLS Site Characteristic	WLS FSAR Reference	WLS Within Site Parameter
Flood Level	Less than plant elevation 100' (WLS Elevation 590' msl)	589.62 ft. msl ~~584.8'~~585.7 ft. msl	Subsection 2.4.2.3 Subsection ~~2.4.3.6~~2.4.1.2.2.6	Yes
Groundwater Level	Less than plant elevation 98' (WLS Elevation 588' msl)	Maximum and average groundwater elevation is projected to be around 584 and 579.4 ft. msl, respectively, with AP1000 elevation 100 ft at 590 ft. msl. This allows for approximately 5 to 10 ft. of unsaturated interval below the plant grade elevation 100 ft.	Subsection 2.5.4.1.3	Yes
Plant Grade Elevation	Less than plant elevation 100' (WLS elevation 590' msl) except for portion at a higher elevation adjacent to the annex building	589.5 ft. msl	Subsection 2.4.1.1.3	Yes
Precipitation				
Rain	20.7 in./hr [1-hr 1-mi^2 PMP]	18.9 in./hr. [1-hr 1-mi^2 PMP]	Table 2.4.2-203	Yes
Snow / Ice	75 pounds per square foot on ground with exposure factor of 1.0 and importance factors of 1.2 (safety) and 1.0 (non-safety)	17.7 pounds per square foot	Subsection 2.3.1.2.7.3	Yes

COLA Part 2, Subsection 2.4.1.2.2.6, the sixth paragraph under the sub-heading Make-Up Pond B is revised to read:

The maximum flood level of surface water features at the Lee Nuclear Station is elevation ~~584.8~~585.7 ft. msl. This elevation would result from a Probable Maximum Flood (PMF) event on Make-Up Pond B watershed with the added effects of coincident wind wave activity as described in Subsection 2.4.3. The Lee Nuclear Station safety-related structures have a grade elevation of 590 ft. msl.

COLA Part 2, FSAR Chapter 2, Subsection 2.4.2.2 is revised at the fourth paragraph as follows:

The maximum flood level at the Lee Nuclear Station is elevation ~~584.8~~589.62 ft. msl. This elevation would result from a PMP event on the Lee Nuclear Station site (local intense precipitation) as described in Subsection 2.4.2.3.~~PMF event on Make-Up Pond B watershed with the added effects of coincident wind wave activity as described in Subsection 2.4.3~~. The maximum flood level of surface water features at the Lee Nuclear Station is elevation 585.7 ft. msl. This elevation would result from a Probable Maximum Flood (PMF) event on Make-Up Pond B watershed with the added effects of coincident wind wave activity as described in Subsection 2.4.3. The Lee Nuclear Station safety-related plant elevation is 590 ft. msl. These maximum flood levels are ~~is~~ identified as ~~a~~ site characteristics in Table 2.0-201.

COLA Part 2, FSAR Chapter 2, Subsection 2.4.2.3 is revised as follows:

The Lee Nuclear Station drainage system was evaluated for a storm producing the PMP on the local area. ~~The~~ Portions of the site ~~is~~ are relatively flat; however, the site is graded such that overall runoff will drain away from safety-related structures to Make-Up Pond B, Make-Up Pond A, or directly to the Broad River. The PMP flood analysis assumes that all discharge structures are non-functioning. Computed water surface elevations in the vicinity of safety-related structures are below plant elevation of 590 ft. The site grading and drainage plan is shown in Figure 2.4.2-202.

The site is graded to drain runoff away from the power blocks. The finished floor elevation is 590 ft. The areas immediately ~~surrounding~~ adjacent to the power blocks ~~are~~ range in elevation from 589.5 ft. to 587 ft. The adjacent grading also incorporates catch basins at an elevation as low as 586 ft. The ~~immediate surrounding~~adjacent area is ~~flat and~~ generally ~~is~~ bounded by ~~the~~ a roadway surrounding the power blocks ~~also at elevation 589.5 ft~~. The power block area bounded by the roadway is either paved or gravel surface. Areas beyond the roadway are generally maintained grass surfaces. Further from the power blocks, the site gently slopes away from the roadway to the vehicle barrier system at elevation 586.5 ft. Beyond the vehicle barrier system, the site continues to gently slope away to a general elevation ranging from ~~of 588~~ 586 ft. to 585 ft. before encountering the steeper slopes into the adjacent water bodies.~~Areas beyond the roadway are generally maintained grass surfaces.~~

~~To analyze the effects of local intense precipitation, the site was divided into four drainage areas (northwest, northeast, southwest, southeast) based on the contours of the grading and drainage plan. Each area was modeled using the U.S. Army Corps of Engineers HEC-RAS version 3.1.3 (Reference 273) (standard-step, backwater analysis) computer software. Cross sections for each of the four areas were determined based on the grading and drainage plan and flows were modeled under steady state conditions. Buildings were modeled to obstruct flow and were not assumed to provide any storage. Tailwater elevations for the Broad River, Make-Up Pond B, and Make-Up Pond A correspond with the higher of the peak PMF water surface elevation provided in Subsection 2.4.3 or the peak dam failure water surface elevation provided in Subsection 2.4.4. A Manning's roughness coefficient, n = 0.025, was used for the paved or gravel surfaces. A Manning's roughness coefficient, n = 0.050 was used for the grass surfaces.~~

~~In the northwest drainage area, a wide, shallow, flat sloped swale directs runoff west to Make-Up Pond B. In the northeast drainage area, a wide shallow swale directs runoff east to the back waters of the Broad River. The swales are bounded by the roadway surrounding the power blocks and the embedded railway track to the north. The at-grade railroad tracks were not considered to provide any type of obstruction. Beyond the railway tracks are several warehouse structures and open areas with a yard elevation of 588 ft. The yard elevation then slopes steeply into Hold-Up Pond A or the backwaters of the Broad River. Because the yard elevation area is graded flat, approximately half of these areas are assumed to contribute runoff to the modeled areas and are also available for storage. The remaining half of the area is assumed to runoff toward the steeper slopes.~~

