UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

October 30, 2018

Mr. William R. Gideon
Site Vice President
Brunswick Steam Electric Plant
8470 River Rd. SE (M/C BNP001)
Southport, NC 28461

SUBJECT: BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 AND 2 – FLOOD HAZARD MITIGATION STRATEGIES ASSESSMENT (EPID NOS. 000495/05000324/L-2016-JLD-0007 AND 000495/05000325/L-2016-JLD-0007)

Dear Mr. Gideon:

By letter dated March 12, 2012 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML12053A340), the U.S. Nuclear Regulatory Commission (NRC) issued a request for information to all power reactor licensees and holders of construction permits in active or deferred status, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR), *Section* 50.54(f), (hereafter referred to as the "50.54(f) letter"). The request was issued in connection with implementing lessons learned from the 2011 accident at the Fukushima Dai-ichi nuclear power plant, as documented in the NRC's Near-Term Task Force (NTTF) report (ADAMS Accession No. ML111861807).

Enclosure 2 to the 50.54(f) letter requested that licensees reevaluate flood hazards for their sites using present-day methods and regulatory guidance used by the NRC staff when reviewing applications for early site permits and combined licenses (ADAMS Accession No. ML12056A046). Concurrent with the reevaluation of flood hazards, licensees were required to develop and implement mitigating strategies in accordance with NRC Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events" (ADAMS Accession No. ML12054A735). In order to proceed with implementation of Order EA-12-049, licensees used the current licensing basis flood hazard or the most recent flood hazard information, which may not be based on present-day methodologies and guidance, in the development of their mitigating strategies.

By letter dated March 21, 2018 (ADAMS Accession No. ML18081A034, non-public), Duke Energy Progress, LLC (Duke, the licensee) submitted the mitigation strategies assessment (MSA) for Brunswick Steam Electric Plant, Units 1 and 2 (Brunswick). The MSAs are intended to confirm that licensees have adequately addressed the reevaluated flooding hazard(s) within their mitigating strategies for beyond-design-basis external events. The purpose of this letter is to provide the NRC's assessment of the Brunswick MSA.

The Enclosure transmitted herewith contains Security-Related Information. When separated from the Enclosure, this document is decontrolled.

The NRC staff has concluded that the Brunswick MSA was performed consistent with the guidance described in Appendix G of Nuclear Energy Institute 12-06, Revision 2, as endorsed by Japan Lessons-Learned Division (JLD) interim staff guidance (ISG) JLD-ISG-2012-01, and that the licensee has demonstrated that the mitigation strategies, if appropriately implemented, are reasonably protected from reevaluated flood hazards conditions for beyond-design-basis external events. This closes out the NRC's efforts associated with EPID Nos. 000495/05000324/L-2016-JLD-0007 AND 000495/05000325/L-2016-JLD-0007.

If you have any questions, please contact me at 301-415-1617 or by e-mail at Frankie.Vega@nrc.gov.

Sincerely,

Frankie Vega, Project Manager
Beyond-Design-Basis Management Branch
Division of Licensing Projects
Office of Nuclear Reactor Regulation

Enclosures:
1. Staff Assessment Related to the Mitigating Strategies for Brunswick (Non-public)
2. Staff Assessment Related to the Mitigating Strategies for Brunswick (Public)

Docket Nos: 50-325 and 50-324

cc w/encl 2: Distribution via Listserv

STAFF ASSESSMENT RELATED TO THE MITIGATION STRATEGIES FOR BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 AND 2 AS A RESULT OF THE REEVALUATED FLOODING HAZARDS REPORT NEAR-TERM TASK FORCE RECOMMENDATION 2.1- FLOODING

EPID NOS. 000495/05000324/L-2016-JLD-0007 AND 000495/05000325/L-2016-JLD-0007

1.0 INTRODUCTION

By letter dated March 12, 2012 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML12053A340), the U.S. Nuclear Regulatory Commission (NRC) issued a request for information to all power reactor licensees and holders of construction permits in active or deferred status, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR), Section 50.54(f), (hereafter referred to as the "50.54(f) letter"). The request was issued in connection with implementing lessons learned from the 2011 accident at the Fukushima Dai-ichi nuclear power plant, as documented in the NRC's Near-Term Task Force (NTTF) report (ADAMS Accession No. ML111861807). Enclosure 2 to the 50.54(f) letter requested that licensees reevaluate flood hazards for their sites using present-day methods and regulatory guidance used by the NRC staff when reviewing applications for early site permits and combined licenses (ADAMS Accession No. ML12056A046).

Concurrent with the reevaluation of flood hazards, licensees were required to develop and implement mitigating strategies in accordance with NRC Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events" (ADAMS Accession No. ML12054A735). That order requires holders of operating reactor licenses and construction permits issued under 10 CFR Part 50 to modify the plants to provide additional capabilities and defense-in-depth for responding to beyond-design-basis external events. In order to proceed with implementation of Order EA-12-049, licensees used the current licensing basis flood hazard or the most recent flood hazard information, which may not be based on present-day methodologies and guidance, in the development of their mitigating strategies.

The NRC staff and industry recognized the difficulty in developing and implementing mitigating strategies before completing the reevaluation of flood hazards. The NRC staff described this issue and provided recommendations to the Commission on integrating these related activities in COMSECY-14-0037, "Integration of Mitigating Strategies for Beyond-Design-Basis External Events and the Reevaluation of Flood Hazards," dated November 21, 2014 (ADAMS Accession No. ML14309A256). The Commission issued a staff requirements memorandum (SRM) on March 30, 2015 (ADAMS Accession No. ML15089A236), affirming that the Commission expects licensees for operating nuclear power plants to address the reevaluated flood hazards, which are considered beyond-design-basis external events, within their mitigating strategies.

Nuclear Energy Institute (NEI) 12-06, Revision 2, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide" (ADAMS Accession No. ML16005A625), has been endorsed by the NRC as an appropriate methodology for licensees to perform assessments of the mitigating strategies against the reevaluated flood hazards developed in response to the March 12, 2012, 50.54(f) letter. The guidance in NEI 12-06, Revision 2, and Appendix G in particular, supports the proposed Mitigation of Beyond-Design-Basis Events rulemaking, currently being reviewed by the Commission and potentially subject to changes. The NRC's endorsement of NEI 12-06, including exceptions, clarifications, and additions, is described in NRC Japan Lessons-Learned (JLD) interim staff guidance (ISG) JLD-ISG-2012-01, Revision 1, "Compliance with Order EA-12-049, Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events" (ADAMS Accession No. ML15357A163). Therefore, Appendix G of NEI 12-06, Revision 2, as endorsed, describes acceptable methods for demonstrating that the reevaluated flooding hazard is addressed within the Brunswick Steam Electric Plant, Units 1 and 2 (Brunswick) mitigating strategies for beyond-design-basis external events.

