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

October 17, 2017

Mr. Mano Nazar
President and Chief Nuclear Officer
Nuclear Division
Florida Power & Light Company
Mail Stop EX/JB
700 Universe Blvd.
Juno Beach, FL 33408

SUBJECT: ST. LUCIE PLANT UNITS 1 AND 2– STAFF ASSESSMENT OF RESPONSE TO 10 CFR 50.54(f) INFORMATION REQUEST – FLOOD-CAUSING MECHANISM REEVALUATION (CAC NOS. MF6113 AND MF6114)

Dear Mr. Nazar:

By letter dated March 12, 2012, the U.S. Nuclear Regulatory Commission (NRC) issued a request for information pursuant to Title 10 of the *Code of Federal Regulations*, Section 50.54(f) (hereafter referred to as the 50.54(f) letter). The request was issued as part of implementing lessons learned from the accident at the Fukushima Dai-ichi nuclear power plant. Enclosure 2 to the 50.54(f) letter requested that licensees reevaluate flood-causing mechanisms using present-day methodologies and guidance. By letter dated March 10, 2015 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML15083A306), Florida Power and Light Company (FPL, the licensee) responded to this request for St. Lucie Plant Units 1 and 2 (St. Lucie).

By letter dated September 3, 2015 (ADAMS Accession No. ML15224B449), the NRC staff sent the licensee a summary of the staff's review of St. Lucie's reevaluated flood-causing mechanisms. The enclosed staff assessment provides the documentation supporting the NRC staff's conclusions summarized in the letter. As stated in the letter, the reevaluated flood hazard results for the local intense precipitation (LIP) flood-causing mechanism was not bounded by the current design basis. In order to complete its response to Enclosure 2 to the 50.54(f) letter, the licensee is expected to submit a focused evaluation for LIP to address this reevaluated flood hazard, as discussed in COMSECY-15-0019, "Closure Plan for the Reevaluation of Flooding Hazard for Operating Nuclear Power Plants," and Japan Lessons-Learned Division (JLD) Interim Staff Guidance (ISG) JLD-ISG-2016-01, "Guidance for Activities Related to Near-Term Task Force Recommendation 2.1, Flooding Hazard Reevaluation; Focused Evaluation and Integrated Assessment." This letter closes out the NRC's efforts associated with CAC Nos. MF6113 and MF6114.

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

Sincerely,

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

Docket Nos. 50-335 and 50-389

Enclosure:
Staff Assessment of Flood Hazard
Reevaluation Report for St. Lucie

cc w/encl: Distribution via Listserv

STAFF ASSESSMENT BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO FLOODING HAZARD REEVALUATION REPORT

NEAR-TERM TASK FORCE RECOMMENDATION 2.1

ST. LUCIE NUCLEAR POWER PLANT, UNITS 1 AND 2

DOCKET NOS. 50-335 AND 50-389

1.0 INTRODUCTION

By letter dated March 12, 2012 (NRC, 2012a), 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* (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 Near-Term Task Force (NTTF) report (NRC, 2011b). Recommendation 2.1 in that document recommended that the NRC staff issue orders to all licensees to reevaluate seismic and flooding for their sites against current NRC requirements and guidance. Subsequent staff requirements memoranda associated with SECY 11-0124 (NRC, 2011c) and SECY-11-0137 (NRC, 2011d), directed the NRC staff to issue requests for information to licensees pursuant to 10 CFR 50.54(f) to address this recommendation.

Enclosure 2 to the 50.54(f) letter (NRC, 2012a) requested that licensees reevaluate flood hazards for their respective sites using present-day methods and regulatory guidance used by the NRC staff when reviewing applications for early site permits (ESPs) and combined licenses (COLs). The required response section of Enclosure 2 specified that NRC staff would provide a prioritization plan indicating Flooding Hazard Reevaluation Report (FHRR) deadlines for each plant. On May 11, 2012, the NRC staff issued its prioritization of the FHRRs (NRC, 2012c).

By letter dated March 10, 2015, Florida Power and Light Company (FPL, the licensee) provided the FHRR for St. Lucie Plant (St. Lucie), Units 1 and 2 (FPL, 2015a). Additionally, FPL submitted electronic input/output (I/O) files in support of the FHRR in letters dated June 3, 2015, and August 20, 2015 (FPL, 2015b and FPL, 2015c, respectively). The NRC staff performed a regulatory audit of FPL's FHRR submittals and supporting documents on July 23, 2015, as documented in the audit report dated October 1, 2015 (NRC, 2015c).

On September 3, 2015, the NRC issued an Interim Staff Response (ISR) letter to the licensee (NRC, 2015b). The purpose of the ISR letter is to provide the flood hazard information suitable for the assessment of mitigating strategies developed in response to Order EA-12-049 (NRC, 2012b) and the additional assessments associated with Recommendation 2.1: Flooding. The ISR letter also made reference to this staff assessment, which documents staff basis and conclusions. In the ISR letter, the NRC staff reported the single maximum elevation for the local intense precipitation (LIP) flood-causing mechanism in Table 2. In this staff assessment, all points of interest reported by the licensee are included in Table 4.1-1. These changes did not alter any conclusions transmitted in the ISR letter.

As mentioned in the ISR letter (NRC, 2015b), the reevaluated flood hazard result for the LIP flood-causing mechanism is not bounded by the plant's current design basis (CDB). Consistent with the 50.54(f) letter and amended by the process outlined in COMSECY-15-0019 (NRC, 2015a), Japan Lessons-Learned Division (JLD) Interim Staff Guidance (ISG) JLD-ISG-2012-01, Revision 1 (NRC, 2016a) and JLD-ISG-2016-01, Revision 0 (NRC, 2016b), the NRC staff anticipates that the licensee will perform and document a focused evaluation for LIP and associated site drainage that assesses the impact of the LIP hazard on the site and evaluates and implements any necessary programmatic, procedural or plant modifications to address this hazard exceedance.

Additionally, for any reevaluated flood hazards that are not bounded by the plant's CDB hazard, the licensee is expected to develop any flood event duration (FED) parameters and associated effects (AE) parameters. These parameters will be used to conduct the Mitigating Strategies Assessment (MSA) and focused evaluations or revised integrated assessments.

2.0 REGULATORY BACKGROUND

2.1 Applicable Regulatory Requirements

As stated above, Enclosure 2 to the 50.54(f) letter (NRC, 2012a) 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 ESPs and COLs. This section of the staff assessment describes present-day regulatory requirements that are applicable to the FHRR.

Sections 50.34(a)(1), (a)(3), (a)(4), (b)(1), (b)(2), and (b)(4), of 10 CFR, describe the required content of the preliminary and final safety analysis reports, including a discussion of the facility site with a particular emphasis on the site evaluation factors identified in 10 CFR Part 100. The licensee should provide any pertinent information identified or developed since the submittal of the preliminary safety analysis report in the final safety analysis report.

General Design Criterion 2 in Appendix A of 10 CFR Part 50 states that structures, systems, and components (SSCs) important to safety at nuclear power plants must be designed to withstand the effects of natural phenomena such as earthquakes, tornados, hurricanes, floods, tsunamis, and seiches without the loss of capability to perform their intended safety functions. The design bases for these SSCs are to reflect appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area. The design bases are also to have sufficient margin to account for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.

Section 50.2 of 10 CFR defines the design-basis as the information that identifies the specific functions that an SSC of a facility must perform, and the specific values or ranges of values chosen for controlling parameters as reference bounds for design which each licensee is required to develop and maintain. These values may be: (a) restraints derived from generally accepted "state of the art" practices for achieving functional goals; or (b) requirements derived from an analysis (based on calculation, experiments, or both) of the effects of a postulated accident for which an SSC must meet its functional goals.

Section 54.3 of 10 CFR defines the "current licensing basis" (CLB) as "...the set of NRC requirements applicable to a specific plant and a licensee's written commitments for ensuring compliance with and operation within applicable NRC requirements and the plant-specific design basis (including all modifications and additions to such commitments over the life of the license) that are docketed and in effect." This includes 10 CFR Parts 2, 19, 20, 21, 26, 30, 40, 50, 51, 52, 54, 55, 70, 72, 73, 100, and appendices thereto; orders; license conditions; exemptions; and technical specifications, as well as the plant-specific, design basis information as documented in the updated final safety analysis report (UFSAR). The licensee's commitments made in docketed licensing correspondence, which remain in effect are also considered part of the CLB.

Present-day regulations for reactor site criteria (Subpart B to 10 CFR Part 100 for site applications on or after January 10, 1997) state, in part that the physical characteristics of the site must be evaluated and site parameters established such that potential threats from such physical characteristics will pose no undue risk to the type of facility proposed to be located at the site. Factors to be considered when evaluating sites include the nature and proximity of dams and other man-related hazards (10 CFR 100.20(b)) and the physical characteristics of the site, including the hydrology (10 CFR 100.21(d)).

2.2 Enclosure 2 to the 50.54(f) Letter

Section 50.54(f) of 10 CFR states that a licensee shall at any time before expiration of its license, upon request of the Commission, submit written statements, signed under oath or affirmation, to enable the Commission to determine whether or not the license should be modified, suspended, or revoked. The 50.54(f) letter (NRC, 2012a) requested, in part, that licensees reevaluate the flood-causing mechanisms for their respective sites using present-day methodologies and regulatory guidance used by the NRC for the ESP and COL reviews.

2.2.1 Flood-Causing Mechanisms

Attachment 1 to Enclosure 2 of the 50.54(f) letter discusses flood-causing mechanisms for the licensee to address in its FHRR (NRC, 2012a). Table 2.2-1 lists the flood-causing mechanisms the licensee should consider and lists the corresponding Standard Review Plan (SRP) (NRC, 2007) section(s) and applicable ISG documents containing acceptance criteria and review procedures.