~~The division for the northern swales begins at the road running between the power blocks to the warehouses. The northeast swale drains runoff to backwaters of the Broad River. The swale width narrows as it passes the elevated cooling tower pad for Unit 2 then widens as it approaches the steeper slopes into the backwaters of the Broad River. The narrowing location~~

~~is used as the critical cross section for determining the time of concentration in the drainage calculations.~~

~~The northwest swale drains runoff to Make-Up Pond B. The swale width narrows as it passes the elevated cooling tower pad for Unit 1 then empties into a wider area adjacent to Make-Up Pond B. The narrowing location is used as the critical cross section for determining the time of concentration in the drainage calculations.~~

~~In the southwest drainage area, a narrow, shallow, flat sloped swale directs runoff west to Make-Up Pond B and in the southeast drainage area, a wide, shallow, flat sloped swale directs runoff east to Make-Up Pond A. The swales are bounded by the roadway surrounding the power blocks and further to the south by steeply rising elevation up to a hill feature and the transmission yard.~~

~~The division for the southern swales begins at the series of structures identified as the maintenance support building, and administration building. The southwest swale narrows as it passes through a cut area between the elevated cooling tower pad for Unit 1 and a hill feature. The narrowing location is used as the critical cross section for determining the time of concentration in the drainage calculations. Beyond the narrowest point the cut swale widens and steepens before it drops into Make-Up Pond B.~~

~~The southeast swale maintains a relatively constant width as it passes between the elevated cooling tower pad for Unit 2 and the elevated transmission yard. This location is used as the critical cross section for determining the time of concentration in the drainage calculations. Beyond the critical cross section, the swale widens and the slope gradually increases as the elevation drops into Make-Up Pond A.~~ The effects of local intense precipitation are analyzed using a series of models, each establishing boundary conditions for additional modeling. Because the slopes across the site are generally very shallow, the overall site is idealized as a dry reservoir and modeled using level-pool storage routing with U.S. Army Corps of Engineers HEC-HMS 3.5 computer software (Reference 302) for the drainage area shown in Figure 2.4.2-202. The power block area, shown in Figure 2.4.2-204, is then evaluated using standard weir flow equations. Therefore, the HEC-HMS modeling becomes the downstream boundary condition for the weir flow evaluation.

The site is modeled as a reservoir element in HEC-HMS. The reservoir element is defined by an elevation-discharge-storage relationship. An elevation-storage relationship is developed based on the available storage areas across the site within the drainage area. No storage is assumed for entire area of the power block within the 587 ft. contour that loops around the two units. In addition, all other site structures are assumed to provide no storage.

There are three defined channels directing runoff either west to Make-Up Pond B or east to the Broad River. Although runoff would also spread out across the site, flowing north between structures to the Broad River and southeast to Make-Up Pond A, these flow paths are not considered in the analysis. The three channels are modeled using standard-step, backwater analysis with U.S. Army Corps of Engineers HEC-RAS 4.1 computer software (Reference 303) to establish the elevation-discharge relationship for the overall site modeling. The downstream boundary conditions for the channels are based on the peak PMF water surface elevations for the receiving water body, Make-Up Pond B or the Broad River.

Cross sections for each of the three channels are determined based on the grading and drainage plan. Site structures are modeled to obstruct flow and are assumed to provide no storage. A Manning's roughness coefficient of n = 0.050 is used for all cross sections. HEC-RAS modeling was performed using steady state analysis to establish an elevation-discharge relationship at the upstream cross section. The results for the three channels are combined with the elevation-storage relationship to establish a complete elevation-discharge-storage relationship for the idealized reservoir.

The local intense PMP is defined by Hydrometeorological Report (HMR) Nos. 51 and 52. PMP values for durations from 6-hr. to 72-hr. are determined using the procedures as described in HMR No. 51 for areas of 10-sq. mi. (Reference 255). Using the Lee Nuclear Station location, the rainfall depth is read from the HMR No. 51 PMP charts for each duration.

The 1-sq. mi. PMP values for durations of 1-hour and less are determined using the procedures as described in HMR No. 52 (Reference 225). Using the Lee Nuclear Station location, the rainfall depth is read from the HMR No. 52 PMP charts for each duration. A smooth curve is fitted to the points. The derived PMP curve is detailed in Table 2.4.2-203. The corresponding PMP depth duration curve is shown in Figure 2.4.2-203.

HMR 52 guidance indicates that PMP rates for 10-sq. mi. areas are the same as point rainfall. Also indicated in HMR 52, the 1-sq. mi. PMP rates may also be considered the point rainfall for areas less than 1-sq. mi. Therefore, intensities for any drainage areas with durations longer than 1-hr. are derived from the PMP rates for 10-sq. mi. areas. Intensities for drainage areas with durations equal to or less than 1-hr. are derived from the PMP rates for 1-sq. mi. areas.

The AP1000 plant design is based on a PMP of 20.7 in/hr. As shown in Figure 2.4.2-203, the site is within the plant design limits for PMP. The PMP is identified as a precipitation site characteristic in Table 2.0-201. Roofs are sloped to preclude ponding of water.