2.0 BACKGROUND

By letter dated March 16, 2017 (ADAMS Accession No. ML17072A364), the NRC issued an interim staff response (ISR) letter for Brunswick. The ISR letter provided the reevaluated flood hazards that exceeded the current design basis (CDB) for Brunswick and were suitable input for the mitigating strategies assessment (MSA) (i.e., the mitigating strategies flood hazard information (MSFHI) described in NEI guidance document NEI 12-06). For Brunswick, the mechanisms not included in the CDB or listed as not bounded by the CDB in the letter (ISR flood levels) were local intense precipitation (LIP), streams and rivers, failure of dams and onsite water control/storage structures, tsunami and combined effects storm surge. The NRC staff subsequently issued the audit report and the staff assessment of the flood hazard reevaluation report (FHRR) for Brunswick by letters dated November 15, 2017, and April 16, 2018 (ADAMS Accession Nos. ML17271A248 and ML18089A055, respectively), containing additional details supporting the NRC staff's conclusions summarized in the ISR letter. The NRC staff review of the flood event duration (FED) and associated effects (AE) parameters associated with the flooding mechanisms not bounded by the CDB is provided below.

By letter dated March 21, 2018 (ADAMS Accession No. ML18081A034, non-public), Duke Energy Progress, LLC (Duke, the licensee) submitted the mitigation strategies assessment (MSA) for Brunswick. The MSA is intended to confirm that licensees have adequately addressed the reevaluated flooding hazards within their mitigating strategies for beyond-design-basis external events.

3.0 TECHNICAL EVALUATION

3.1 Mitigating Strategies under Order EA-12-049

The NRC staff evaluated the Brunswick strategies as developed and implemented under Order EA-12-049, as described in the Brunswick final integrated plan (FIP) provided by Duke in letters dated June 3, 2015 (ADAMS Accession No. ML15173A013), and May 19, 2016 (ADAMS Accession No. ML16146A604). The NRC staff's safety evaluation is dated December 14, 2016 (ADAMS Accession No. ML16335A031). The safety evaluation concluded that the licensee has developed guidance and a proposed design that, if implemented appropriately, will adequately address the requirements of Order EA-12-049.

Brunswick, Units 1 and 2, are General Electric Model 4 boiling-water reactors (BWRs) each with a Mark I containment. The licensee's three-phase approach to mitigate a postulated extended loss of alternating current power (ELAP) event, as described in the FIP, is summarized below.

For Phase 1, the initial FLEX[1] strategy for reactor core cooling is to remove decay heat by opening the safety relief valves (SRVs) on high pressure and dumping steam from the reactor pressure vessel (RPV) to the suppression pool located in the containment. Makeup to the RPV is provided by the reactor core isolation cooling (RCIC) turbine-driven pump. The normal alignment for the RCIC pump is to draw suction from the condensate storage tank (CST). For Brunswick, the CSTs have been evaluated to be robust structures. Within 1 hour, Brunswick will swap suction from the CST to the suppression pool to conserve CST inventory. When suppression pool water temperature reaches 190 degrees Fahrenheit (°F), Brunswick will swap RCIC pump suction back to the CST. Using this approach, replenishment of the CST inventory will not be required for approximately 52 hours. Maintaining RCIC suction temperature below 190°F ensures sufficient net positive suction head (NPSH) for the RCIC pump. Within 1 hour, the operators take manual control of the SRVs to perform a controlled cooldown and depressurization of the reactor. The cooldown of the primary system is stopped when reactor pressure reaches a control band of 150 pounds per square inch gauge (psig) to 300 psig to ensure sufficient steam pressure to operate the RCIC pump. The RPV makeup will continue to be provided from the RCIC system until the gradual reduction in RPV pressure resulting from diminishing decay heat requires a transition to Phase 2 methods. The RCIC injection source will be maintained for as long as possible, since it is a closed loop system using relatively clean CST and suppression pool water.

For Phase 2, the transition would occur as portable and pre-installed resources are utilized. When the RCIC system is no longer available, the preferred RPV makeup supply in Phase 2 comes from a portable FLEX pump. The portable FLEX pump will be aligned to existing systems using pre-designated hose and FLEX connections to inject water into the RPV. The credited sources of water for the FLEX pumps include the CST and the discharge canal. Other sources of water that may be available, but are not credited as part of the FLEX strategy, include the demineralized water tank, the fire water tank, and condensate hotwells. Brunswick will use sources with higher quality water first. Raw water will be used only if necessary.

Brunswick has developed their FLEX response strategies to not rely on "anticipatory venting" of containment. If required, Brunswick would vent containment through the hardened wetwell vent prior to reaching the primary containment pressure limit (PCPL) of 70 psig. The hardened wetwell vent can be powered by the FLEX diesel generators (DGs), which would be operating prior to containment reaching the PCPL. Brunswick would continue venting through the hardened wetwell vent, as necessary.

Using electric power from the station batteries and pneumatic supplies from the nitrogen backup systems, the SRVs will remain functional following an ELAP. In addition to powering the SRVs, the station 125/250 Volts-direct current (Vdc) Division II batteries will also power the RCIC system and vital instrumentation. Brunswick has permanently pre-staged two 480 volts-ac (Vac) 500 kilowatt (kW) FLEX DGs that can provide power within 1 hour of event initiation. Associated cabling is also permanently pre-staged so deployment consists only of racking in a 480 Vac breaker at a plant emergency bus and starting the FLEX DGs. The permanently pre-staged FLEX DGs will supply power to emergency busses associated with Division II on each

---

1 FLEX is not an acronym, but refers to the industry's response to Order EA-12-049, which it has named "Diverse and Flexible Coping Strategies (FLEX)"

unit. Either FLEX DG can be aligned to both emergency busses, energizing both units' Division II battery chargers.

Because only Division II is credited for FLEX strategies, the permanently pre-staged FLEX DGs are fully redundant. In practice, both permanently pre-staged FLEX DGs would be placed into service and the capacity of both FLEX DGs will enable use of Division I battery chargers and Control Building heating, ventilation, and air conditioning (HVAC) equipment.

If these FLEX DGs are not immediately available, Brunswick can perform battery load shedding, which will extend availability of dc power from the batteries to 2 hours and 10 minutes.

In addition, during Phase 3, a National Strategic Alliance of FLEX Emergency Response (SAFER) Response Center (NSRC) will provide additional equipment (e.g., pumps, DGs) to back up the on-site FLEX equipment. The pumps supplied by the NSRC are compatible with the FLEX connections used at Brunswick. The NSRC generators will be connected to the electrical distribution system using Brunswick-specific cables and connectors that are stored in the Brunswick FLEX Storage Building (FSB).