2.2.2 Associated Effects

In reevaluating the flood-causing mechanisms, the "flood height and associated effects" should be considered. Guidance document JLD-ISG-2012-05 (NRC, 2012), defines "flood height and associated effects" as the maximum stillwater surface elevation plus:

- Wind waves and runup effects
- Hydrodynamic loading, including debris
- Effects caused by sediment deposition and erosion
- Concurrent site conditions, including adverse weather conditions
- Groundwater ingress
- Other pertinent factors

2.2.3 Combined Effect Flood

The worst flooding at a site that may result from a reasonable combination of individual flooding mechanisms is sometimes referred to as a "combined effects flood." It should also be noted that for the purposes of this staff assessment, the terms "combined effects" and "combined events" are synonyms. Even if some or all of these individual flood-causing mechanisms are less severe than their worst-case occurrence, their combination may still exceed the most severe flooding effects from the worst-case occurrence of any single mechanism described in the 50.54(f) letter (see SRP Section 2.4.2, Areas of Review (NRC, 2007)). Attachment 1 of the 50.54(f) letter describes the "combined effect flood" as defined in American National Standards Institute/American Nuclear Society (ANSI/ANS) 2.8-1992 (ANSI/ANS, 1992) as follows:

> For flood hazard associated with combined events, American Nuclear Society (ANS) 2.8-1992 provides guidance for combination of flood causing mechanisms for flood hazard at nuclear power reactor sites. In addition to those listed in the ANS guidance, additional plausible combined events should be considered on a site specific basis and should be based on the impacts of other flood causing mechanisms and the location of the site.

If two less severe mechanisms are plausibly combined per ANSI/ANS-2.8-1992 (ANSI/ANS, 1992), then the licensee will document and report the result as part of one of the hazard sections. An example of a situation where this may occur is flooding at a riverine site located where the river enters the ocean. For this site, storm surge and river flooding are plausible combined events and should be considered.

2.2.4 Flood Event Duration

Flood event duration was defined in JLD-ISG-2012-05 (NRC, 2012d), as the length of time during which the flood event affects the site. It begins when conditions are met for entry into a flood procedure, or with notification of an impending flood (e.g., a flood forecast or notification of dam failure), and includes preparation for the flood. It continues during the period of inundation, and ends when water recedes from the site and the plant reaches a safe and stable state that can be maintained indefinitely. Figure 2.2-1 of this assessment illustrates flood event duration.

2.2.5 Actions Following the FHRR

For the sites where the reevaluated flood hazard is not bounded by the CDB flood hazard elevation for any flood-causing mechanisms, the 50.54(f) letter (NRC, 2012a) requests licensees and construction permit holders to:

- Submit an interim action plan with the FHRR documenting actions planned or already taken to address the reevaluated hazard; and

- Perform an integrated assessment to: (a) evaluate the effectiveness of the CDB (i.e. flood protection and mitigation systems); (b) identify plant-specific vulnerabilities; and (c) assess the effectiveness of existing or planned systems and procedures for protecting against and mitigating consequences of flooding for the flood event duration.

If the reevaluated flood hazard is bounded by the CDB flood hazard for all flood-causing mechanisms at the site, licensees were not required to perform an integrated assessment.

COMSECY-15-0019 (NRC, 2015a) outlines a revised process for addressing cases in which the reevaluated flood hazard is not bounded by the plant's CDB. The revised process describes an approach in which licensees with LIP hazards exceeding their CDB flood will not be required to complete an integrated assessment, but instead will perform a focused evaluation. As part of the focused evaluation, licensees will assess the impact of the LIP hazard on their sites and then evaluate and implement any necessary programmatic, procedural or plant modifications to address the hazard exceedance. For other flood hazard mechanisms that exceed the CDB, licensees can assess the impact of these reevaluated hazards on their site by performing either a focused evaluation or a revised integrated assessment (NRC, 2015a and NRC, 2016a).

3.0 TECHNICAL EVALUATION

The NRC staff reviewed the information provided for the reevaluation of the flood hazards at St. Lucie, Units 1 and 2 (FPL, 2015a and NRC, 2015c, respectively). The licensee conducted the hazard reevaluation using present-day methodologies and regulatory guidance used by the NRC staff in connection with ESP and COL reviews. Additionally, the licensee provided electronic copies of computer I/O files used in the numerical modeling on the docket for staff's review (FPL, 2015b and FPL, 2015c, repectively).

3.1 Site Information

The 50.54(f) letter (NRC, 2012a) includes the SSCs important to safety in the scope of the hazard reevaluation. The NRC staff reviewed and summarized this information in the sections below.

All elevations in this staff assessment are given with respect to the North American Vertical Datum of 1988 (NAVD88). The licensee used the Plant St. Lucie Datum (PSL Datum) at times in the St. Lucie FHRR, and provided a conversion to NAVD88 from PSL Datum (FPL, 2015a). The St. Lucie site grade elevation is 15.2 ft NAVD88 (FPL, 2015a). Table 3.0-1 of this assessment provides the summary of controlling reevaluated flood-causing mechanisms the licensee computed to be higher than the powerblock elevation.

3.1.1 Detailed Site Information

The St. Lucie FHRR (FPL, 2015a) describes the site specific information related to the flood hazard evaluation. The St. Lucie site is comprised of approximately 1,132 acres on Hutchinson Island in St. Lucie County, Florida. Hutchinson Island is a 23-mile long barrier island that lies offshore of the Floridian Peninsula between the Ft. Pierce and St. Lucie Inlets.

The St. Lucie site is bounded to the east by the Atlantic Ocean (FPL, 2015a). To the west the site is bounded by the Indian River, a tidal lagoon. Big Mud Creek, an inlet off the Indian River, bounds the St. Lucie site to the north and Herman Bay bounds the site to the south. Surface drainage from the site flows to either the Atlantic Ocean or the Indian River, either directly or through Big Mud Creek. Figure 3.1-1 of this assessment provides the layout of the St. Lucie site.

Safety-related structures at the St. Lucie site have a minimum entrance elevation of 16.2 feet (ft.) NAVD88. The crown elevation of the roadways on the St. Lucie site have an elevation of 15.7 ft. NAVD88. Unimproved portions of the site are generally flat, covered with water, and contain dense vegetation characteristic of Florida mangrove swamps.

3.1.2 Design-Basis Flood Hazards

The CDB flood levels are summarized by flood-causing mechanism in Table 3.1 1 of this assessment. The NRC staff reviewed the information provided in the St. Lucie FHRR (FPL, 2015a) and determined that sufficient information was provided to be responsive to Enclosure 2 of the 50.54(f) letter (NRC, 2012a).

3.1.3 Flood-related Changes to the Licensing Basis

The licensee noted in its FHRR that there have been no revisions to the flood hazards analysis and no significant changes to the flood protection strategies for the St. Lucie site (FPL, 2015a). The NRC staff reviewed the flood hazard information provided and determined that sufficient information on the flood-related changes to the licensing basis was provided to be responsive to Enclosure 2 of the 50.54(f) letter (NRC, 2012a).

3.1.4 Changes to the Watershed and Local Area

The licensee stated in its FHRR that no changes have occurred to the contributing watershed that influence site run-on/runoff conditions (FPL, 2015a). The NRC staff reviewed the information provided and determined that sufficient information was provided to be responsive to Enclosure 2 of the 50.54(f) letter.

3.1.5 Current Licensing Basis Flood Protection and Pertinent Flood Mitigation Features

In its FHRR, the licensee stated that there were no revisions to the licensing basis flood elevations or significant changes to flood protection strategies. The licensee noted that minor changes have occurred to waterproofing materials and stoplog installation details have been incorporated. The NRC staff reviewed the information provided in the St. Lucie FHRR and determined that sufficient information was provided to be responsive to Enclosure 2 of the 50.54(f) letter.

3.1.6 Additional Site Details to Assess the Flood Hazard

The licensee made electronic copies of the I/O files for the computer models and calculation packages used in connection with the flood hazard reevaluations available for review (FPL, 2015b and FPL, 2015c, respectively). The NRC staff reviewed the information provided in the FHRR and determined that sufficient information was provided to be responsive to Enclosure 2 of the 50.54(f) letter.

3.1.7 Results of Plant Walkdown Activities

The 50.54(f) letter (NRC, 2012a) requested that licensees plan and perform plant walkdown activities to verify that current flood protection systems were available, functional, and implementable. Other parts of the 50.54(f) letter asked the licensee to report any relevant information from the results of the plant walkdown activities (NRC, 2012a).

By letter dated November 26, 2012 (FPL, 2012), FPL submitted a Flooding Walkdown Report as requested in Enclosure 4 of the 50.54(f) letter for the St. Lucie site. On June 27, 2014 (NRC, 2014), the NRC staff issued its assessment of the Walkdown Report, which documented its review of that licensee action and concluded that the licensee's implementation of the flooding walkdown methodology met the intent of the walkdown guidance.

3.2 Local Intense Precipitation and Associated Site Drainage

The licensee reported in its FHRR that the reevaluated flood hazard for LIP is based on a maximum water depth of accumulated water in the powerblock area of 3.2 ft. (FPL, 2015a). The effects of wind waves and runup were not included by the licensee in the LIP flood reevaluation. This flood-causing mechanism is not discussed in the licensee's CDB. The licensee reevaluated the flood from an LIP event using the two dimensional (2D) FLO-2D computer model (Build 13.01.12) (FLO-2D Software, Inc., 2009).

3.2.1 Site Drainage and Elevations

The licensee reevaluated flood-hazard resulting from LIP due to a LIP storm over the immediate drainage area of approximately 425 acres (FPL, 2015b). The drainage area includes the buildings and structures, vehicle barrier system (VBS), and contiguous natural drainage areas that could potentially effect runoff on the St. Lucie site. For the LIP modeling, the licensee developed a digital terrain model (DTM) based on data obtained from a site specific survey conducted in July 2013 and light detection and ranging (LiDAR) derived 10-ft.-spatial-resolution digital elevation data developed in 2007.

The licensee modeled barriers, such as VBS, berms, and walls located on the St. Lucie site as a FLO-2D levee option and buildings and roofs were entered into the FLO-2D model (FPL, 2015a). Building top elevations were based on surveys conducted in July 2013 or estimated using 10-ft-spatial-resolution LiDAR data. Roof tops were not credited for water storage and flow from roof tops were routed directly to the ground adjacent to the building. The licensee assumed that the St. Lucie site drainage system, including catch basins, site drains, and associated piping, was not functional.

The licensee stated that the antecedent conditions included in the model assumed full ground saturation and zero infiltration losses (FPL, 2015a). Manning's n values for various site cover conditions within the FLO-2D model are based on guideline in the FLO-2D Reference Manual (FLO-2D, 2012). The licensee assigned Manning's n values of 0.2 when water depths within a grid cell became less than 6 in., as recommended by the FLO-2D Reference Manual (FLO-2D, 2012).

The NRC staff reviewed the licensee's methodology to set up the FLO-2D for site drainage and elevations and determined that it is consistent with guidance found in NUREG/CR-7046 (NRC, 2011e).