~~The rational method (Reference 201) was used to determine peak runoff rates for the areas between each cross section of the four HEC-RAS models. The rational method is given by the equation:~~

$$\cancel{Q = k * C * i * A}$$

~~where: Q = runoff (cfs)~~

~~k = constant (1 for English units)~~

~~C = unitless coefficient of runoff~~

~~i = intensity (in/hr)~~

~~A = drainage area (ac.)~~

~~No runoff losses were assumed. Therefore the runoff coefficient was assumed equal to one. Rainfall durations are assumed equal to or greater than the time of concentrations for each site drainage area.~~

~~The intensity component of the rational method was determined for each of the four HEC-RAS models using the corresponding time of concentration for the drainage area and the depth duration curve for the local intense PMP provided in Table 2.4.2-203 and Figure 2.4.2-203. Because the site is so flat, with slopes less than one-half percent, an iterative process was used to determine the time of concentration.~~

~~For each HEC-RAS model an assumed time of concentration was used for the first trial. The time of concentration was converted to an intensity using the depth duration curve. The rational method was used to determine the flow at each cross section up to the critical cross section using the total drainage area at each cross section. The flow at the critical cross section was carried over to each successive downstream cross section. The calculated flows were inputted into the HEC-RAS models.~~

~~The resulting flow velocities from the HEC-RAS model at each cross section were averaged between successive cross sections and a travel time was determined based on the distance between successive cross sections. The total travel time to the critical cross section was then used as a new time of concentration. The process was repeated until the total travel time converged with the time of concentration.~~ Two storms are modeled on the basis of the PMP curve detailed in Table 2.4.2-203 and Figure 2.4.2-203. A 72-hr. duration storm with a 1-hr. precipitation interval is examined along with a 6-hr. duration storm with a 5-min. precipitation interval to capture the effect of the short-term, high intensity on the peak flow. The local intense PMP is converted to runoff at each increment by multiplying the drainage area by the intensity of each increment and converting the units to cubic feet per second. This approach is essentially equivalent to the Rational Method (Reference 201) using a runoff coefficient of one. Therefore, rainfall is converted to runoff instantaneously and no runoff losses are included.

Runoff is applied to the site reservoir model in HEC-HMS and level-pool storage routing is used to determine the resulting water surface elevation. Several time distributions are examined for both modeled storm events. For the 72-hr. duration storm, an end peaking storm event is found to result in the highest water surface elevation for the site. The corresponding hyetograph is provided in Figure 2.4.3-236.

As a conservative approach, the results from the 72-hr. duration storm are used to establish the starting elevation for the 6-hr. duration storm. For the 6-hr. duration storm, an end peaking storm event is also found to result in the highest water surface elevation for the site. The corresponding hyetograph is provided in Figure 2.4.3-235. Based on a combination of the two storms the maximum water surface elevation determined using HEC-HMS is 588.05 ft. This elevation is applied to the overall site and used as the downstream boundary condition for the analysis of the power block area immediately adjacent to the units.

As shown in Figure 2.4.2-204, runoff is directed away from the units to lower lying areas. Under the assumption that all subsurface drainage features are non-functional, runoff would overtop roadways or other topographical features as the flow exits the areas immediately adjacent to the units. Overtopping is evaluated using the standard weir flow equation and two approaches. The first approach is based on simply applying a weir flow coefficient of C = 2.6. The second approach is based on roadway overtopping methodology (Reference 304) and adjusting an initial weir flow coefficient of C = 2.5 for gravel or C = 2.9 for paving to account for weir submergence due to downstream conditions. The more conservative of the results is selected as the maximum water surface elevation.

For each area shown in Figure 2.4.2-204, the peak runoff is determined using the maximum PMP intensity of 6.2 in/5 min from Table 2.4.2-203. The peak runoff is determined by multiplying the drainage area by the intensity and converting the units to cubic feet per second. This approach is essentially equivalent to the Rational Method using a runoff coefficient of one. Therefore, rainfall is converted to runoff instantaneously and no runoff losses are included.

Runoff from Areas A, B1, and E2 overtops the roadway looping around the power block into the site area idealized as a reservoir. Runoff from Areas E1 and B2 overtops interior roadways into Area A. Runoff from Areas C1 and D1 overtops a combination of interior roadways and topographical features into Area B1. Similarly, runoff from Areas C2 and D2 overtops a combination of interior roadways and topographical features into Area B2.

The resulting water surface elevations are provided in Table 2.4.2-204. All Lee Nuclear Station safety-related structures are located above the effects of local intense precipitation at plant elevation 590 ft. The maximum water surface elevation determined is 589.62 ft. and occurs on the west side of each unit in the area between the Annex Building and the Diesel Generator Building. All Lee Nuclear Station safety-related structures are located above the effects of local intense precipitation at plant elevation 590 ft.

~~The resulting water surface elevations at the safety-related structures are identified in Table 2.4.2-204. All Lee Nuclear Station safety-related structures are located above the effects of local intense precipitation at plant elevation 590 ft. For each of the four areas modeled, the table also identifies: the total drainage area, the converged time of concentration for the drainage area, the corresponding PMP depth from the depth duration curve, the converted intensity used in the rational method formula, and the resulting flow rate at the critical cross section.~~

Due to temperate climate and relatively light snowfall, significant icing is not expected. Based on the site layout and grading, any potential ice accumulation on site facilities is not expected to affect flooding conditions or damage safety-related facilities. Ice effects are discussed in Subsection 2.4.7.