3.2 Evaluation of Flood Parameters in the MSA

3.2.1 Evaluation of Flood Hazard Elevations

The NRC staff reviewed flood hazard elevations provided in the MSA and compared them to values in the FHRR and associated documents prepared by the NRC staff (i.e., ISR, FHRR staff assessment and FHRR audit report). This flood hazard elevation information is used as input to the MSA for flood-causing mechanisms that are not bounded by the CDB. Flood hazard elevations for these flood-causing mechanisms are summarized in Table 3.2.1-1 of this assessment. Within this assessment, the NRC staff rounded elevations and water depths to the nearest one-tenth of a foot if values were presented at a higher level of precision in the MSA.

For the LIP hazard mechanism, the licensee references a LIP flood depth of 1.1 feet (ft.) as the maximum LIP-inundation depth at buildings containing structures, systems and components (SSCs) that are safety-related or necessary for the FLEX strategy. This is consistent with the FHRR and the FHRR staff assessment for Door D-3. The licensee confirmed that the LIP model used to reevaluate the LIP hazard described in the FHRR, and found acceptable by the NRC staff as documented in the FHRR staff assessment, is the same LIP model used for the MSA. The licensee reports in its MSA that the maximum LIP water depth in the powerblock area is 2.4 ft. The NRC staff notes that the MSA does not state the water surface elevation associated with this water depth, nor does it state the location within the powerblock area. The MSA used the 2.4-foot LIP water depth to assess personnel and equipment movement for the purposes of the MSA deployment strategy. The NRC staff concludes that the MSA reflects flood hazard elevations reported in the FHRR and previously reviewed by the NRC staff as documented in the FHRR staff assessment, and therefore, finds the water elevations acceptable for use in the MSA.

For the streams and rivers hazard mechanism, the licensee references a peak water surface elevation of 11.9 ft. National Geodetic Vertical Datum of 1929 (NGVD29) for the Cape Fear River. This elevation is consistent with the FHRR and the FHRR staff assessment of the stillwater elevation. The maximum total water surface elevation is 16.3 ft. NGVD29, including 4.4 ft. due to wave effects. The licensee references a peak water surface elevation of 15.5 ft.

NGVD29 for Nancys (or Nancy's) Creek. This elevation is consistent with the FHRR and the NRC staff assessment of the FHRR stillwater elevation and total water surface elevation where no wave effects are expected. For both locations (site locations near Cape Fear River and those near Nancys Creek), the stillwater and the total water surface elevations are below the site grade elevation of 20.0 ft. NGVD29. Therefore, the NRC staff concludes that the MSA reflects flood hazard elevations for this flooding mechanism consistent with those previously reviewed and accepted by the NRC staff as documented in the FHRR staff assessment, and therefore, finds the water elevations acceptable for use in the MSA.
For the Failure of Dams and Onsite Water Control/Storage Structures hazard mechanism, the licensee references a peak stillwater surface elevation for the Cape Fear River of [redacted] NGVD29 which is an increase of [redacted] above the elevation reported in the FHRR. The FHRR's total water surface elevation is [redacted] NGVD29 when wave effects are included. All flood hazard elevations associated with this hazard mechanism are below the site grade (elevation 20.0 ft. NGVD29). Therefore NRC staff concluded that a detailed review of the MSA's flood elevation for this hazard mechanism is not warranted and finds the water elevation acceptable for use in the MSA.

For the Storm Surge hazard mechanism, the MSA states that the relevant flood hazard stillwater elevations range from 26.6 to 26.9 ft. NGVD29, and the ISR letter states that the values range from 26.4 to 26.7 ft. NGVD29. The MSA states that only the surge flood hazard elevations at the Reactor Building and the DG Building locations are relevant for the MSA. The MSA states that the storm surge reevaluated (total water) hazard elevations range from 33.0 to 33.6 ft. NGVD29, and the ISR letter states that the values range from 33.5 to 33.8 ft. NGVD29. The MSA states that the stillwater and total water elevation values differ from those in the ISR letter, because the licensee revised its calculations. The NRC staff reviewed the revision and concluded that the values are reasonably consistent with those in the ISR letter. Therefore, the stillwater and total water hazard elevations reported by the licensee in the MSA are acceptable for use in the MSA.

For the tsunami hazard mechanism, the licensee references a peak stillwater elevation of 10.2 ft. NGVD29. The flood hazard elevation is consistent with both the stillwater elevation and total water surface elevation represented in the FHRR and the FHRR staff assessment. The flood hazard elevation is below site grade of 20.0 ft. NGVD29. Therefore, the NRC staff concludes that the MSA reflects flood hazard elevations for this flooding mechanism consistent with those previously reviewed and accepted by the NRC staff, as documented in the FHRR staff assessment, and finds the water elevations acceptable for use in the MSA.

3.2.2 Evaluation of Flood Event Duration

The NRC staff reviewed information provided by Duke in its FHRR and MSA regarding the FED parameters needed to perform the MSA for flood hazards not bounded by the CDB. The FED parameters for the flood-causing mechanisms not bounded by the CDB are summarized in Table 3.2.2-1. Within this assessment, the FED parameters were rounded to one-tenth of an hour when presented at a higher level of precision in the MSA.

The licensee confirmed that the LIP model results discussed in the MSA were produced by the same model described in the FHRR, and accepted by the NRC staff and documented in the FHRR staff assessment. The MSA does not credit warning time for LIP because personnel movement and deployment strategies would not be affected by the maximum water depths. The MSA also states that LIP warning time is not credited because only the Reactor Building airlock doors could potentially be inundated by the LIP event. For this bounding rainfall event, the water surface elevation would be above the finished floor elevation (FFE) at the Reactor Building airlock doors for up to 6.3 hours by a maximum of 1.1 ft. at these doors. These values are consistent with those in the FHRR.

Additional information in the MSA includes a time sequence of mitigation steps during a LIP event. The MSA states that FLEX equipment may be deployed 3 hours into the LIP event or sooner. The MSA states that the first time constraint is related to FLEX diesel generator refueling, which is to occur 6 to 12 hours into the event. The licensee states in the MSA that after consideration of the LIP timing, the deployment path and these activities, the maximum LIP water depth encountered would be 1.0 ft. The NRC staff notes that the specific water surface elevation, location and timing are not provided in the MSA. The licensee states in the MSA that the 1.0 ft. water depth would not affect FLEX deployment vehicles.