3.2.2 Local Intense Precipitation

The LIP event described in the FHRR (FPL, 2015a) was based on the 1-hour (h), 1-square mile (mi^2) probable maximum precipitation (PMP) derived from National Oceanic and Atmospheric Administration (NOAA) National Weather Service (NWS) *Hydrometeorological Report* (HMR) Nos. 51 (NOAA, 1978) and 52 (NOAA, 1982). Using these reports, the licensee determined that the 1-h, 1-mi^2 PMP depth is 19.4 in. (FPL, 2015a). The licensee used multiplier factors from HMR-52 (NOAA, 1982) to estimate the 30-, 15-, and 5-minute (min) PMP depths for a 1-mi^2 drainage area.

The licensee considered six different scenarios (A to F), all with four different hyetograph distributions of the PMP, to determine the bounding LIP effects (FPL, 2015a). The scenarios were based on the number of operating units which determine the water level in the Intake

Canal at the St. Lucie site, with and without the addition of the FLEX building. Scenario A and D included two operating units; Scenario B and E included 1 operating unit, and Scenario C and F included no operating units. Scenario A, B, and C considered the St. Lucie site without the addition of the FLEX building, Scenario D, E, and F included the addition of the FLEX building. The four PMP temporal distributions included a front loaded (first quartile), center loaded (second and third quartiles), and end loaded (fourth quartile) distributions depending on how the 5-min peak PMP value is placed. All four hyetographs resulted in a precipitation depth of 19.4 in. for a 1-h, 1-mi^2 rainfall event at the St. Lucie site.

The NRC staff used the location of the St. Lucie site to verify, from HMR 52 (NOAA 1982), that the licensee's LIP depth estimates are appropriate and the licensee's methodology is consistent with the guidelines provided by the NUREG/CR-7046 (NRC, 2011e).

3.2.3 Runoff Process

The licensee relied on a 20-ft. by 20-ft. grid system covering the entire FLO-2D model domain. The grid elevations were derived from bathymetry and topographic point data found in surveys and LiDAR data to provide computational coverage of the St. Lucie site (FPL, 2015a). The licensee used the FLO-2D model to route the process of rainfall-runoff over the land surfaces or in channels in the grid system using the continuity equation and a dynamic wave approximation to the momentum equation. Boundary elements were specified as outflow points with no prescribed hydrograph (FPL, 2015b). The licensee assigned a minimum flow depth of 0.01 ft. across solution cells to prevent small flow oscillations from increasing computational time (FPL, 2015a). Additionally, the licensee applied a minimum storage depth of 0.01 ft. to grid cells to meet non-zero storage volume criterion for a FLO-2D solution.

The licensee provided the FLO-2D I/O files, including the water surface elevation (WSE) results described in the FHRR for the staff's review (FPL, 2015b and FPL, 2015c). Using the computer I/O files, the NRC staff confirmed that the configuration of the FLO-2D computational domain used in the LIP analysis was consistent with the description provided in the FHRR. The NRC staff compared available topographic data, provided by the licensee, for the site to the grid elevations in the FLO-2D computational model and determined that the licensee's computer model reasonably represented the actual ground-surface elevation of the St. Lucie site. The NRC staff also determined that the location of the VBS and other building structures within the St. Lucie powerblock area were properly represented in the model. Furthermore, the NRC staff reviewed the configuration of the licensee-provided FLO-2D model and confirmed that storm water-conveyance structures on-site were assumed to be blocked and that infiltration losses were neglected, consistent with guidance in NUREG/CR-7046.

In the matter of how the rainfall-induced runoff from buildings was treated, the NRC staff determined that the representation of buildings as overland-flow grid cells with elevations higher than the surrounding terrain was a reasonable approach to account for the vertical flow effects from building tops. The NRC staff also determined that the licensee's use of a minimum uniform flow depth of 0.01 ft. and minimum storage depth of 0.01 ft. was reasonable to ensure the stability of the model simulations.

3.2.4 Water Level Determination

The licensee reported reevaluated flood elevations at 36 points of interest (POIs) within the powerblock and at the intake structure location in response to a 1-h, 1-mi2 PMP event (FPL, 2015a). The locations of these POIs are shown in Figure 3.2-1. The licensee obtained flood elevation time series and depth for each of the POIs. Six LIP scenarios were simulated for 2-h simulation time to obtain flood elevations, as well as periods of inundation and recession. Table 3.2-1 of this assessment shows the maximum WSEs and flood depths at each of the POIs, that is, peak values among six scenarios. POIs 1 through 16 represent locations near St. Lucie, Unit 1 and POIs 17 through 36 represent locations near the St. Lucie, Unit 2. The maximum flood depths ranged from 0.1 ft to 3.2 ft. The maximum depth at St. Lucie, Unit 1 is 3.2 ft. and was the result of Scenario A (both units operating without the addition of the FLEX building). The maximum depth at St. Lucie, Unit 2 is 2.1 ft and was the result of Scenario F (no units operating with the addition of the FLEX building).

The licensee reported the maximum mass balance error for the LIP simulations was 2×10^{-6} percent (FPL, 2015a). The NRC staff reviewed the licensee's input and output files and observed that the mass balance error for the FLO-2D model ranged from 1.4×10^{-5} to 1.6×10^{-5} acre-ft. This range was within the maximum mass balance error reported by the licensee. The inundation areas and flow pathways appear reasonable, and the flow velocities are reasonable, with no indication of numerical instabilities and no supercritical flow conditions. Based on those results, the NRC staff concluded that the licensee's FLO-2D model has a reasonable basis for evaluating the potential flood hazard due to the LIP flood-causing mechanism.

3.2.5 Conclusion

In summary, the NRC staff confirmed the licensee's conclusion that the reevaluated flood hazard for LIP and associated site drainage is not bounded by the CDB flood hazard. Therefore, the NRC staff expects that the licensee will submit a focused evaluation for LIP and associated site drainage for the St. Lucie site.

3.3 Streams and Rivers

The licensee reported in its FHRR that the reevaluated flood hazard for streams and rivers is not applicable to the St. Lucie site (FPL, 2015a). This flood-causing mechanism is not discussed in the licensee's CDB.

The licensee stated that the Indian River is a tidal lagoon connected to the Atlantic Ocean and Big Mud Creek is an arm of the Indian River tidal lagoon. The licensee stated that water levels on the St. Lucie site are not affected by streams and rivers located in the region. The NRC staff reviewed the information provided in the St. Lucie FHRR (FPL, 2015a) and topographic maps (USGS, 2016) of the St. Lucie site and determined that the licensee's bases for concluding that the St. Lucie site is not affected by flooding from streams and rivers is reasonable.

In summary, the NRC staff confirmed the licensee's conclusion that the reevaluated flood hazard for streams and rivers is bounded by the CDB flood hazard. Therefore, the NRC staff determined that flooding due to streams and rivers does not need to be analyzed in a focused evaluation or revised integrated assessment.

3.4 Failure of Dams and Onsite Water Control/Storage Structures

The licensee reported in the St. Lucie FHRR, that the reevaluated flood hazard for failure of dams and onsite water control or storage structures is not applicable to the St. Lucie site (FPL, 2015a). This flood-causing mechanism is not discussed in the licensee's CDB.

The NRC staff reviewed the USACE National Inventory of Dams database (USACE, 2016) and determined that there were no dams located in the region that could contribute to flooding hazards at the St. Lucie site (USACE, 2017a). Additionally, the NRC staff reviewed the FHRR and determined that there were no onsite water control or storage structures that would contribute to flooding on the St. Lucie site (FPL, 2015a).

In summary, the NRC staff confirmed the licensee's conclusion that the reevaluated hazard for flooding due to the failure of dams and onsite water control or storage structures is bounded by the CDB flood hazard at the St. Lucie site. Therefore, the NRC staff determined that flooding from dam failure does not need to be analyzed in a focused evaluation or revised integrated assessment.

3.5 Storm Surge

The licensee reported in the St. Lucie FHRR (FPL, 2015a) that the reevaluated flood hazard for a probable maximum storm surge (PMSS) has a stillwater WSE of 14.9 ft. NAVD88 and is based on a probable maximum hurricane (PMH) with a tracking direction of 70 degrees. The CDB storm surge is based on a PMH in the Indian River and produces a maximum stillwater WSE of 13.9 ft. NAVD88. The CDB PMSS including wind/wave run-up varies depending on the location at the plant site and ranges from 14.8 ft. to 15.5 ft. NAVD88.

3.5.1 Probable Maximum Hurricane

The licensee discussed the historical major hurricanes that occurred within 120 nautical miles (nmi) of the St. Lucie site since 1842 (FPL, 2015a). Major hurricanes are defined as storms rating category 3 status or higher on the Saffir-Simpson Hurricane Scale. The licensee stated based on historical data that a major hurricane landed the 240 nmi stretch of coast near the St. Lucie site once every 20 years on average. Additionally, all the hurricanes making landfall approached the coast line from an east to west or southeast to northwest trajectory (FPL, 2015a).

The licensee selected the design hurricane based on guidance provided in NUREG/CR-7046, NUREG-0800, and JLD-ISG-2012-06 (FPL, 2015a). The licensee used the methodology discussed in the National Weather Service (NWS) Technical Report 23 (NWS23) to determine the probable maximum hurricane (PMH) parameters (NWS, 1979). The licensee analyzed a number of storm radii, headings and forward speeds, to determine the critical PMH parameters of storm size, pressure, and wind fields for a storm making landfall near the St. Lucie site.

The licensee applied the following PMH parameters for the site in the FHRR analysis as derived from the NWS 23 methodology (FPL, 2015a):

- Peripheral pressure equal to 1,020 mb;
- Central pressure equal to 885.5 mb;
- Radius of maximum wind (RMW) range from 4 nmi to 20 nmi;
- Forward speed range from 6 to 20 knots; and
- Tracking direction ranging from 70 to 160 degrees (measured counterclockwise from the north).

The licensee determined the critical PMH parameters producing the maximum storm surge as (FPL, 2015a):

- Central pressure equal to 885.5 mb;
- RMW of 19 nmi;
- Forward speed of 20 knots; and
- Tracking direction of 70 degrees.

The NRC staff determined that the licensee's PMH methodology and results were reasonable and follow the guidance on PMH parameters provided by the NWS-23 (NWS, 1979).