WLS COL 2.4-2

TABLE 2.4.2-204
SITE DRAINAGE AREAS DETAILS

Drainage Area	~~Area (ac.)~~ Flow Rate (cfs)	~~Time of Concentration (min.)~~	~~PMP Depth (in.)~~Weir Flow Coefficient (C)	~~Intensity (in/hr)~~ Total Effective Weir Length (ft.)	~~Flow Rate (cfs)~~ Maximum Depth of Flow (ft.)	Maximum Water Surface Elevation~~(1)~~ (ft.)
~~NW~~A	~~50.26~~ 1202	~~54~~	~~18.2~~2.6	~~20.2~~795.58	~~1015~~ 0.75	~~589.08~~588.75
~~NE~~B1	~~38.49~~ 538	~~122~~	~~22.6~~1.95	~~11.1~~641.09	~~427~~0.57	~~588.88~~588.07
~~SW~~C1	~~50.90~~ 30	~~420~~	~~31.5~~2.5	~~4.5~~69.12	~~229~~0.62	~~589.57~~589.62
~~SE~~D1	~~33.50~~ 95	~~55~~	~~18.4~~2.5	~~20.1~~102.34	~~673~~0.69	~~588.81~~589.19
E1	134		0.82	241.04	0.77	588.77
B2	538		0.58	641.09	1.28	588.78
C2	30		2.5	69.12	0.62	589.62
D2	95		2.5	102.34	0.69	589.19
E2	134		2.6	241.04	0.36	588.36

~~1) Resulting water surface elevation at safety-related structures using HEC-RAS steady state flow analyses.~~

COLA Part 2, FSAR Chapter 2, Subsection 2.4.3.6 is revised under the sub-heading, McKowns Creek/Make-Up Pond B, as follows:

McKowns Creek/Make-Up Pond B

Wind wave activity on Make-Up Pond B is evaluated coincident with the maximum water surface elevation of the PMF as discussed in Subsection 2.4.3.5. The determined critical fetch length of ~~1.48~~1.47 mi. is shown in Figure 2.4.3-234. The 2-year annual extreme mile wind speed is adjusted based on the factors of fetch length, level overland or over water, critical duration, and stability. The critical duration is approximately ~~36~~ 35 min. The adjusted wind speed is ~~50.22~~50.33 mph.

Significant wave height (average height of the maximum one-third of waves) is estimated to be 2.07 ft., crest to trough. The maximum wave height (average height of the maximum 1 percent of waves) is estimated to be 3.44 ft., crest to trough. The corresponding wave period is 2.2 sec.

The slopes approaching the units are not constant. The slopes above the PMF elevation are steep up to elevation 585.5 ft., then level out to an average of 0.36 percent. To represent a conservative approach, runup is calculated using the higher base elevation of 585.5 ft. instead of the PMF elevation. The ~~0.66~~0.36 percent slopes along the banks of Make-Up Pond B adjacent to the site are used to determine the wave setup and runup. The maximum runup, including wave setup, is estimated to be ~~0.26~~0.16 ft. The maximum wind setup is estimated to be 0.08 ft. Therefore, the total wind wave activity is estimated to be ~~0.34~~0.24 ft. The PMF and the coincident wind wave activity results in a flood elevation of ~~584.8~~585.7 ft. msl. The Lee Nuclear Station safety-related plant elevation is 590 ft. msl and is unaffected by flood conditions and coincident wind wave activity.

COLA Part 2, FSAR Chapter 2, Subsection 2.4.5 is revised under the sub-heading, Make-Up Pond B as follows:

Make-Up Pond B

Make-Up Pond B surge flooding is evaluated coincident with the 100-yr. water surface elevation of 576.22 ft. The critical fetch length is ~~1.21~~1.30 mi. as shown in Figure 2.4.5-202. The wind speed is adjusted based on the factors of fetch length, level overland or over water, critical duration, and stability using U.S. Army Corps of Engineers guidance (Reference 295). The critical duration is ~~21~~ 26 min. The adjusted wind speed is ~~90.6~~90.1 mph.

Significant wave height (average height of the maximum 33-1/3 percent of waves) is estimated to be ~~3.87~~3.97 ft., crest to trough. The maximum wave height (average height of the maximum 1 percent of waves) is estimated to be ~~6.46~~6.63 ft., crest to trough. The corresponding wave period is 2.6 sec.

The slopes along the banks of Make-Up Pond B adjacent to the site area are approximately 9 percent and are used to determine the wave setup and runup. The maximum runup, including wave setup, is estimated to be ~~3.28~~3.35 ft. The maximum wind setup is estimated to be ~~0.21~~0.25 ft. Therefore, the total water surface elevation increase due to high speed wind wave activity is estimated to be ~~3.49~~3.60 ft. The resulting flood elevation is ~~579.71~~579.82 ft. The Lee Nuclear Station safety-related plant elevation is 590 ft. and is unaffected by high speed wind wave flooding conditions.

Seiche evaluation is based on the natural fundamental period for Make-Up Pond A and Make-Up Pond B. The natural fundamental period of both water bodies is determined using Merian's formula (Reference 295).

$$T = 2 * L / (g * h)^{0.5}$$

where;

T = natural oscillation period at the fundamental mode (sec.)

L = fetch length (ft.)

g = gravitational acceleration (ft/sec2)

h = depth of water (ft.)

Based on bathymetry mapping, an average depth of 29.81 ft. is determined for Make-Up Pond A and used as the depth of water. The resulting natural fundamental period is 2.1 min. The Make-Up Pond B average depth is ~~33.05~~30.44 ft. The resulting natural fundamental period is ~~6.5~~7.3 min. The wave periods determined above (1.8 sec. and 2.6 sec.) are much shorter than the natural fundamental period for both water bodies (2.1 min. and ~~6.5~~7.3 min.). Furthermore, natural fundamental periods are significantly shorter than meteorologically induced wave periods (e.g., synoptic storm pattern frequency and dramatic reversals in steady wind direction necessary for wind setup). Since the natural periods of Make-Up Pond A and Make-Up Pond B are significantly different than the period of the excitations, they are not susceptible to meteorologically induced seiche waves. Seismically induced waves are discussed in Subsection 2.4.6.