For the storm surge flood-causing mechanism, the licensee determined the FED parameters using the combined effects storm surge event. This combined event is not bounded by the CDB for the hazard mechanism. The NRC staff agrees with the licensee's approach for determining the set of FED parameters, as this approach is consistent with guidelines provided by Appendix G of NEI 12-06, Revision 2. For the storm surge event, the licensee determined the following FED parameters:

- The warning time and site preparation time is 48 hours prior to arrival of a hurricane.
- The period of inundation is 3.4 hours.
- The period of recession, which occurs when flood water completely recedes below site grade, is 3.2 hours.

To determine the adequacy of the flood event duration parameters, the NRC staff reviewed the licensee's hydrologic and hydraulic models and resulting tabular summary as presented in the FHRR. Based on this review, the staff determined that the licensee's FED parameters are reasonable and acceptable for use in the MSA.

3.2.3 Evaluation of Associated Effects

The NRC staff reviewed the information provided by Duke in the FHRR and the MSA regarding AE parameters for flood hazards not bounded by the CDB. The AE parameters related to water surface elevation (i.e., stillwater elevation with wind waves and runup effects) were previously reviewed by the NRC staff and transmitted to the licensee via the ISR letter. The NRC staff documented its review in the FHRR staff assessment. The AE parameters not directly associated with water surface elevation are discussed below and are summarized in Table 3.2.3-1 of this assessment.

For a LIP event, the licensee provided, in its FHRR, the maximum impact and static loads. However, these values are not replicated in the MSA because they were not necessary to perform the MSA. In its MSA, the licensee discusses this lack of impact to credited equipment. The MSA states that the only building containing SSCs that are safety-related, or necessary for the FLEX strategy, and with a FFE below the maximum LIP flood elevation, is at the airlock doors to the Reactor Building. The NRC staff concludes that the LIP associated effects previously accepted by the staff as part of the FHRR review are consistent with values reported by the licensee for the LIP flood-causing mechanism in the MSA.

For storm surge hazard mechanism, the licensee determined the AE parameters using the combined effects storm surge event. In addition to the MSA, the NRC staff reviewed AE calculation details provided in Brunswick Calculation Number BNP-14-009 "Combined Effect Flood Evaluation, Revision 1." The MSA provides the maximum hydrostatic, hydrodynamic, and debris loads, but does not describe the methodology used or the location-specific values from which the maximal values were identified. Calculation BNP-14-009 provides some of the information lacking in the FHRR and the MSA submittals. The NRC staff back-calculated the maximum AE values using reasonable or critical parameter values. The NRC found the licensee's reported AE values to be reasonable based on the independent staff assessment. The NRC staff assessment methods for these AEs are based on approaches described in the U.S. Army Corps of Engineers guidance documents: "Maximum Impact Force of Woody Debris on Floodplain Structures," Engineering Research and Development Center (ERDC)/Cold Regions Research and Engineering Laboratory (CRREL) TR-02-2, February 2002 and "Coastal Engineering Manual" EM 1110-2-1100, Part VI. Change 3.

For the storm surge hazard mechanism, the licensee determined that AE parameters other than maximum hydrostatic loading, maximum hydrodynamic loading, and maximum debris impact were not significant or applicable. The licensee's basis for this determination was attributed to the lack of sufficient water speed to impact the integrity of the asphalt and concrete surfaces and the necessary water speed needed to mobilize fine gravel in gravel-covered areas. The MSA does not report the peak water speeds associated with the storm surge event used in the MSA. The NRC staff back-calculated the range of likely water speeds and found that the MSA's AEs are based on water speeds within a reasonable range.

In summary, the staff determined the licensee's methods were appropriate and the provided AE parameters are reasonable for use in the MSA.

3.3 Evaluation of Current FLEX Strategies

The MSA is intended to confirm that licensees have adequately addressed the reevaluated flooding hazards within their mitigating strategies for beyond-design-basis external events. For Brunswick, the mechanisms either not included in the CDB or not bounded by the CDB, as described in the ISR letter, were LIP, streams and rivers, failure of dams and onsite water control/storage structures, Tsunami and Combined Effects Storm Surge.

LIP

The MSA states that the LIP event is not included in the Brunswick CDB. The licensee provided an analysis of the flood levels associated with this flood mechanism in its FHRR. The ISR shows maximum water elevations estimated at several critical doors. These maximum water elevations ranged from 20.8 ft. NGVD29 to 21.7 ft. NGVD29. The licensee stated that flood water ingress from a LIP hazard could affect the Reactor Building airlock doors which have access openings at 20 ft. NGVD29. The Reactor Building is the only building containing SSCs that are safety-related or necessary for the FLEX strategy that has a FFE below the maximum LIP flood elevations. All other safety-related structures are designed to protect safety-related components from water intrusion due to external flooding to a still water elevation of 22 ft. NGVD29. The MSA described the reevaluated LIP effects upon FLEX deployment strategy and water in-leakage into the airlock doors of the Reactor Building.

The licensee indicated that the LIP flood water will maintain a depth of 1.07 ft. above critical Reactor building airlock door openings for a maximum of 6.3 hours. The licensee stated that any leakage past these doors will be intercepted by floor drains and routed to sump areas on the -17 ft. level of the Reactor Building. The licensee expects water to spread over this large Reactor Building area and not challenge any plant equipment relied upon for the FLEX strategy. The licensee stated that the Reactor Core Isolation Cooling pump foundation located inside this area of the Reactor Building has a height of 2 ft. 8 inches off the floor which is considerably higher than the few inches of expected flooding.

The licensee also assessed the LIP flood levels around the power block and the FLEX building and stated that any LIP potential flood level would be low enough that it will not impact deployment of personnel and equipment. The licensee indicated that the maximum flood level in the power block area is approximately 2.41 ft., and this flood level would not prevent personnel movement to perform operator actions. Additionally, the licensee stated that the first time constraint associated with FLEX refueling occurs 6 to 12 hours into the event. The licensee estimated that the maximum flood level along the FLEX deployment path at 6 hours into the event is 1.02 ft. Therefore, flood waters would have receded and would not prevent deployment of the FLEX equipment. Based on the above assessment, the licensee stated that the ISR flood levels for LIP do not adversely impact the FLEX strategies.