3.5.2 Antecedent Water Levels

The St. Lucie FHRR (FPL, 2015a) states that the licensee based the antecedent water level (AWL) analysis for storm surge estimation on guidance found in JLD-ISG-2012-06 (NRC, 2013a). The AWL presented by the licensee includes a 10 percent exceedance high tide plus long-term sea level rise (SLR) trend. The licensee used records of measured tidal levels from Lake Worth Pier NOAA Station to determine the 10 percent exceedance high tide. The Lake Worth Pier NOAA Station contained 16 years of observed tidal data. However, the licensee considered 21 years resynthesized data appropriate to determine the 10 percent exceedance monthly spring high tide.

The licensee used two approaches to estimate SLR at the St. Lucie site (FPL, 2015a): a fitted 30-year linear trend line estimation and a 100-year, second-order trend model based on Walton (2007). Four NOAA stations were used to estimate the SLR at the St. Lucie site (FPL, 2015a). The resulting 30- and 100-year SLR trends were based on 43 years of consecutive data from the Fernandina Beach, FL NOAA station. The licensee's resulting 10 percent exceedance high tide plus SLR equaled to +1.9 ft NAVD88.

The NRC staff performed an independent evaluation of the AWL for St. Lucie, using available water level data and a SLR annual rate at the Fort Worth Pier, FL NOAA tidal gaging station (ID 8722670) and the Mayport, FL NOAA station (ID 8720218), respectively. The NRC staff estimated a 10 percent exceedance high tide of 1.7 ft-NAVD88 and a linear SLR projected to 30 years (remaining licensed life of St. Lucie) of 0.3 ft-NAVD88, resulting in an AWL of 2 ft-NAVD88. A comparison of the NRC staff-estimated AWL and the licensee-estimated AWL shows almost identical results for the surge simulations. Therefore, the NRC staff determined that the licensee's AWL methodology and results are reasonable.

3.5.3 Delft3D Surge Model

The St. Lucie FHRR (FPL, 2015a) states that the licensee applied Delft3D Version 4.00.01 software package (Deltares, 2011) in the storm surge analysis. The licensee used the Delft3D-FLOW and Delft3D-WAVE modules to simulate the coupled effects of flow movement (surge) and wave propagation (wave spectra, height, period, and setup) (FPL, 2015a). The grid elevations of the numerical model are created from regional and local bathymetry and topography. The licensee's analysis included simulations to calibrate and validate the model to observed tides during historical storms (hurricanes Irene, Floyd, Frances, and Jeanne). The AWL conditions, including 10 percent exceedance high and low tides and potential SLR, are included in the numerical model as initial conditions. The SLR is estimated for the next 30-year licensed life of the St. Lucie site. The licensee stated that the critical PMH combination of storm parameters produces a storm surge elevation of 14.9 ft. NAVD88. The licensee concluded that the PMSS does not inundate the Units 1 and 2 powerblock area, the independent spent fuel storage installation, and the FLEX building.

The NRC staff confirmed that the Delft3D-FLOW model provided a suitable model to simulate hydrodynamic conditions near the St. Lucie site. The NRC staff also concluded that the model grid setup and resolution were appropriate for the site setting and forcing conditions.

3.5.4 Wind-Wave Runup

The St. Lucie FHRR (FPL, 2015a) states the runup evaluations follow the guidance from ANS-2.8 (1992) with calculations based on methods from the USACE Shore Protection Manual and Coastal Engineering Manual (CEM) (1984 and 2011). The wave runup analysis applies the maximum storm surge stillwater level (14.9 ft. NAVD88), which includes the 10 percent exceedance high tide, 30-year SLR (0.2 ft.), wind and pressure setup (12.4 ft.), and wave setup (0.7 ft.) (FPL, 2015a). The wave runup analysis applies the wave conditions from the storm that produced the maximum storm surge stillwater level. The St. Lucie FHRR states that the primary direction of wave approach is from the Atlantic Ocean with minimal direct wave attack observed on the west, southwest and south sides of the St. Lucie site (FPL, 2015).

During the PMH storm, the Delft3D-WAVE results indicate waves moving predominately to the west and entering the site through the dune feature along the coastal line facing the Atlantic Ocean (FPL, 2015a). The licensee considered a postulated breach of the dune in front of St. Lucie; however, the result of the wave modeling indicates that the dune breach does not affect the wave height at the St. Lucie power block. The licensee estimated the maximum possible wave height at the St. Lucie power block equals 0 ft. as the peak depth of water at the power block area for the postulated PMH flood-causing mechanism equals 0 ft. As a result, the St. Lucie FHRR states that the configuration of the important power block infrastructure and the mean wave direction during the maximum storm surge, does not create direct wave runup at the St. Lucie site.

3.5.5 Staff's Independent Analysis

The NRC staff performed independent simulations to provide a comparison point for the results of the licensee's modeling effort. This effort focused on providing a reasonable deterministic limit for tropical/hybrid cyclones capable of generating extreme storm surges at the St. Lucie site. The NRC staff's approach was similar to that used in Resio et al. (2012) to determine deterministic asymptotic values at sites along the U.S. Gulf of Mexico coasts and south Florida Atlantic coast. For storm intensity, the NRC staff applied the Maximum Possible Intensity (MPI) via idealized physical concepts (Emanuel, 1988 and Holland, 1997) and compared to observational data (Tonkin et al., 2000).

Based on consideration of sea surface temperature, the NRC staff used storms in the range of 885 to 890 mb for central pressures in the St. Lucie area (Graham and Nunn, 1959). The NRC staff used a storm size range from 25 to 45 nmi for sensitivity analysis and selected 25 to 30 nmi to yield the maximum storm surge produced by the PMH for application in the model simulations. Landfall locations were varied relative to each site to ensure that the maximum value fell within the range of storms simulated. The NRC staff limited the storm track angles considered to 0-degrees (a track normal to the coast), -22.5 degrees (approaching out of the east-southeast), and -45 degrees (approaching out of the southeast). Finally, because the Holland B parameter has a smaller effect on large storms, the NRC staff limited the value to 1.2.

The NRC staff used the coupled SWAN+ADCIRC model for an independent simulation of maximum storm surge. The first step in the staff's assessment of the storm surge water levels consisted of evaluating the ADCIRC model mesh files obtained from FEMA and the licensee. Review of FEMA's Region IV East Coast Central Florida model mesh indicated sufficiently resolved bathymetric and topographic features near St. Lucie and additional mesh resolution or edits were not needed. Following verification of the ADCIRC mesh files, the NRC staff verified WSE output to replicate the WSE results from FEMA's Hurricane Frances coupled SWAN+ADCIRC model simulation. Comparisons on a site-by-site basis, as well as on a global basis (entire mesh domain) demonstrated the ability of the SWAN+ADCIRC model runs. Next, the NRC staff applied time-varying, two-dimensional wind and pressure fields for tropical storms with the validated FEMA model grid and input files to evaluate PMH-induced water levels near the St. Lucie site. Review of the test simulation results showed the landfall location at 1-RMW from the site and angles at landfall of 180 and 205 degrees clockwise from east produced the highest water levels at the St. Lucie site.

The NRC staff also performed an independent evaluation of the AWL for the St. Lucie site, using available water level data and a SLR annual rate at the Fort Worth Pier, FL NOAA tidal gaging station and the Mayport, FL NOAA station, respectively. The NRC staff estimated a 10 percent exceedance high tide of 1.7 ft. NAVD88 and a linear SLR projected to 30 years (remaining licensed life of St. Lucie) of 0.3 ft. NAVD88, resulting in an AWL of 2 ft. NAVD88. A comparison of the staff-estimated AWL and the licensee-estimated AWL shows similar AWL results for the surge simulations.

The NRC staff's analysis included wave runup estimates based on the independent SWAN+ADCIRC water level and wave conditions for locations within the main area of infrastructure for the St. Lucie site. The calculations applied the vertical runup equation as listed in USACE CEM (USACE, 2011). Notably, the independent analysis runup calculations applied the significant wave height within the equations due to the differences in the SWAN+ADCIRC model (no structures) and the effect of infrastructure during an actual storm. The NRC staff's analysis also featured higher stillwater levels and calculated additional runup for some locations and runs. The NRC staff's radius of maximum winds sensitivity analysis showed that stillwater levels for the 25 nmi storm (15 ft. NAVD88) were similar to the FHRR storm surge results.

3.5.6 Conclusion

By letter dated December 19, 2016, the licensee submitted its MSA that addressed the flooding potential of the St. Lucie site as a result of the FHRR reevaluated maximum storm surge elevation (FPL, 2016). The licensee stated that although the maximum elevation of the reevaluated storm surge exceeds the CLB elevation, the water surface elevation is lower than the elevation of permanent and passive flood protection for critical plant equipment. The grade elevation for the plant island is 15.2 ft. NAVD88 and the minimum entrance elevation to all safety-related buildings is 16.2 ft. NAVD88. The NRC staff's review of the MSA is documented in a separate staff assessment (NRC, 2017). The NRC staff concluded that the licensee provided sufficient detail on the methods and sources used to determine the maximum storm surge elevation and the licensee's conclusions are reasonable.

In summary, the NRC staff confirmed the licensee's conclusion that flooding due to storm surge does not inundate the St. Lucie site. Therefore, the NRC staff determined that flooding from storm surge does not need to be analyzed in a focused evaluation or revised integrated assessment for the St. Lucie site.

3.6 Seiche

The licensee reported in the St. Lucie FHRR that flooding due to seiche is not likely to occur at the St. Lucie site (FPL, 2015a). Seiche flooding is discussed in the St. Lucie CDB, but no flood elevations are provided.

The licensee evaluated seiche at the St. Lucie site with consideration of meteorological, astronomical, and seismic forcing as the causative mechanism for low frequency water surface oscillations or seiche in Indian River (FPL, 2015a). The licensee stated that there is no documentation of historical seiches in the Indian River. However, the licensee evaluated the Indian River for natural periods of resonance (or modes), called Eigen periods, with Merian's two-dimensional formula (Ichinose et al., 2000).

The licensee calculated Eigen periods using Merian's formula for three different water levels: mean sea level, 10 percent exceedance high tide level, and 10 percent exceedance high tide level plus sea level rise after 30 years (FPL, 2015a). The calculated Eigen periods were then contrasted with periods obtained for wind speeds from 14 meteorological stations and a buoy with hourly records maintained by NOAA or Florida Automated Weather Network.

To verify any correlation of the Indian River Lagoon response with the forcing meteorological variable in the same frequency, the licensee performed spectral analysis of historical wind data in the region using fast Fourier transform (FFT) (FPL, 2015a). In the St. Lucie FHRR, the licensee provided the fundamental natural periods of Indian River. Based on the FFT results, the St. Lucie FHRR states that the typical frequency for the wind speeds cluster around 0.75, 1.0, 1.25, 1.75, and 2.25 hours which do not coincide with any of the natural periods. Therefore, the licensee concluded that no seiche is likely to occur at the St. Lucie site.