COLA Part 2, FSAR Chapter 2, Subsection 2.4.14 is revised at the first paragraph as follows:

S COL 2.4-6 The maximum flood level at the Lee Nuclear Station is elevation ~~584.8~~589.62 ft. msl. This elevation would result from a PMP event on the Lee Nuclear Station site (local intense precipitation) as described in Subsection 2.4.2.3~~Probable Maximum Flood (PMF) event on the Make-Up Pond B watershed with the added effects of coincident wind wave activity as described in Subsection 2.4.3.6~~. The maximum flood level of surface water features at the Lee Nuclear Station is elevation 585.7 ft. msl. This elevation would result from a Probable Maximum Flood (PMF) event on Make-Up Pond B watershed with the added effects of coincident wind wave activity as described in Subsection 2.4.3. The Lee Nuclear Station safety-related structures have a plant elevation of 590 ft. msl. Also, Subsection 2.4.12.5 describes plant elevation relative to the maximum anticipated groundwater level. The hydrostatic loading is not expected to exceed design criteria.

COLA Part 2, FSAR Chapter 2, Subsection 2.4.16, References is revised to add the following new references:

2.4.16 REFERENCES

302. U.S. Army Corps of Engineers, Hydrologic Engineering Center, Hydrologic Modeling System, HEC-HMS computer software, version 3.5.

303. U.S. Army Corps of Engineers, Hydrologic Engineering Center, River Analysis System, HEC-RAS computer software, version 4.1.

304. Federal Highway Administration, "Hydraulic Design of Highway Culverts," Hydraulic Design Series No. 5, Second Edition, FHWA-NHI-01-020, May 2005.

Lee Nuclear Station

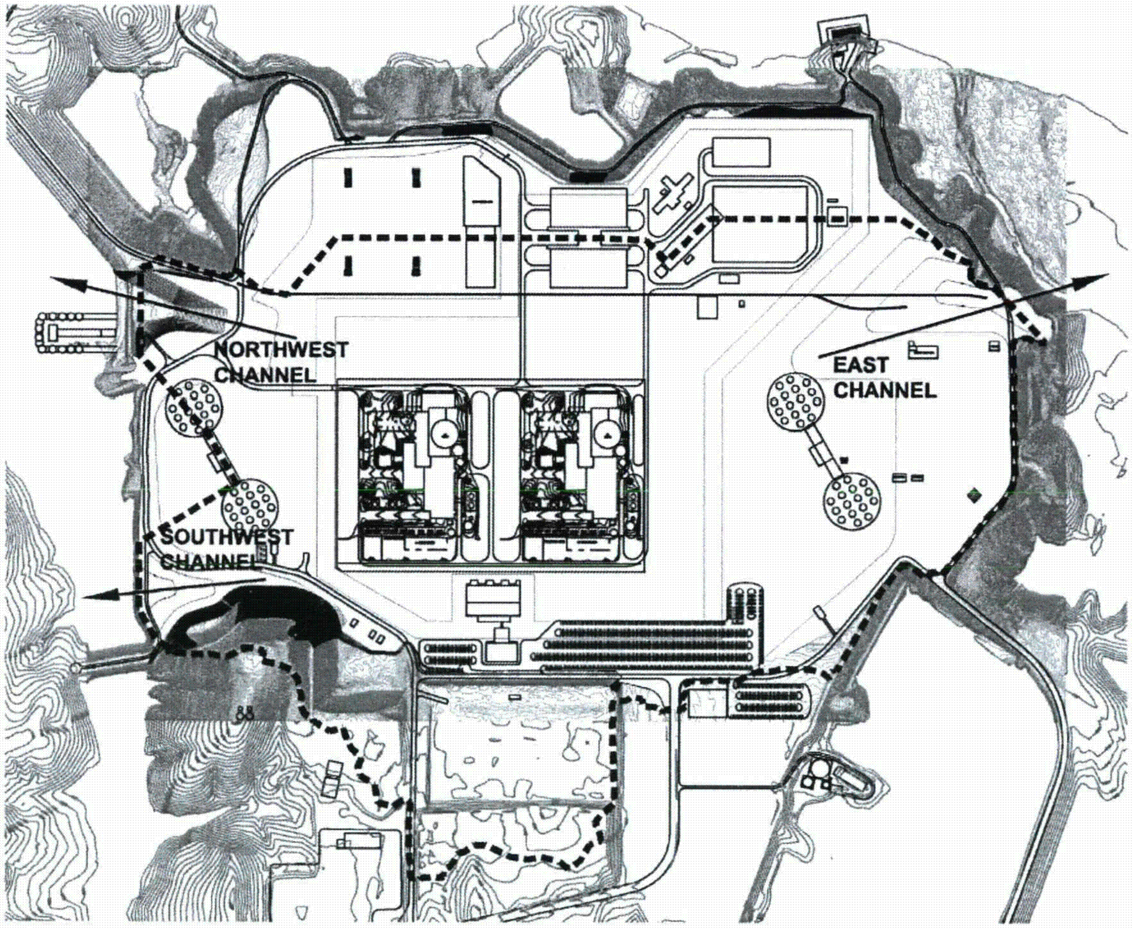
Attachment 2 to Supplemental Response to

Request for Additional Information

RAI 10.04.05-02

FSAR Chapter 2 Figure Revisions:

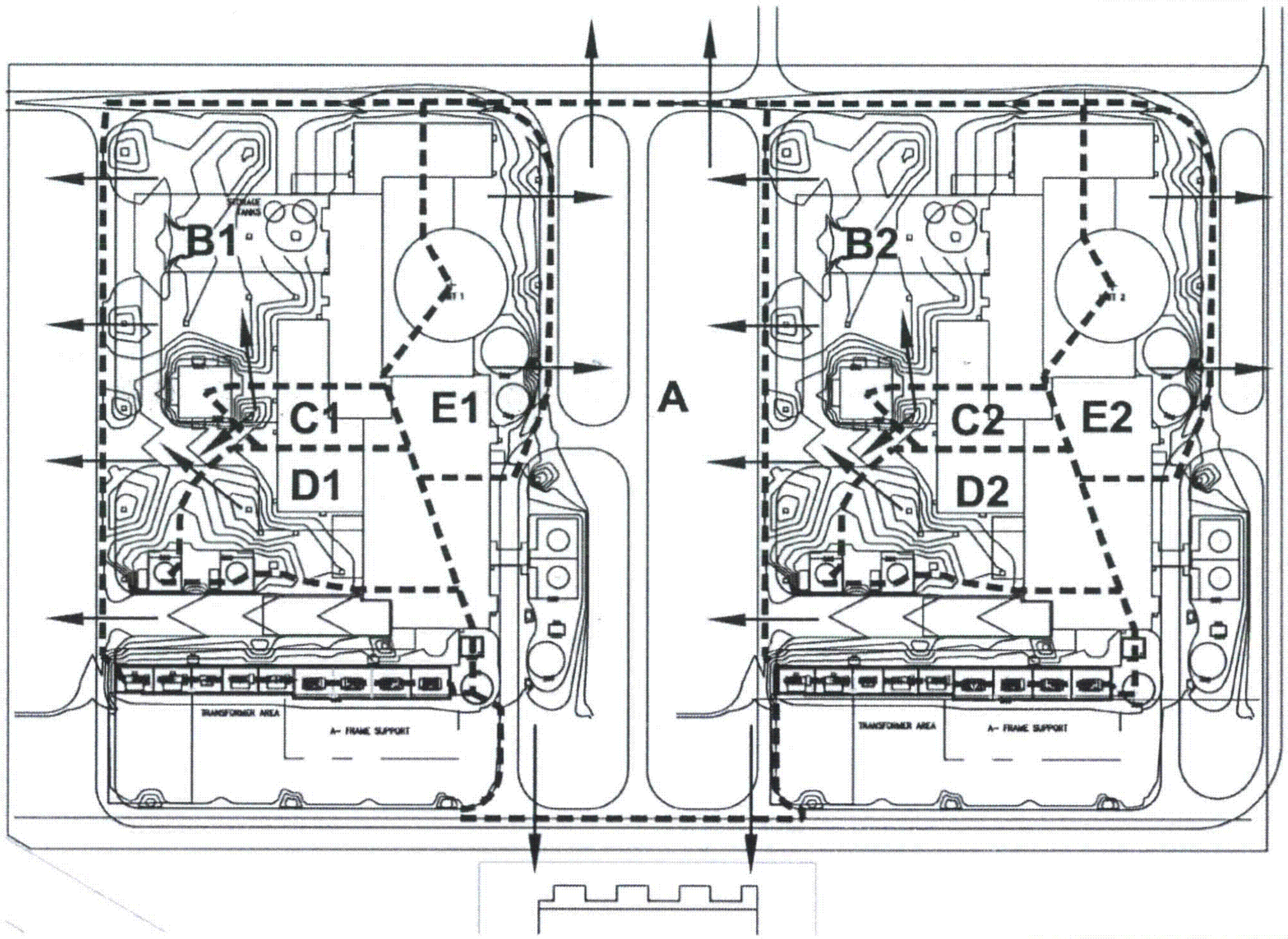
FSAR Figure 2.4.2-202
New FSAR Figure 2.4.2-204
FSAR Figure 2.4.3-234
FSAR Figure 2.4.5-202