The NRC staff reviewed the licensee's assessment of the reevaluated LIP flood levels in the MSA. Since LIP flood levels exceed the elevation of several door openings, the NRC staff reviewed the impacts of the LIP water intrusion at doors that would not be protected. As part of the audit process and in order to confirm that no key FLEX equipment is impacted by the LIP water ingress into the Reactor Building, the NRC staff asked the licensee to provide additional information regarding in-leakage water quantities and expected flood water depths at the -17 ft. level of the Reactor Building. The licensee's email response dated September 26, 2018 (ADAMS Accession No. ML18275A296), provided (1) the in-leakage rate, (2) the amount of time water is expected to be above critical Reactor Building airlock door openings, (3) the total surface area at this elevation, and (4) the total water depth expected at this elevation (approximately 0.3 ft). The staff reviewed the licensee's response and confirmed that important FLEX equipment is located at a higher elevation than the expected water level. Therefore, the staff agrees that SSCs relied upon for the FLEX strategy would not be adversely affected by LIP. The NRC staff also evaluated whether the reevaluated LIP hazard impacted any of the storage location(s) of FLEX equipment, any staging areas, haul paths, connection points, activities, etc. The staff agrees that, based on the duration of the LIP event and eventual recession, there appears to be sufficient time for flood waters to recede prior to the FLEX response activity taking place. Therefore, no impact is expected to occur as a result of the reevaluated LIP hazard. The NRC staff concludes that the licensee has adequately assessed the ISR flood levels for the LIP event and that, if appropriately implemented, the applicable FLEX strategy is reasonably protected from the reevaluated LIP hazard.

Streams and Rivers

The MSA states that the streams and rivers event is not included in the Brunswick CDB. The licensee provided an analysis of the flood levels associated with this flood mechanism in its FHRR. As shown in ISR letter, the maximum water elevations estimated for the site are 16.3 ft. NGVD29 and 15.5 ft. NGVD29 due to flooding from the Cape Fear River and Nancy's Creek, respectively. Since these flood levels are below the average plant grade of 20 ft. NGVD29, the licensee concluded that the streams and rivers event will have no impact on the ability to implement the FLEX strategy.

The NRC staff reviewed the information provided in the MSA and finds that the licensee has adequately assessed the ISR flood levels for the streams and rivers flood event, and that the applicable FLEX strategies, if appropriately implemented, are reasonably protected from the reevaluated streams and rivers event hazard.

Failure of Dams and Onsite Water Control/Storage structures

The MSA states that the dam failure event is not included in the Brunswick CDB. The licensee provided an analysis of the flood levels associated with this flood mechanism in its FHRR. As shown in the ISR letter, the maximum water elevations estimated for the site considering overtopping, seismic and sunny day failures are below the average plant grade of 20 ft. NGVD29. Therefore, the licensee concluded that the dam failure event will have no impact on the ability to implement the FLEX strategy.

The NRC staff reviewed the information provided in the MSA and finds that the licensee has adequately assessed the ISR flood levels for the Dam Failure flood event and that the applicable FLEX strategies can be implemented.

Tsunami

The MSA states that the tsunami event is not included in the Brunswick CDB. The licensee provided an analysis of the flood levels associated with this flood mechanism in its FHRR. As shown in the ISR letter, the maximum water elevation estimated for the site is 10.21 ft. NGVD29. Since this flood level is below the average plant grade of 20 ft. NGVD29, the licensee concluded that the tsunami event will have no impact on the ability to implement the FLEX strategy.

The NRC staff reviewed the information provided in the MSA and finds that the licensee has adequately assessed the ISR flood levels for the tsunami flood event, and that the applicable FLEX strategies can be implemented.

Combined Effects Storm Surge

The MSA states that the combined effects storm surge event (wind/wave runup and high tide only, no rainfall event) is included in the Brunswick CDB. The ISR letter provides the maximum water elevations estimated at several specific buildings. As part of its MSA, the licensee refined their storm surge analysis and obtained slightly different water elevations from those detailed in the ISR letter. Table 3.2.1-1 of this assessment provides combined effects storm surge water elevations used in the MSA. As stated above, the staff considers the stillwater and total water hazard elevations reported by the licensee in its MSA as acceptable for use in the MSA.

As described in the MSA, the reevaluated combined effects storm surge water levels shown in Table 3.2.1-1 of this staff assessment, exceed the CDB flood elevations of 22 ft. NGVD29 and 25.6 ft. NGVD29 for still water and total water, respectively, at the site safety-related buildings that are relied upon for the FLEX strategy. The reevaluated combined effects storm surge levels also exceed flood protection barriers (also referred to as cliff edge barriers) designed to protect safety-related equipment to a flood water elevation of 26 ft. NGVD29. These temporary flood protection barriers will be installed internal to plant structures (i.e., selected doors in the Control, Reactor and DG Buildings) in accordance with plant Procedure 0AI-68 "Brunswick

Nuclear Plant Response to Severe Weather Warnings", Revision 52. The licensee stated that the combined effects storm surge flood mechanism would potentially affect the site's ability to implement FLEX strategies as described in FIP. The licensee plans to modify the FLEX strategy in order to address the combined effects storm surge flood mechanism for the site. The licensee's evaluation and specific actions proposed to address this flood mechanism and the staff's evaluation of these actions are described below.

3.4 Reevaluated Combined Effects Storm Surge and Modified FLEX Strategies

The licensee performed an evaluation, consistent with guidelines provided in Section 6 of NEI 12-06, to assess the impacts to the FLEX strategy relative to the reevaluated combined effects storm surge. The licensee's calculation BNP-14-009, "Combined Effects Flood Evaluation", Revision 1, provides detailed information on flood elevations, applicable AEs (i.e., static, hydrodynamic, and debris loads) and period of inundation at various points of interest throughout the site. Based on this information, the licensee identified several key areas where the reevaluated flood elevations exceeded flood protection levels. The Brunswick FLEX strategies rely on plant equipment located in the Reactor Building, the DG Building, and the Control Building. Specific locations along these buildings and the FLEX storage building (FSB), FLEX DG enclosure, FLEX connections and FLEX deployment haul paths were the focus of the licensee's evaluation.

The licensee stated that the FSB will not be affected by the reevaluated combined effect storm surge since it has a FFE of 29.5 ft. NGVD29, which is above the maximum expected water level at this location. In addition, the licensee stated that the FSB would not be affected by wave run-up since it is located over 2 ft. above the still water and any waves would dissipate on the ground prior to reaching the FSB. Therefore, the licensee concluded that the FLEX equipment stored in the FSB would be protected against the reevaluated combined effects storm surge.

The licensee also assessed the location of the two pre-staged FLEX DGs. The FLEX DG enclosure is located near the DG building, on top of the Fuel Oil Tank Chamber (FOTC) roof, and the enclosure is water proof up to an elevation of 28.4 ft. NGVD29 which is above the maximum estimated water level of 26.7 ft. NGVD29 at this location. The licensee stated the FLEX DG enclosure would not be affected by wave run-up since it is surrounded by other structures. Additionally, the licensee stated that in order to access and operate these FLEX DGs, an operator is required to transit a portion of the yard that could experience over 6 ft. of flood waters. Since this amount of water would prevent the operator from accessing the FLEX DGs, the licensee plans to pre-stage an operator in the FLEX DG enclosure prior to site inundation to ensure the FLEX DGs are started within the corresponding time constraints. The licensee has stated it will update plant procedures to include this action.