The NRC staff applied the seiche equations presented in the CEM (Coastal Engineering Manual) (USACE, 2002) and confirmed the primary and secondary mode periods with representative length and depth values for the Indian River. The NRC staff determined the licensee's methodology and results were reasonable.

In summary, the NRC staff confirmed the licensee's conclusion that flooding from seiche does not impact the St. Lucie site. Therefore, the NRC staff determined that flooding from seiche does not need to be analyzed in a focused evaluation or revised integrated assessment for the St. Lucie site.

3.7 Tsunami

The licensee reported in the St. Lucie FHRR that the reevaluated hazard for flooding from tsunami is 14.3 ft. NAVD88 (FPL, 2015a). This flood-causing mechanism was not described in the licensee's CDB.

3.7.1 Historic Tsunami Data

The licensee obtained historical tsunami runup events along the U.S. Atlantic Coast near the St. Lucie site from the National Geophysical Data Center (NGDC) tsunami database (FPL, 2015a). The licensee characterized the tsunami sources by their specific generation characteristic and examined each source to determine if the source was a credible threat to the St. Lucie site. The licensee considered any source capable of producing tsunami amplitudes greater than 3.3 ft. to be a tsunami source for the evaluation.

3.7.2 Potential Tsunami Mechanisms

The St Lucie FHRR discusses two possible mechanisms for tsunamis: an earthquake along the Marques de Pombal Fault near Spain, earthquakes along the Puerto Rico and Hispaniola Trenches in the northern Caribbean, and landslides near Cape Fear and Cape Lookout along the U.S. east coast (FPL, 2015a). Information about each of the possible sources is taken from the published literature and historical databases (NOAA, 2014 and ten Brink et al., 2008) and simulations are performed for each type of source.

The FHRR discusses potential tsunamis from three different earthquake sources: a source similar to the 1755 Lisbon earthquake, a large earthquake along the Puerto Rico trench, and an earthquake along the Hispaniola trench (FPL, 2015a). Source parameters are taken from the published literature, with recurrence values appropriate for this study.

The FHRR discusses two possible sources for landslide-generated tsunamis. A 200 km^3 slide offshore of Cape Fear and a 165 km^3 slide similar to the prehistoric Currituck slide (FPL, 2015a). Using landslide distribution information found in the literature, the St. Lucie FHRR states that the recurrence probability of the Cape Fear and Currituck slides are ~$2e^{-5}$ and $9e^{-5}$ (~0.013 and ~0.06), respectively.

The NRC staff reviewed the licensee's methodology for determining potential sources of tsunamis at the St. Lucie site and determined that it was reasonable.

3.7.3 Tsunami Analysis

The licensee conducted the tsunami analysis using the numerical model Delft3D (Deltares, 2011). Specific information regarding bathymetry sources and grid development is provided. The St. Lucie FHRR presents an AWL, composed of the 10 percent exceedance high tide (2.7 ft.) and sea level rise (0.2 ft.) (FPL, 2015a).

The St. Lucie FHRR states that the PMT arises from the Cape Fear landslide, with a maximum flood elevation of 14.3 ft. NAVD88 including 10 percent high tide and sea level rise (FPL, 2015a). The Saint Lucie site grade is 15.15 ft. NAVD88. Therefore, the licensee concluded that flooding from tsunami hazards would not inundate the St. Lucie site.

The NRC staff reviewed the methodologies used by the licensee to determine the severity of the tsunami phenomena reflected in this analysis and noted that they are consistent with present day methodologies and guidance. In the context of the above discussion, the NRC staff finds the licensee's analysis and use of these methodologies is consistent with present-day guidance and methodologies.

The NRC staff performed an independent confirmatory analysis consisting of numerical modeling of three tsunami sources consisting of both far-field seismogenic (Puerto Rico subduction zone) and far field (Canary Islands) and near-field (Cape Fear/Currituck) landslides as potential generators for the PMT (Lynett and Weiss, 2015 and ten Brink et al., 2008). The NRC staff used the Boussinesq-based numerical model COULWAVE (Lynett and Liu, 2002) for three different types of tsunami sources. For all conditions, the most conservative source parameters were employed, even when arguably unphysical, to provide an absolute upper limit on the possible tsunami effects at the St. Lucie site. The NRC staff concluded that the Puerto Rico Trench Landslide source is the PMT for the St. Lucie site with a maximum near-site tsunami water elevation that is less than the maximum water elevation reported in the licensee's analysis.

In summary, the NRC staff confirmed the licensee's conclusion that the maximum water surface elevation from tsunami-induced flooding is bounded by the CDB flood hazard. Therefore, the NRC staff determined that flooding from tsunamis does not need to be analyzed in a focused evaluation or revised integrated assessment for the St. Lucie site.

3.8 Ice-Induced Flooding

The licensee reported in its FHRR that the reevaluated hazard for site flooding from ice-induced flooding does not inundate the plant site (FPL, 2015a). Ice induced flooding is discussed in the St. Lucie CDB, but no flood elevations are provided. The licensee stated that subfreezing temperatures at the St. Lucie site are rare and durations are short. The licensee reviewed the USACE ice jams database and did not find any recorded incidences of ice jams near the St. Lucie site.

The NRC staff reviewed the Cold Regions Research and Engineering Laboratory (CRREL) ice jam database (USACE, 2017a) for records of historical ice jams near the St. Lucie site, and found that no Ice jams have been reported on the St. Lucie or Indian Rivers. The NRC staff verified that the ice jams flooding mechanism is not a likely cause of flooding at the St. Lucie site.

In summary, the NRC staff confirmed the licensee's conclusion that the reevaluated hazard for flooding due to ice jams is bounded by the CDB flood hazard at the St. Lucie site. Therefore, the NRC staff determined that flooding from ice jams does not need to be analyzed in a focused evaluation or a revised integrated assessment.

3.9 Channel Migrations or Diversions

The licensee reported in its FHRR that the reevaluated hazard for channel migrations or diversions does not pose a plausible risk to the St. Lucie site (FPL, 2015a). Flooding as a result of channel migration or diversion is discussed in the St. Lucie CDB, but no flood elevations are provided.

The licensee reported in its FHRR that the St. Lucie site is constructed on a stable carbonate platform formed from thick deposits of Cretaceous and Tertiary limestones, dolomites, evaporates, and small amounts of clastic sediments (FPL, 2015a). Additionally, the licensee stated that no major natural channels or rivers exist on the St. Lucie site.

NUREG/CR-7046 (NRC, 2011e) acknowledges that there are no well-established predictive models for estimating the potential for channel diversion in a riverine environment. However, the potential for channel migrations or diversions can be assessed by visually-inspecting available topographic maps for topographic/geomorphic evidence of past channel migrations or diversions (Fairbridge, 1968). In its independent evaluation of the St. Lucie FHRR, the NRC staff reviewed historic and current topographic maps of the Indian River basin for evidence of meandering or channel diversion. Examination of both sets of topographic maps of the area suggest that the course of the Indian River has remained relatively fixed for the last century.

Based on these comparisons, the NRC staff concludes that there is no evidence of river meandering and/or channel diversion for at least the last century.

In summary, the NRC staff confirmed the licensee's conclusion that the reevaluated hazard for flooding due from channel migration or diversions is bounded by the CDB flood hazard at the St. Lucie site. Therefore, the NRC staff determined that channel migration or diversion-related flooding does not need to be analyzed in a focused evaluation or a revised integrated assessment.

4.0 REEVALUATED FLOOD ELEVATION, EVENT DURATION AND ASSOCIATED EFFECTS FOR HAZARDS NOT BOUNDED BY THE CDB

4.1 Reevaluated Flood Elevation for Hazards Not Bounded by the CDB

Section 3 of this staff assessment documents the staff review of the licensee's flood hazard water elevations results. Table 4.1-1 contains the maximum flood elevation results, including waves and runup, for flood mechanisms not bounded by the CDB presented in Table 3.1-1. The NRC staff agrees with the licensee's conclusion that LIP is the only hazard mechanism not bounded by the CDB. The NRC staff anticipates the licensee will submit a focused evaluation for LIP and associated site drainage.

4.2 Flood Event Duration for Hazards Not Bounded by the CDB

The NRC staff reviewed information provided in FPL's 50.54(f) response (FPL, 2015a; FPL, 2015b; FPL, 2015c, FPL 2016 and NRC, 2015c) regarding the FED parameters needed to perform the additional assessments of plant response for flood hazards not bounded by the CDB. FED parameter values for the flood-causing mechanisms not bounded by the CDB are summarized in Table 4.2-1. By letter dated December 19, 2016, the licensee submitted the MSA (FPL, 2016). The NRC staff review and conclusions regarding the FED parameters provided in the MSA are documented in a separate staff assessment that was issued on May 2, 2017 (NRC, 2017). In its MSA, the licensee reported the periods of inundation and recessions of 2.6 hours and 1.3 hours, respectively. The licensee used the 2D numerical modeling described in the FHRR to determine these parameters. In the MSA staff assessment, the NRC staff confirmed that the licensee's reevaluation of the FED parameters for LIP and associated drainage uses present-day methodologies and regulatory guidance. Therefore, the NRC staff concludes that the licensee's FED parameters are acceptable for use in the additional assessment.

4.3 Associated Effects for Hazards Not Bounded by the CDB

The NRC staff reviewed information provided in FPL's 50.54(f) response (FPL, 2015a; FPL, 2015b; FPL, 2015c, FPL, 2016 and NRC, 2015c, respectively) regarding AE parameters needed to perform future additional assessments of plant response for flood hazards not bounded by the CDB. The AE parameters directly related to the maximum WSE, such as wave height and runup, are provided in Table 4.1-1. The AE parameters not directly associated with a maximum WSE are listed in Table 4.3-1.