WILLIAM STATES LEE III
NUCLEAR STATION UNITS 1 & 2

Grading and Drainage Plan

FIGURE 2.4.2-202

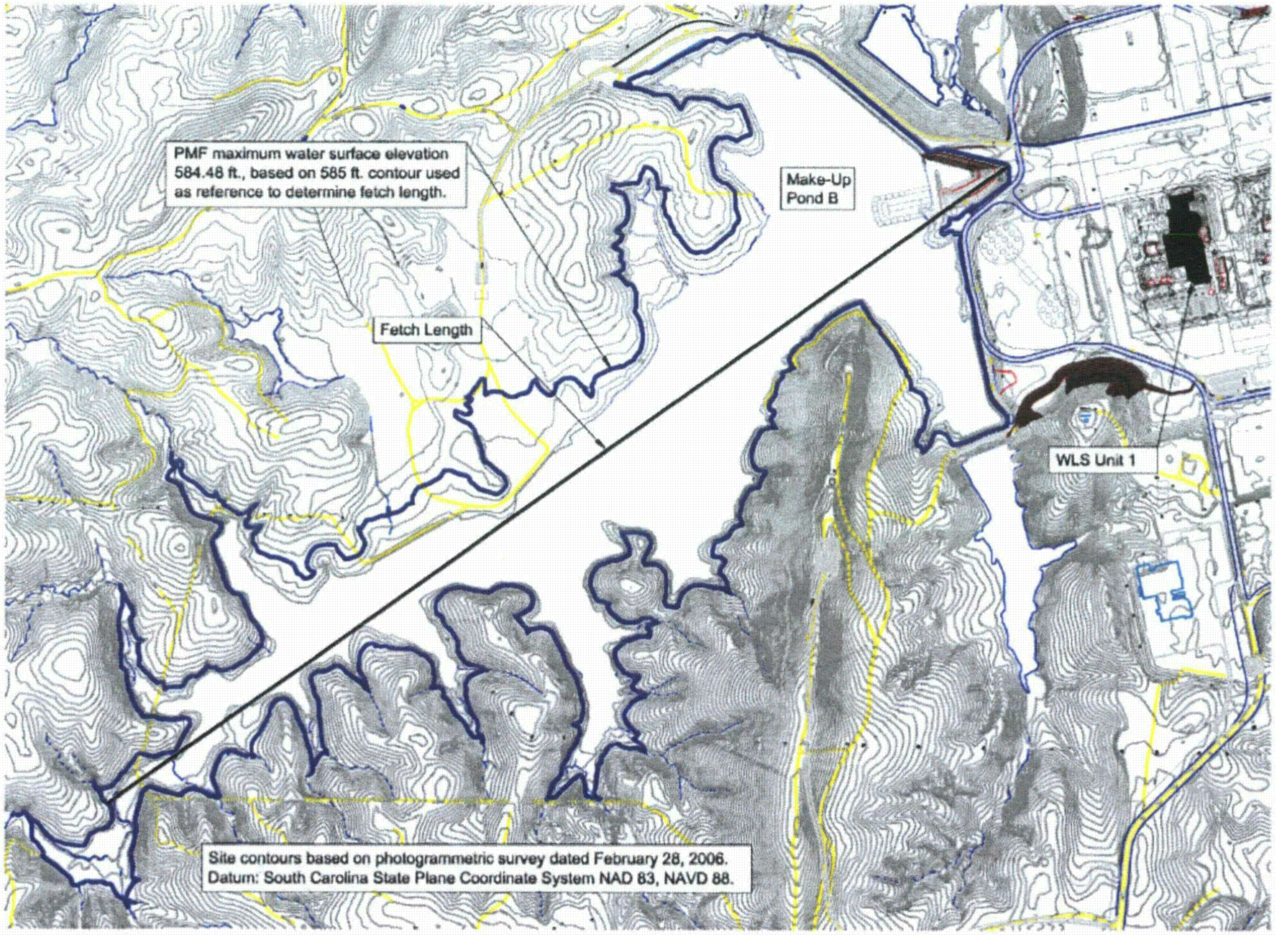


WLS COL 2.4-2

WILLIAM STATES LEE III
NUCLEAR STATION UNITS 1 & 2

Site Analysis Drainage Areas

FIGURE 2.4.2-204

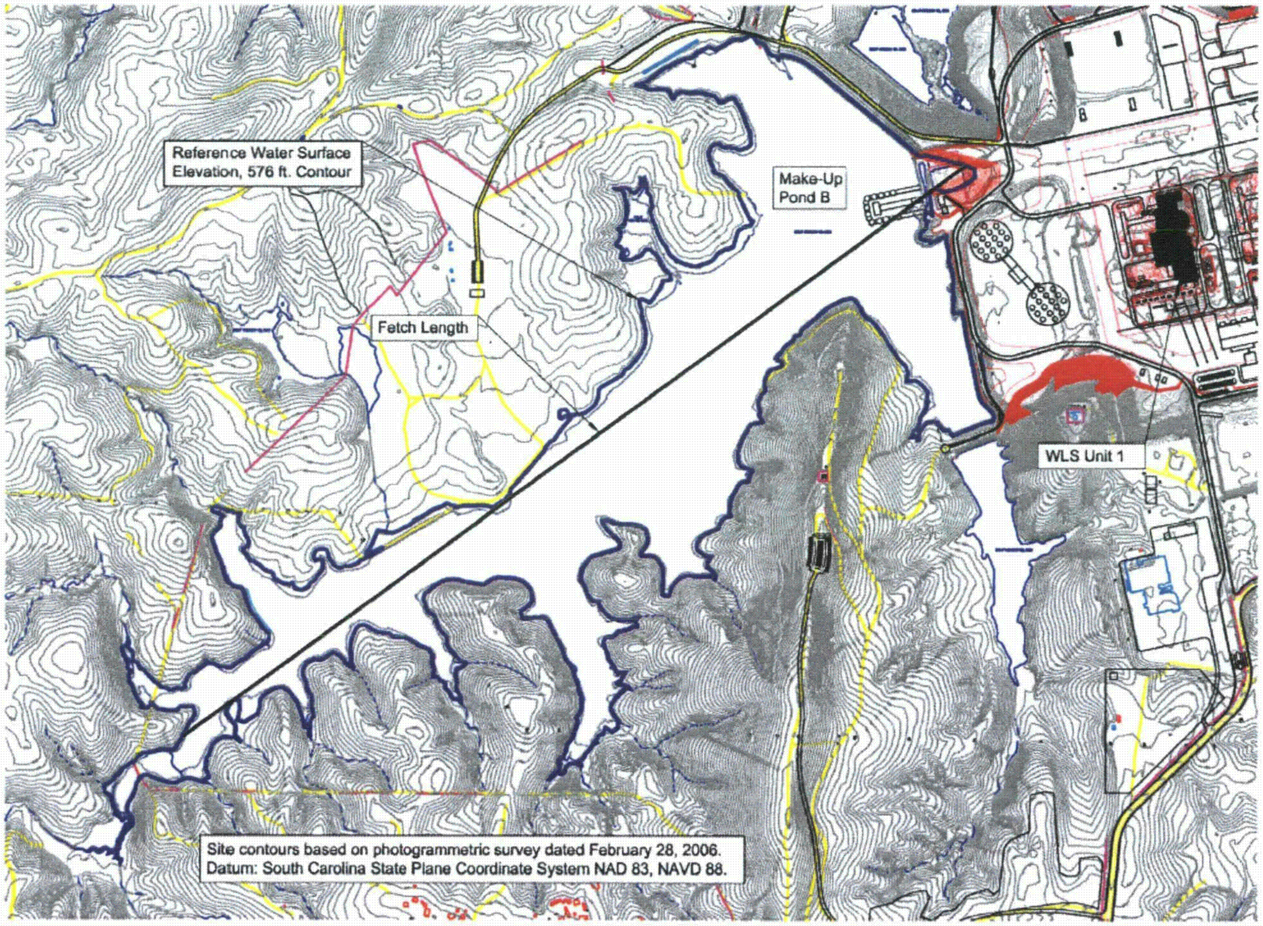


WILLIAM STATES LEE III
NUCLEAR STATION UNITS 1 & 2

Make-Up Pond B Coincident Wind Wave Fetch Length

FIGURE 2.4.3-234

WLS COL 2.4-2



WILLIAM STATES LEE III
NUCLEAR STATION UNITS 1 & 2

Make-Up Pond B
Extreme Wind Speed Fetch Length

FIGURE 2.4.5-202

WLS COL 2.4-2

Lee Nuclear Station

Attachment 3 to Supplemental Response to

Request for Additional Information

RAI 10.04.05-02

FSAR Chapter 10 Revisions:

FSAR Subsection 10.4.5.2.2

COLA Part 2, FSAR Chapter 10, Subsection 10.4.5.2.2 is revised at the third paragraph under the sub-heading Cooling Towers as follows:

The cooling tower basins serve as storage for the circulating water inventory and allow bypassing of the cooling tower during cold weather operations. The cooling tower nearest to the Unit 1 safety-related structures, systems and components (SSCs) is located over 700 ft. west of the Unit 1 auxiliary building. The cooling tower nearest to the Unit 2 safety-related SSCs is located over 600 ft. east of the Unit 2 containment building. ~~The elevation of the cooling tower berms is 20 ft. above plant grade.~~ The cooling tower basins are below grade such that a basin failure will not result in migration of water across the site. The site is graded to direct surface water flow away from the nuclear islands. A break in the cooling tower basin or the associated circulating water system piping will not have an adverse affect on safety-related SSCs~~systems, structures, or components~~ resulting from external plant flooding. The grading of the site combined with the location and below-grade elevation of the cooling tower~~s~~ basins and the associated circulating water system piping will preclude adverse interactions with safety-related SSCs.

Lee Nuclear Station

Attachment 4 to Supplemental Response to

Request for Additional Information

RAI 10.04.05-02

FSAR Chapter 19 Revisions:

FSAR Table 19.58-201

COLA Part 2, FSAR Chapter 19, Table 19.58-201, Sheet 3 of 12 will be revised as follows:

TABLE 19.58-201 (Sheet 3 of 12)
EXTERNAL EVENT FREQUENCIES FOR WLS

Category	Event	Evaluation Criteria (See Notes)	Applicable to Site? (Y/N)[1]	Explanation of Applicability Evaluation	Event Frequency (Events/yr)
				These event frequencies are bounded by the limiting initiating event frequencies given in Table 3.0-1 of APP-GW-GLR-101. Therefore, the safety features of the AP1000 are unaffected and the CDFs given in APP-GW-GLR-101 Table 3.0-1 for these events are applicable to WLS Units 1 and 2. Winds below 74 mph (storms) are not considered to have an adverse impact of WLS Units 1 and 2 as the switchyard and non-safety buildings will be designed to function at a higher wind speed (96 mph). Therefore, no additional PRA considerations are required for winds below hurricane force.	
External Flood	External Flood	D	Y	As discussed in Subsections 2.4.2.2 and 2.4.5, specific analysis of Broad River flood levels resulting from surges, seiches, snowmelt, ice effects, flood-waves from landslides, and tsunamis is not required for the Lee Nuclear Station. <u>As discussed in Subsections 2.4.2.2 and 2.4.2.3, the Probable Maximum Precipitation (PMP) event for the site (local intense precipitation) results in a flood elevation of 589.62 ft. The Lee Nuclear Station safety-related plant elevation is 590 ft.</u> As discussed in Subsection 2.4.4, failure of the on-site reservoirs would not affect the safety-related facilities. As discussed in Subsections 2.4.1.2.2.6 and 2.4.3.6, the Probable Maximum Flood (PMF) event on the Make-Up	N/A

TABLE 19.58-201 (Sheet 3 of 12)
EXTERNAL EVENT FREQUENCIES FOR WLS

Category	Event	Evaluation Criteria (See Notes)	Applicable to Site? (Y/N)[1]	Explanation of Applicability Evaluation	Event Frequency (Events/yr)
				Pond B watershed with the added effects of coincident wind wave activity results in a flood elevation of ~~584.6~~585.7 ft. The Lee Nuclear Station safety-related plant elevation is 590 ft. This result shows a margin exceeding ~~5~~ 4 ft. between	

Input-Output Files Related to Analyses of Site Local Intense Precipitation

TABLE A	
HEC-RAS Input/Output File List	**HEC-HMS Input/Output File List**
WLSsite.prj – main project input file	Basin_72hr_.basin
WLSsite.g01– geometry input file	Control_6hr_.control
WLSsite.f01 – flow data input file	Control_72hr_.control
WLSsite.p01 – plan data input file	MAX_HISTORIC.log
WLSsite.r01 – run data input file	Met_1.met
WLSsite.O01 – raw data output file	test.dss
RUN 586.rep.txt – elevation 586 output file	WLS_Site_Analysis.access
RUN 586_5.rep.txt – elevation 586.5 output file	WLS_Site_Analysis.dsc
RUN 587.rep.txt – elevation 587 output file	WLS_Site_Analysis.dss
RUN 587_5.rep.txt – elevation 587.5 output file	WLS_Site_Analysis.gage
RUN 588.rep.txt – elevation 588 output file	WLS_Site_Analysis.hms
RUN 588_5.rep.txt – elevation 588.5 output file	WLS_Site_Analysis.log
RUN 589.rep.txt – elevation 589 output file	WLS_Site_Analysis.out
RUN 589_5.rep.txt – elevation 589.5 output file	WLS_Site_Analysis.pdata
RUN 590.rep.txt – elevation 590 output file	WLS_Site_Analysis.run
	Basin_72hr_.basin
	Control_6hr_.control
	Control_72hr_.control

HEC-RAS and HEC-RMS Input / Output Files are presented in Attachment 1 of this Enclosure.

HEC-RAS and HEC-RMS Input / Output Files are listed below in Table A.

References

None

Associated Revision to the Lee Nuclear Station Combined License Application

None

Attachment

Attachment 1: CD Containing HEC-RAS and HEC-HMS Input / Output Files