The licensee stated that the FLEX deployment timeline would not be challenged by the reevaluated combined effects storm surge. The period of site inundation for the site was estimated to be 3.42 hours. As stated above, the first time constraint associated with FLEX refueling occurs 6 to 12 hours into the event. Therefore, the licensee has the option to defer deployment of FLEX equipment until flood waters have receded without challenging the FLEX deployment timeline.

The main source of fuel for the FLEX equipment is located in tanks at the base of the FOTC. According to licensee's evaluation, the FOTC has several doors and penetrations that could be vulnerable to flooding, and water could potentially enter the chamber, prevent personnel access into the FOTC and potentially affect the FLEX strategy. Therefore, the licensee plans to install new barriers to prevent water ingress into the FOTC or demonstrate through additional evaluations that potential water ingress will not affect the implementation of the FLEX strategy. The licensee stated that any new or enhanced barriers will meet the design requirements of NEI 12-06, Appendix G, Section G.5. Additionally, given that FLEX DGs are capable of operating for at least 12 hours before refueling and that the period of site inundation was estimated to be 3.42 hours, the licensee stated that the delivery of fuel to FLEX equipment would not be impacted by the reevaluated combined effects storm surge.

The licensee evaluated the connection points for FLEX equipment in order to ensure that they remain viable for the reevaluated storm surge flood levels. As stated above, the FLEX DG enclosure would not be impacted by the reevaluated flood levels; therefore, the connection points located in this enclosure will not be affected. However, in order to use the FLEX DGs an operator action consisting of closing breakers located in the DG building is required. The DG building has several doors with door sills lower than the reevaluated flood levels. Estimated flood levels at these doors are also expected to exceed the height of the flood protection barriers; therefore, water could leak through these doors and prevent operators from closing the breakers. The licensee plans to address these potential vulnerabilities by modifying the current flood protection barriers, installing temporary barriers or demonstrating through additional evaluations that potential water ingress will not affect the implementation of the FLEX strategy. The licensee stated that any new or enhanced barriers will meet the design requirements of NEI 12-06, Appendix G, Section G.5.

The licensee stated that several other connections associated with the RPV makeup are located below the reevaluated flood levels at several locations throughout the site. The licensee stated that these connections are not needed until after the period of site inundation; therefore, these connections would not be affected by the reevaluated combined effects storm surge. In addition, the licensee stated that other FLEX connections internal to the Reactor Building are not expected to be affected since the Reactor Building provides protection from debris and waves.

Finally, the licensee assessed the utilization of off-site resources. The licensee stated that the arrival of additional equipment from the NSRC is expected after 24 hours, well after the end of the period of site inundation. The licensee also noted its capabilities of delivering equipment by helicopter in case road access was not available. Therefore, flood waters are expected to have receded and the reevaluated combined effect storm surge is not expected to affect utilization of off-site resources or arrival of personnel from off-site within the timeline specified by the FIP.

3.5 Evaluation of Modified FLEX Strategies

The NRC staff reviewed the reevaluated storm surge flood information provided in the MSA and in Brunswick Calculation BNP-14-009, "Combined Effect Flood Evaluation, Revision 1." Specifically, the staff reviewed the flood elevations at critical locations throughout the site, FED values, and hydrostatic, hydrodynamic and debris loading assessments performed for critical structures. Figure 2-1 of Brunswick Calculation Number BNP-14-009 provides the locations of the points of interest analyzed in the MSA. Table 6-1 of this calculation shows the maximum stillwater level, flood duration and flooding above finished floor level at the door locations for buildings containing SSCs important to safety. Table 6-2 summarizes these results for buildings not important to safety. As stated in the MSA, only the Reactor Building and the DG Building are relevant for the FLEX strategy. The staff reviewed the hydrodynamic, hydrostatic and debris loading effects on these structures. Since these structures were designed to prevent penetration of tornado generated missiles, the water loads associated with reevaluated hazards are not expected to exceed these design loads. As such, loads associated with the reevaluated flood hazard would have a negligible effect on these structures. However, the staff notes that exterior doors associated with these structures were not designed to the loads associated with the reevaluated flood hazard. Therefore, as stated in the MSA, these doors are not credited as waterproof, leaving the protection of key SSCs to the cliff edge barriers. Since these barriers were not designed to the loads associated with the reevaluated hazard, the staff agrees with the licensee's conclusion that any modified barriers would need to be assessed to the reevaluated water flood level. The design of these barriers should meet the design requirements of NEI 12-06, Appendix G, Section G.5. These flood protection barriers were proposed by the licensee as part of the interim actions associated with the 50.54(f) letter. As documented in the staff's review of these interim actions (ADAMS Accession No. ML15321A433, non-public) the NRC staff concludes that the interim actions for Brunswick provide an appropriate short-term response to address the reevaluated flood hazard defined in the licensee's FHRR and support the longer-term flooding evaluation for Brunswick.

The staff reviewed Brunswick Administrative Instruction 0AI-68 which describes the installation of the temporary flood protection barriers after a hurricane watch is issued. The staff confirmed that these barriers, as currently designed, are expected to be installed at least 12 hours prior to the predicted storm surge of 20 ft. or greater on site. Given the 48 hours credited in the MSA for warning time and site preparation, the NRC staff agrees that there is sufficient time for these flood protection barriers to be installed prior to the arrival of the storm. However, the NRC staff notes that, as stated above, several of these flood protection barriers are expected to be modified; therefore, it is expected that Administrative Instruction 0AI-68 be modified to incorporate such changes.

In addition to the vulnerabilities identified in the MSA regarding DG Building and FOTC doors, the staff notes that the Reactor Building airlock doors, which have access openings at 20 ft. NGVD29, could also be vulnerable due to the storm surge event. As shown in the ISR, the stillwater elevation expected at the Reactor Building is 26.5 ft. NGVD29, which is above the flood protection level of 26 ft. NGVD29 provided by the cliff edge barriers. As part of the audit process, the staff asked the licensee to address the potential water ingress through these doors and confirm that no key FLEX equipment is impacted by the storm surge water levels. The licensee's email response dated September 26, 2018 (ADAMS Accession No. ML18275A296), stated that flood protection barriers are to be installed interior to the reactor airlock doors in accordance with Brunswick Administrative Instruction 0AI-68. The licensee also stated that no in-leakage is expected through these barriers. Finally, the licensee stated that it expects to modify these barriers to raise the top elevation from 26 ft. to 27.5 ft. NGVD29. As stated above, the staff expects that Administrative Instruction 0AI-68 be modified to incorporate such changes.