For the LIP event, the licensee stated that the AE of the LIP event would not affect the safety of the plant due to relatively low flow velocities (FPL, 2015; FPL, 2016). Specifically, the licensee noted that the flow velocities within the powerblock are low, minimizing the ability for waterborne projectiles to adversely affect the plant facilities and flood protection features. The licensee also stated that scouring or erosion from an LIP event is insignificant due to low flow velocities. The NRC staff reviewed the licensee-provided LIP model input and output files and confirmed this statement. The NRC staff noted that the estimated inundation depths and flow velocities are very low and that the modeling is reasonable for use in the MSA. By letter dated December 19, 2016, the licensee submitted its MSA (FPL, 2016). The NRC staff review and conclusions regarding the FED parameters provided in the MSA are documented in a separate staff assessment that was issued on May 2, 2017 (NRC, 2017). In its MSA staff assessment, the NRC staff agreed with the licensee's conclusion that the AE parameters for LIP are minimal impact on the safety-related plant facilities.

4.4 Conclusion

Based upon the preceding analysis, NRC staff confirmed that the reevaluated flood hazard information defined in the Section 4 is appropriate input to the additional assessments of plant response as described in the 50.54(f) letter (NRC, 2012a), COMSECY-15-0019, (NRC, 2015a), and associated guidance.

5.0 CONCLUSION

The NRC staff reviewed the information provided for the reevaluated flood-causing mechanisms for St. Lucie, Units 1 and 2. Based on its review of available information provided in FPL's 50.54(f) response (FPL, 2015a; FPL, 2015b; FPL, 2015c and NRC, 2015c, respectively), the NRC staff concludes that the licensee conducted the hazard reevaluation using present-day methodologies and regulatory guidance used by the NRC staff in connection with ESP and COL reviews.

Based upon the preceding analysis, the NRC staff confirmed that the licensee responded appropriately to Enclosure 2, Required Response 2, of the 50.54(f) letter, dated March 12, 2012. In reaching this determination, the NRC staff confirmed the licensee's conclusions that: (a) the reevaluated flood hazard results for LIP is not bounded by the CDB flood hazard; (b) additional assessments of plant response will be performed for the LIP flood-causing mechanism; and (c) the reevaluated flood-causing mechanism information is appropriate input to the additional assessments of plant response as described in the 50.54(f) letter and COMSECY-15-0019 (NRC, 2015a), and associated guidance. The NRC staff has no additional information needs at this time with respect to the licensee's 50.54(f) response.

6.0 REFERENCES:

Note: ADAMS Accession No. refers to documents available through NRC's Agencywide Documents Access and Management System (ADAMS). Publicly-available ADAMS documents may be accessed through http://www.nrc.gov/reading-rm/adams.html.

U.S. Nuclear Regulatory Commission Documents and Publications:

NRC (U.S. Nuclear Regulatory Commission), 2007, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition", NUREG-0800, 2007. ADAMS stores the Standard Review Plan as multiple ADAMS documents, which are accessed through NRC's public web site at http://www.nrc.gov/reading-rm/basic-ref/srp-review-standards.html

NRC, 2011a, "Near-Term Report and Recommendations for Agency Actions Following the Events in Japan," Commission Paper SECY-11-0093, July 12, 2011, ADAMS Accession No. ML11186A950.

NRC, 2011b, "Recommendations for Enhancing Reactor Safety in the 21st Century: The Near-Term Task Force Review of Insights from the Fukushima Dai-Ichi Accident," Enclosure to Commission Paper SECY-11-0093, July 12, 2011, ADAMS Accession No. ML111861807.

NRC, 2011c, "Recommended Actions to be Taken Without Delay from the Near-Term Task Force Report," Commission Paper SECY-11-0124, September 9, 2011, ADAMS Accession No. ML11245A158.

NRC, 2011d, "Prioritization of Recommended Actions to be Taken in Response to Fukushima Lessons Learned," Commission Paper SECY-11-0137, October 3, 2011, ADAMS Accession No. ML11272A111.

NRC, 2011e, "Design-Basis Flood Estimation for Site Characterization at Nuclear Power Plants in the United State of America," NUREG/CR-7046, November 2011, ADAMS Accession No. ML11321A195.

NRC, 2012a, letter from Eric J. Leeds, Director, Office of Nuclear Reactor Regulation and Michael R. Johnson, Director, Office of New Reactors, to All Power Reactor Licensees and Holders of Construction Permits in Active or Deferred Status, "Request for Information Pursuant to Title 10 of the Code of Federal Regulations 50.54(f) Regarding the Recommendations 2.1, 2.3, and 9.3, of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident," March 12, 2012, ADAMS Accession No. ML12056A046.

NRC, 2012b, letter from Eric J. Leeds, Director, Office of Nuclear Reactor Regulation, to All Power Reactor Licensees and Holders of Construction Permits in Active or Deferred Status, "Issuance of Order to Modify Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events," Order EA-12-049, March 12, 2012, ADAMS Accession No. ML12054A736.

NRC, 2012c, letter from Eric J. Leeds, Director, Office of Nuclear Reactor Regulation, to All Power Reactor Licensees and Holders of Construction Permits in Active or Deferred Status, "Prioritization of Response Due Dates for Request for Information Pursuant to Title 10 of the Code of Federal Regulations 50.54(f) Regarding Flooding Hazard Reevaluations for

Recommendation 2.1 of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident," May 11, 2012, ADAMS Accession No. ML12097A510.

NRC, 2012d, "Guidance for Performing the Integrated Assessment for External Flooding," Japan Lessons-Learned Project Directorate, Interim Staff Guidance JLD-ISG-2012-05, Revision 0, November 30, 2012, ADAMS Accession No. ML12311A214.

NRC, 2013a, "Guidance for Performing a Tsunami, Surge, or Seiche Hazard Assessment," Japan Lessons-Learned Project Directorate, Interim Staff Guidance JLD-ISG-2012-06, Revision 0, January 4, 2013, ADAMS Accession No. ML12314A412.

NRC, 2013b, "Guidance For Assessment of Flooding Hazards Due to Dam Failure," Japan Lessons-Learned Project Directorate, Interim Staff Guidance JLD-ISG-2013-01, Revision 0, July 29, 2013, ADAMS Accession No. ML13151A153.

NRC, 2014, "St. Lucie Nulcear Plant, Units 1 and 2 - Staff Assessment of the Flooding Walkdown Report Supporting Implementation of Near-Term Task Force Recommendation 2.3 Related to the Fukushima Dai-Ichi Nuclear Power Plant Accident." June 27, 2014, ADAMS Accession No. ML14135A422.

NRC, 2015a, "Closure Plan for Flooding Hazard for Operating Nuclear Power Plants," Commission Paper COMSECY-15-0019, June 30, 2015, ADAMS Accession No. ML15153A104.

NRC, 2015b, "St. Lucie Nuclear Power Plant, Units 1 and 2 - Interim Staff Response to Reevaluated Flood Hazards Submitted in Response to 10 CFR 50.54(f) Information Request - Flood-Causing Mechanism Reevaluation," September 3, 2015, ADAMS Accession No. ML15224B449.

NRC, 2015c, "Nuclear Regulatory Commission Report for the Audit of Florida Power and Light Company's Flood Hazard Reevaluation Report Submittals Relating to the Near-Term Task Force Recommendation 2.1-Flooding for St. Lucie Plant, Units 1 and 2," October 1, 2015, ADAMS Accession No. ML15273A209.

NRC, 2016a, "Compliance with Order EA-12-049 Order to Modify Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events," Interim Staff Guidance JLD-ISG-2012-01, Revision 1, January 22, 2016, ADAMS Accession No. ML15357A163.

NRC, 2016b, "Guidance for Activities Related to Near-Term Task Force Recommendation 2.1, Flooding Hazard Reevaluation; Focused Evaluation and Integrated Assessment," Interim Staff Guidance JLD-ISG-2016-01, Revision 0, July 11, 2016, ADAMS Accession No. ML16162A301.

NRC, 2017, "St. Lucie Plant, Units 1 and 2 – Flood Hazard Mitigation Strategies Assessment," May 2, 2017, ADAMS Accession No. ML17094A811.

<u>Codes and Standards</u>

ANSI/ANS (American National Standards Institute/American Nuclear Society), 1992, ANSI/ANS-2.8-1992, "Determining Design Basis Flooding at Power Reactor Sites," American Nuclear Society, LaGrange Park, IL, July 1992.

Other References:

Deltares, 2011, Deltares, Delft3D Hydro-Morphodynamics and Water Quality Computer Program, Version 4.00.01, 2600 MH Delft, The Netherlands, 2011.

Emanuel, K., 1988: The maximum intensity of hurricanes. J. Atmos. Sci., 45, 1143-1155.

Fairbridge, R.W. (ed.), 1968, "The Encyclopedia of Geomorphology," Encyclopedia of Earth Science Series, Vol. III, Van Nostrand Reinhold, New York.

FLO-2D Software, Inc. (FLO-2D), "FLO-2D Reference Manual," Updated September 1, 2012.

FLO-2D, FLO-2D Pro Model Software, vPRO Build 13.11.06.

FPL (Florida Power and Light), 2012, "'Flooding Walkdown Report,' in Response to NRC 10 CFR 50.54(f) Request for Information Regarding Near-Term Task Force Recommendation 2.3, Flooding," November 26, 2012, FPL060-PR-001, ADAMS Accession No. ML12335A202.

FPL, 2015a, "St. Lucie, Units 1 and 2 – Submittal of Revision 0 to FPL-072-PR-002, Flooding Hazards Reevaluation Report," March 10, 2015, ADAMS Accession No. ML15083A264.

FPL, 2015b, "St. Lucie, Units 1 and 2 - Electronic Input/Output Files Supporting the Flooding Hazards Reevaluation Report," June 3, 2015, ADAMS Accession No. ML15166A089.

FPL, 2015c, "St. Lucie Plant - Request for Information Response and Electronic Input/Output Files Supporting the Flooding Hazards Reevaluation Report," August 20, 2015, ADAMS Accession No. ML15265A487.

FPL, 2016, "St. Lucie Unit 1 and Unit 2 – NEI 12-06, Revision 2, Appendix G, G.4.2: Modifying FLEX Strategies, (MSA) report for the New Flood Hazard Information," December 19, 2016, ADAMS Accession No. ML16365A005.

Graham, H.E. and D.E. Nunn, 1959, "Meteorological considerations pertinent to the Standard Project Hurricane, Atlantic and Gulf coasts of the United States," National Hurricane Research Project Report No. 33, Weather Bureau, U.S. Dept of Commerce, Washington, D.C. 76 p.

Holland, G. J., 1997, "The maximum potential intensity of tropical cyclones," Journal of Atmospheric Sciences, 54, 2519-2541.

Ichinose, G.A., J.G. Anderson, K. Satake, R.A. Schweickert, and M.M. Lahren, 2000. "The potential hazard from tsunami and seiche waves generated by large earthquakes within Lake Tahoe, California-Nevada," Geophysical Research Letters, Vol. 27, Issue 8, pp. 1203-1216, 2000.

Lynett, P., and P.L.F. Liu, 2002, "A Numerical Study of Submarine-Landslide-Generated Waves and Runup," Proceedings of the Royal Society of London, A, Vol. 458: pp 2885–2910, December 2002.

Lynett, Patrick J. and R. Weiss, 2015, Technical Letter Report St. Lucie Nuclear Power Plant: Technical Evaluation Report St. Lucie Nuclear Power Plant Hazard Reevaluation Review.

Prepared for the U.S. Nuclear Regulatory Commission by Taylor Engineering, Inc. August, 2015.

NEI (Nuclear Energy Institute), 2015, "Warning Time for Local Intense Precipitation Events," Revision 6, April 8, 2015, ADAMS Accession No. ML15104A158.

NOAA (National Oceanic and Atmospheric Administration), 1978, "Probable Maximum Precipitation Estimates, United States, East of the 105th Meridian," NOAA Hydrometeorological Report No. 51, June 1978.

NOAA, 1982, "Application of Probable Maximum Precipitation Estimates, United States, East of the 105th Meridian," NOAA Hydrometeorological Report No. 52, August 1982.

NOAA, 2014, National Geophysical Data Center/World Data Service (NGDC/WDS): Global Historical Tsunami Database, National Geophysical Data Center, Available at: http://ngdc.noaa.gov/hazard/tsu_db.shtml, Accessed May 2014.

NWS (National Weather Service), 1979, Technical Report 23 (NWS 23), "Meteorological Criteria for Standard Project Hurricane and Probable Maximum Hurricane Wind fields, Gulf and East Coast of the United States," U.S. Department of Commerce, National Oceanic Atmospheric Administration (NOAA), September 1979.

Resio, D.T, T.V. Wamsley, M.A. Cialone, and T.C. Massey, 2012, "The Estimation of Very-Low Probability Hurricane Storm Surges for Design and Licensing of Nuclear Power Plants in Coastal Areas," NUREG/CR-7134, U.S. Nuclear Regulatory Commission, Washington DC (DRAFT). ADAMS Accession No. ML12310A025.

ten Brink , U., D. Twichell, E. Geist, J. Chaytor, J. Locat, H. Lee, B. Buczkowski, R. Barkan, A. Solow, B. Andrews, T. Parsons, P. Lynett, J. Lin and M. Sansoucy, 2008, "Evaluation of Tsunami Sources with the Potential to Impact the U.S. Atlantic and Gulf Coasts," USGS Administrative report to the U.S. Nuclear Regulatory Commission, 300 pp., August 22, 2008. ADAMS Accession No. ML082960196

Tonkin, H., Holland, G.J. Holbrook, N., and A. Henderson-Sellers. 2000, "An Evaluation of Thermodynamic Estimates of climatological maximum potential tropical cyclone intensity, Mon. Wea. Rev., 128, 746-762.

USACE (U.S. Army Corps of Engineers), 1984, "Shore Protection Manual, Volumes 1 and 2."

USACE, 2011, "Coastal Engineering Manual - Parts I-VI," Engineer Manual 1110-2-1100, Change 3, September 2011.
USACE, 2017, "National Inventory of Dams," accessed from http://nid.usace.army.mil, accessed February 2017.

USACE, 2017, "Ice Jam Database," Cold Region Research and Engineering Laboratory (CRREL), available at: http://www.crrel.usace.army.mil/technical_areas/hh/, accessed March 2017.

USGS (U.S. Geological Survey), 2016, National Map Viewer, http://viewer.nationalmap.gov/viewer, accessed July 18, 2016.

Walton, T.L., 2007, "Projected sea level rise in Florida," Ocean Engineering, Volume 34, pp. 1832 - 1840.

Table 2.2-1. Flood-Causing Mechanisms and Corresponding Guidance

FLOOD-CAUSING MECHANISM	SRP SECTION(S) AND JLD-ISG
Local Intense Precipitation and Associated Drainage	SRP 2.4.2 SRP 2.4.3
Streams and Rivers	SRP 2.4.2 SRP 2.4.3
Failure of Dams and Onsite Water Control/Storage Structures	SRP 2.4.4 JLD-ISG-2013-01
Storm Surge	SRP 2.4.5 JLD-ISG-2012-06
Seiche	SRP 2.4.5 JLD-ISG-2012-06
Tsunami	SRP 2.4.6 JLD-ISG-2012-06
Ice-Induced	SRP 2.4.7
Channel Migrations or Diversions	SRP 2.4.9

SRP refers to the Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition (NRC, 2007).
JLD-ISG-2012-06 refers to the "Guidance for Performing a Tsunami, Surge, or Seiche Hazard Assessment" (NRC, 2013a).
JLD-ISG-2013-01 refers to the "Guidance for Assessment of Flooding Hazards Due to Dam Failure" (NRC, 2013b).

Table 3.0-1. Summary of Controlling Flood-Causing Mechanisms at the St. Lucie Site

Reevaluated Flood-Causing Mechanisms and Associated Effects That May Exceed The Powerblock Elevation (15.2 ft. NAVD88)[1]	ELEVATION (NAVD88)
Local Intense Precipitation and Associated Drainage	19.3 ft.[2]

[1] Flood Height and Associated Effects as defined in JLD-ISG-2012-05

[2] The LIP mechanism has multiple elevations, the most significant of which is this maximum water-surface elevation at critical door sills (refer to Table 3.2-1 for detailed elevations).

Table 3.1-1. Current Design Basis Flood Hazard Elevations at the St. Lucie site (FPL, 2015a)

MECHANISM	STILLWATER ELEVATION	WAVES/ RUNUP	DESIGN BASIS HAZARD ELEVATION	REFERENCE
Local Intense Precipitation	Not included in design-basis (DB)	Not included in DB	Not included in DB	FHRR Section 3.1
Streams and Rivers	No Impact on the Site Identified	No Impact on the Site Identified	No Impact on the Site Identified	FHRR Section 3.2
Failure of Dams and Onsite Water Control/Storage Structures	Not included in DB	Not included in DB	Not included in DB	FHRR Section 3.3
Storm Surge				
Plant Island Southeast Corner	13.9 ft. NAVD88	1.0 ft.	14.8 ft. NAVD88	FHRR Section 3.4 and FHRR Section 3.9
Up south Discharge Canal;	13.9 ft. NAVD88	1.3 ft.	15.2 ft. NAVD88	FHRR Section 3.4 and FHRR Section 3.9
Northern Unit 1	13.9 ft. NAVD88	1.6 ft.	15.5 ft. NAVD88	FHRR Section 3.4 and FHRR Section 3.9
Nose of Discharge Canal	13.9 ft. NAVD88	10.8 ft.	24.7 ft. NAVD88	FHRR Section 3.4 and FHRR Section 3.9
Seiche	No Impact on the Site Identified	No Impact on the Site Identified	No Impact on the Site Identified	FHRR Section 3.5
Tsunami	Not included in DB	Not included in DB	Not included in DB	FHRR Section 3.6
Ice-Induced Flooding	No Impact on the Site Identified	No Impact on the Site Identified	No Impact on the Site Identified	FHRR Section 3.7
Channel Migrations or Diversions	No Impact on the Site Identified	No Impact on the Site Identified	No Impact on the Site Identified	FHRR Section 3.8

Note 1: Reported values are rounded to the nearest one-tenth of a foot.

Table 3.2-1: Maximum Water Depths and Water Surface Elevations for Points of Interests at the St. Lucie Site

Points of Interest (POI)	Scenario(s) Producing Maximum Water Depth	Door Sill Elevation (ft., NAVD88)	Maximum Water Surface Elevation (ft., NAVD88)	Maximum Water Depth (ft.)
1	D	16.2	17.3	1.2
2	A&D	16.2	17.5	1.3
3	A	16.2	17.5	1.3
4	D	16.2	17.6	1.5
5	F	16.2	18.6	2.4
6	A&E	16.2	18.0	1.9
7	F	16.2	18.2	2.1
8	A	16.2	19.3	3.2
9	A	16.2	17.5	1.4
10	A	16.2	17.5	1.4
11	A	16.2	19.3	3.2
12	B&C	16.2	17.9	1.8
13	F	16.2	18.0	1.9
14	A	16.2	18.0	1.9
15	A,B,C,D,E,&F	19.3	19.9	0.6
16	A	16.7	17.4	0.8
17	F	16.2	16.7	0.6
18	C	16.2	17.4	1.2
19	D	16.2	16.8	0.6
20	A,B,C,E,&F	16.2	17.2	1.0
21	E	16.2	17.8	1.7
22	A	16.2	18.0	1.9
23	F	16.2	18.2	2.1
24	A,B,C,D,E,&F	16.2	16.7	0.5
25	E&F	16.2	18.0	1.9
26	A,B,D,&E	16.2	18.2	2.0

27	A&F	16.2	17.6	1.5
28	A,B,C,E,&F	16.2	17.2	1.0
29	A	16.2	16.8	0.7
30	A&D	16.2	16.5	0.3
31	D	16.2	16.8	0.6
32	D&F	16.2	16.8	0.6
33	A,B,C,D,E,&F	19.3	19.4	0.1
34	A,E,&F	19.3	20.5	1.3
35	A&D	19.3	19.5	0.2
36	A,B,C,D,E,&F	19.3	19.4	0.1

Source: Modified from FPL, 2015a

Note: Reported values are rounded to the nearest one-tenth of a foot.