The staff also reviewed the information provided in the FIP, which included the locations of FLEX equipment, connection points, staging areas and FLEX strategy timeline. The staff reviewed Section 2.9.1 of the FIP, which presents the sequence of events timeline for an ELAP/Loss of access to the Ultimate Heat Sink event at Brunswick. The staff confirmed that given the estimated site inundation and period of recession, the current FLEX strategies for deployment and refueling of FLEX equipment could be delayed without impacting the FLEX strategy timeline. The NRC staff confirmed that, based on the location, design and FFEs of the FLEX storage and FLEX DG buildings, these buildings are not expected to be affected by the reevaluated combined storm surge event. However, in order to successfully start and operate the FLEX DGs within the appropriate time constraints, the licensee plans to pre-stage an operator in the FLEX DG enclosure. As stated in Section 6.2.1.2 of its MSA, the licensee plans to revise plant procedures to reflect this action. The NRC staff notes that all procedural changes should be validated in accordance with the requirements of Appendix E of NEI 12-06, as appropriate.

The staff concludes that given the impacts of the storm surge hazards at the specific locations at the site, the FLEX strategies cannot be implemented as documented in the FIP. Therefore, the following modifications to the FLEX strategy are needed:

1. Enhance the existing temporary flood barriers (i.e., Cliff Edge Barriers) or perform analyses to demonstrate that any water intrusion will not prevent successful implementation of the FLEX strategy.

2. Install new temporary flood barriers for the personnel doors to the DG Building or perform analyses to demonstrate that any water intrusion will not prevent successful implementation of the FLEX strategy.

3. Provide protection for the FOTC personnel access doors, the vents, and penetrations on the FOTC roof, or perform analyses to demonstrate that any potential water intrusion will not prevent successful implementation of the FLEX strategy.

4. Confirm that all barriers conform to the performance criteria for flood protection features specified in NEI 12-06, Appendix G, Section G.5.

5. Revise procedures and instructions for external flooding related to placement of the flood barriers and pre-staging of personnel, as necessary. The feasibility and timing of revised procedures will be validated in accordance with the guidance of NEI 12-06, Appendix E, as necessary.

As documented in Enclosure 2 of its MSA, the licensee committed to complete these activities no later than 3 years from effective date of the Mitigating Beyond-Design-Basis Events Rule 10 CFR Section 50.155.

The staff concludes that the FLEX strategy, using FLEX procedures and storm preparation procedures modified as described in the MSA, equipment, and personnel, if appropriately implemented, is reasonably protected from a combined effects storm surge event. The staff notes that the procedural revisions and flood protection modifications that the licensee describes in its MSA may be subject to future NRC inspection. In SECY-16-0142 (ADAMS Accession No. ML16301A005), the NRC staff proposed requirements for licensees to consider the effects of the reevaluated flooding hazard information within the mitigation strategies and guidelines consistent with the process outlined in COMSECY-14-0037. If requirements currently proposed in the draft final rule change, the NRC staff will reevaluate whether verification of completion of these commitments is necessary consistent with Commission direction.

4.0 AUDIT REPORT

The NRC staff previously issued a generic audit plan by letter dated December 5, 2016 (ADAMS Accession No. ML16259A189), that described the NRC staff's intention to conduct audits related to MSAs and issue an audit report that summarizes and documents the NRC's regulatory audit of the licensee's MSA. The NRC staff activities have been limited to performing the reviews described above. Because this staff assessment appropriately summarizes the results of those reviews, the NRC staff concludes that a separate audit summary report is not necessary, and that this document serves as the final audit report described in the December 5, 2016, letter.

5.0 CONCLUSION

The NRC staff has reviewed the information provided in the Brunswick MSA and supplemental information provided in response to the NRC staff's request for additional information related to current FLEX strategies, as evaluated against the reevaluated hazard(s) described in Section 3 of this staff assessment, and found that:

- Impacts to the FLEX strategies have been adequately identified;
- The licensee proposed changes to FLEX strategies and procedures should provide reasonable protection from the reevaluated hazards; and
- The licensee has provided an adequate description and justification of flood protection features necessary to implement the FLEX strategy to account for the reevaluated flood hazards mechanisms.

Therefore, the NRC staff concludes that the licensee's proposed modified FLEX strategies should be effective during a postulated beyond-design-basis event for the reevaluated flood-causing mechanism(s), including AEs and FED. The NRC staff confirmed that the Brunswick flood hazard MSA was performed consistent with the guidance in Appendix G of NEI 12-06, Revision 2, as endorsed by JLD-ISG-2012-01, Revision 1. Based on the licensee's appropriate hazard characterization, methodology used in the Brunswick MSA evaluation, and the description of its modified FLEX strategies, the NRC staff concludes that the licensee has demonstrated that these mitigation strategies, if appropriately implemented, should be capable of providing reasonable plant protection during the reevaluated flood hazard conditions.

Table 3.2.1-1. Flood Event Elevations for Flood-Causing Mechanisms Not Bounded by the CDB

Flood-Causing Mechanism	Stillwater Elevation(1)	Waves/Runup(1)	Reevaluated Hazard Elevation(1)
Local Intense Precipitation			
Reactor Building (Door D-3)(2)	21.1 ft. NGVD29	minimal	21.1 ft. NGVD29
Turbine Building (Door D-24)	21.7 ft. NGVD29	minimal	21.7 ft. NGVD29
Reactor Building (Door D-2)	20.8 ft. NGVD29	minimal	20.8 ft. NGVD29
Rivers and Streams			
Cape Fear River	11.9 ft. NGVD29	4.4 ft.	16.3 ft. NGVD29
Nancys Creek	15.5 ft. NGVD29	minimal	15.5 ft. NGVD29
Failure of Dams and Onsite Water Control/Storage Structures(3)			
Cape Fear River – Overtopping Dam Breach	[redacted]	[redacted]	[redacted]
Cape Fear River – Seismically-Induced Dam Failure	[redacted]	[redacted]	[redacted]
Storm Surge(4)			
Reactor Building	26.5 ft. NGVD29 (26.7 ft. NGVD29)	7.0 ft. (6.7 ft.)	33.5 ft. NGVD29 (33.4 ft. NGVD29)
Diesel Generator Building	26.5 ft. NGVD29 (26.7 f.t NGVD29)	7.1ft. (6.7 ft.)	33.6 ft. NGVD29 (33.4 ft. NGVD29)
Service Water Building/Intake Structure	26.4 ft. NGVD29 (26.6 ft. NGVD29)	7.1 ft. (6.4 ft.)	33.5 ft. NGVD29 (33.0 ft. NGVD29)
AOG Building	26.4 ft. NGVD29 (26.6 ft. NGVD29)	7.2 ft. (6.9 ft.)	33.6 ft. NGVD29 (33.5 ft. NGVD29)
Radwaste Building	26.5 ft. NGVD29 (26.7 ft. NGVD29)	7.2 ft. (6.8 ft.)	33.7 ft. NGVD29 (33.5 ft. NGVD29)

Turbine Building	26.7 ft. NGVD29 (26.9 ft. NGVD29)	7.1 ft. (6.7 ft.)	33.8 ft. NGVD29 (33.6 ft. NGVD29)
Tsunami			
At the Intake Canal	10.2 ft. NGVD29	Not applicable	10.2 ft. NGVD29

Sources: (FHRR; MSA)
Notes:
(1) Values for stillwater, wave runup and reevaluated hazard elevation are consistent with those in the ISR letter; for instances where the MSA contains values that are different then the ISR letter, the values are given parenthetically.
(2) For the LIP hazard mechanism, the licensee references a LIP flood depth of 1.1 ft. as the maximum LIP-inundation depth at buildings containing SSCs that are safety-related or necessary for the FLEX strategy. This is consistent with the FHRR and the FHRR staff assessment for Door D-3. The MSA states that within the powerblock area the maximum LIP depth is 2.4 ft.
(3) The licensee references a peak stillwater surface elevation for the Cape Fear River of [redacted] ft. NGVD29]] which is an increase of [redacted] above the elevation reported in the FHRR. The FHRR's total water surface elevation is [redacted]. NGVD29]] when wave effects are included.
(4) The MSA (Table 2) has slightly different stillwater and reevaluated hazard elevation that are found in the ISR letter Table 2; the staff differenced the MSA reevaluated hazard elevation and the MSA stillwater elevation to infer a MSA-consistent wave runup as these wave runup values were not explicitly stated in the MSA. The MSA acknowledges these differences and explains that there are supported by revised calculations. The NRC staff found the difference to be in reasonable agreement with the ISR letter.

Table 3.2.2-1. Flood Event Durations for Flood-Causing Mechanisms Not Bounded by the CDB

Flood-Causing Mechanism	Time Available for Preparation for Flood Event	Duration of Inundation of Site	Time for Water to Recede from Site
Local Intense Precipitation	None Credited	6.3 hours(1)	Included in Inundation Period(3)
Rivers and Streams(2)	Not Applicable	Not Applicable	Not Applicable
Failure of Dams and Onsite Water Control/Storage Structures(2)	Not Applicable	Not Applicable	Not Applicable
Storm Surge	48 hours	3.4 hours	3.2 hours
Tsunami(2)	Not Applicable	Not Applicable	Not Applicable

Sources: (FHRR; MSA)
Notes:

(1) Flood duration at Reactor Building Door D-3 (FHRR Table 4-2). Longer periods of inundations (up to 10.8 hours) were reported in the FHRR for other door locations. The selection of Door D-3 for the flooding duration is based on it being the exterior door with the lowest bottom door elevation (20 ft. NGVD29) at buildings containing SSCs that does not have a corresponding credited interior door with a higher bottom door elevation (23 ft. NGVD29).

(2) The reevaluated flood hazards for streams and rivers, failure of dams, and tsunami were determined to not inundate the Brunswick site; therefore, FEDs for these flood-causing mechanisms were not applicable.

(3) There is an insignificant difference between the ground elevations at the doors and adjacent ground therefore the recession is assumed to end at the time the inundation period ends (NRC, 2017b).

TABLE 3.2.3-1. ASSOCIATED EFFECTS PARAMETERS NOT DIRECTLY ASSOCIATED WITH TOTAL WATER ELEVATION FOR FLOOD-CAUSING MECHANISMS NOT BOUNDED BY THE CDB

	Flood-Causing Mechanism		
Associated Effects Parameter	**Local Intense Precipitation**	**Storm Surge**	**Streams and Rivers, failure of dams and onsite, and tsunami(2)**
Maximum Hydrostatic and Hydrodynamic loading at site grade(1)	Minimal	1604 lbf./ft. for hydrostatic load 1944 lbf./ft. for hydrodynamic load	Not applicable
Maximum Debris loading at site grade	Minimal	5414 lbf. for debris load	Not applicable
Sediment loading at site grade	Minimal	Minimal(3)	Not applicable
Sediment deposition and erosion	Minimal	Minimal(3)	Not applicable
Concurrent conditions, including adverse weather	None	Hurricane Winds	Not applicable
Groundwater ingress	Minimal	Not Applicable(4)	Not Applicable
Other pertinent factors (e.g., waterborne projectiles)	None	None identified	Not applicable

Sources: (FHRR; MSA; FHRR audit report; and FHRR staff assessment)

Notes:

(1) Loadings are per linear feet of structure in length. LIP loading are provided in the FHRR but are not used and therefore not repeated in the MSA. NRC staff note that LIP loadings were about two orders of magnitude lower than those associated with storm surge and therefore are characterized as minimal.

(2) These flood-causing mechanisms were included in the ISR letter but the reevaluated hazard elevations does not exceed the site grade.

(3) Storm surge related sediment loading, deposition and erosion are marked as "N/A" in MSA Table 2 with notes that reflect the conclusion that there is "no consequent safety risk for safety related structures" and "no significant impact on the already reduced water levels at the site". NRC staff determined that "minimal" sediment impacts is more reflective of the conditions described than "Not applicable".

(4) Groundwater ingress is not stated as being not applicable based on above ground storage and staging of FLEX equipment, and the protection of safety-related components from groundwater intrusion. The MSA states that "plant equipment used for FLEX strategies is not susceptible to flooding from ground water intrusion."

SUBJECT: BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 AND 2 – FLOOD HAZARD MITIGATION STRATEGIES ASSESSMENT DATED OCTOBER 30, 2018

DISTRIBUTION
Public
PBMB R/F
RidsNRRDlp Resource
RidsNrrDorllpl2-2 Resource
RidsNrrDorl Resource
RidsNrrPMBrunswick Resource
RidsNrrlaSLent Resource
RidsOgcMailCenter Resource
RidsOpaMail Resource
RidsACRS_MailCtr Resource
RidsNroDLSE Resource
RidsRgn2MailCenter Resource
PBamford, NRR
SDevlin-Gill, NRO
FVega, NRR

ADAMS Accession Nos. Pkg .ML18284A388; Non-Public Encl ML18262A416; Public Encl ML18284A397 *via email

OFFICE	NRR/DLP/PBMB/PM	NRR/DLP/PBMB/LA	NRR/DLP/PBMB/PM*	NRO/DLSE/RHM
NAME	FVega	SLent	PBamford	SDevlin
DATE	09/20/2018	09/19/2018	10/11/18	08/15/2018
OFFICE	NRR/DLP/PBMB/BC(A)	NRR/DLP/PBMB/PM		
NAME	BTitus	FVega		
DATE	10/26/2018	10/30/2018		

OFFICIAL RECORD COPY