Table 4.1-1: Reevaluated Hazard Elevations for Flood-Causing Mechanisms Not Bounded by the CDB

MECHANISM	STILLWATER ELEVATION	WAVES/RUNUP	REEVALUATED HAZARD ELEVATION
Local Intense Precipitation			
Point of Interest 1	17.3 ft. NAVD88	Minimal	17.3 ft. NAVD88
Point of Interest 2	17.5 ft. NAVD88	Minimal	17.5 ft. NAVD88
Point of Interest 3	17.5 ft. NAVD88	Minimal	17.5 ft. NAVD88
Point of Interest 4	17.6 ft. NAVD88	Minimal	17.6 ft. NAVD88
Point of Interest 5	18.6 ft. NAVD88	Minimal	18.6 ft. NAVD88
Point of Interest 6	18.0 ft. NAVD88	Minimal	18.0 ft. NAVD88
Point of Interest 7	18.2 ft. NAVD88	Minimal	18.2 ft. NAVD88
Point of Interest 8	19.3 ft. NAVD88	Minimal	19.3 ft. NAVD88
Point of Interest 9	17.5 ft. NAVD88	Minimal	17.5 ft. NAVD88
Point of Interest 10	17.5 ft. NAVD88	Minimal	17.5 ft. NAVD88
Point of Interest 11	19.3 ft. NAVD88	Minimal	19.3 ft. NAVD88
Point of Interest 12	17.9 ft. NAVD88	Minimal	17.9 ft. NAVD88
Point of Interest 13	18.0 ft. NAVD88	Minimal	18.0 ft. NAVD88
Point of Interest 14	18.0 ft. NAVD88	Minimal	18.0 ft. NAVD88
Point of Interest 15	19.9 ft. NAVD88	Minimal	19.9 ft. NAVD88
Point of Interest 16	17.4 ft. NAVD88	Minimal	17.4 ft. NAVD88
Point of Interest 17	16.7 ft. NAVD88	Minimal	16.7 ft. NAVD88
Point of Interest 18	17.4 ft. NAVD88	Minimal	17.4 ft. NAVD88
Point of Interest 19	16.8 ft. NAVD88	Minimal	16.8 ft. NAVD88
Point of Interest 20	17.2 ft. NAVD88	Minimal	17.2 ft. NAVD88
Point of Interest 21	17.8 ft. NAVD88	Minimal	17.8 ft. NAVD88
Point of Interest 22	18.0 ft. NAVD88	Minimal	18.0 ft. NAVD88
Point of Interest 23	18.2 ft. NAVD88	Minimal	18.2 ft. NAVD88
Point of Interest 24	16.7 ft. NAVD88	Minimal	16.7 ft. NAVD88
Point of Interest 25	18.0 ft. NAVD88	Minimal	18.0 ft. NAVD88
Point of Interest 26	18.2 ft. NAVD88	Minimal	18.2 ft. NAVD88
Point of Interest 27	17.6 ft. NAVD88	Minimal	17.6 ft. NAVD88
Point of Interest 28	17.2 ft. NAVD88	Minimal	17.2 ft. NAVD88
Point of Interest 29	16.8 ft. NAVD88	Minimal	16.8 ft. NAVD88
Point of Interest 30	16.5 ft. NAVD88	Minimal	16.5 ft. NAVD88
Point of Interest 31	16.8 ft. NAVD88	Minimal	16.8 ft. NAVD88
Point of Interest 32	16.8 ft. NAVD88	Minimal	16.8 ft. NAVD88
Point of Interest 33	19.4 ft. NAVD88	Minimal	19.4 ft. NAVD88
Point of Interest 34	20.5 ft. NAVD88	Minimal	20.5 ft. NAVD88
Point of Interest 35	19.5 ft. NAVD88	Minimal	19.5 ft. NAVD88
Point of Interest 36	19.4 ft. NAVD88	Minimal	19.4 ft. NAVD88

Source: FHRR (FPL, 2015a) Table 4.2 and Figure 4.6

Note 1: The NRC staff evaluated the flood event duration parameters (including warning time and period of inundation) and flood associated effects during its review of the MSA (NRC, 2017).

Note 2: Reevaluated hazard mechanisms bounded by the current design basis (see Table 1) are not included in this table.

Note 3: Reported values are rounded to the nearest one-tenth of a foot.

Table 4.2-1. Flood Event Duration Parameters for Flood-Causing Mechanisms Not Bounded by the St. Lucie's CDB

MECHANISM	TIME AVAILABLE FOR PREPARATION FOR FLOOD EVENT	DURATION OF INUNDATION OF SITE	TIME FOR WATER TO RECEDE FROM SITE	REFERENCE
Local Intense Precipitation and Associated Drainage	NEI 15-05 (NEI, 2015)	2.6 hours	1.3 hours	MSA Letter (FPL, 2016)

Table 4.3-1. Associated Effects Parameters not Directly Associated with Total Water Height for Flood-Causing Mechanisms not Bounded by the St. Lucie's CDB

ASSOCIATED EFFECTS FACTOR	FLOOD-CAUSING MECHANISM
	Local Intense Precipitation and Associated Drainage
Hydrodynamic Loading at Plant Grade	Minimal
Debris Loading at Plant Grade	Minimal
Sediment Loading at Plant Grade	Minimal
Sediment Deposition and erosion	Minimal
Concurrent Conditions, Including Adverse Weather	Minimal
Other Pertinent Factors (e.g., Waterborne Projectiles)	Minimal

Source: FPL (2016)

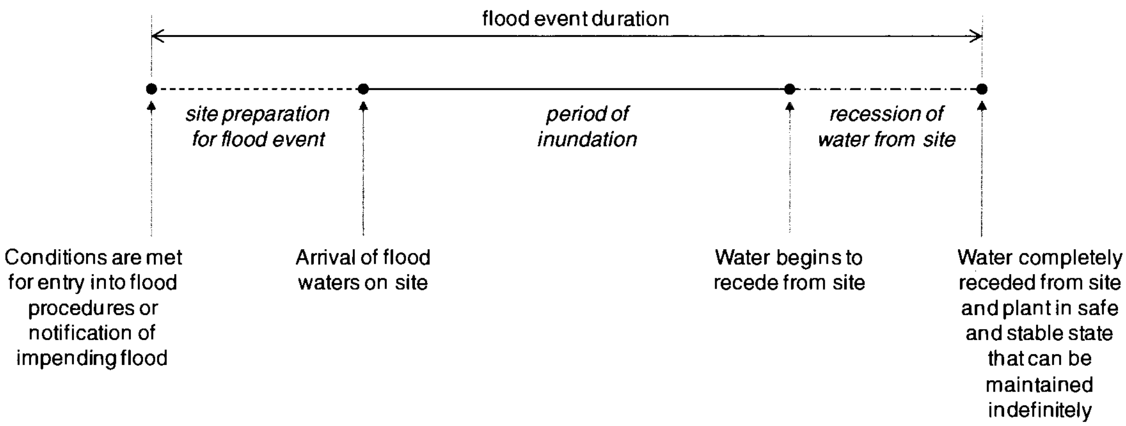
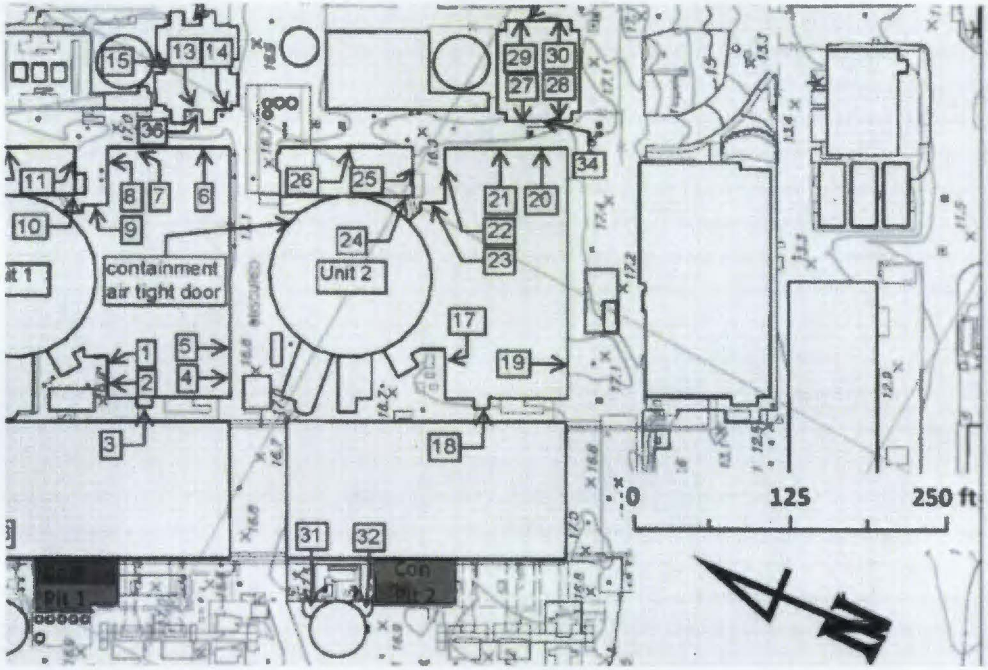


Figure 2.2-1 Flood Event Duration

Source: JLD-ISG-2012-05 (NRC, 2012e), Figure 6

Figure 3.1-1: St. Lucie Nuclear Power Plant, Units 1 and 2 Site Layout (FPL, 2015a)



2	143	RA-18	19.5	RAB
3	140 & 143	RA-11	19.5	RAB
4	N/A	RA-35	19.5	RAB
5	N/A	RA-32	19.5	RAB
6	148	RA-37	19.5	RAB
7	147	RA-38	19.5	RAB
8	146	RA-39	19.5	RAB
9	145	M002	19.5	RAB
10	172	FH-003	19.5	FHB
11	169	FH-002	19.5	FHB
12	163	FH-001	19.5	FHB
13	175	DG-004	19.5**	DGB
14	175	DG-005	19.5**	DGB
15	177	DG-003	22.6	DGB
16	121	N/A	20	CST
				Unit 2
17	243	RA-037	19.5	RAB
18	240 & 241	RA-030	19.5	RAB
19	240	RA-041	19.5	RAB
20	248	RA-073	19.5	RAB
21	247	RA-084	19.5	RAB
22	246	RA-083	19.5	RAB
23	245	RA-082	19.5	RAB
24	272	FH-003	19.5	FHB
25	269	FH-002	19.5	FHB
26	263	FH-001 & FH-001A	19.5	FHB

Figure 3.2-1: LIP Points of Interest at the St. Lucie Site (Source FPL, 2015a)

ST. LUCIE PLANT, UNITS 1 AND 2– STAFF ASSESSMENT OF RESPONSE TO 10 CFR 50.54(f) INFORMATION REQUEST – FLOOD-CAUSING MECHANISM REEVALUATION DATED OCTOBER 17, 2017

DISTRIBUTION:

PUBLIC	PBMB R/F	RidsNRRDLP Resource
RidsNroDsea Resource	LKGibson, NRR	
MShams, NRR	CCook, NRO	RidsNrrPMStLucie
RidsNrrDorllpl2Resource	RidsNrrDorl Resource	Resource RidsRgn2MailCenter
RidsOpaMail Resource	RidsNrrLASLent	RidsNrrJLD Resource
RidsOgcMailCenter Resource	JThompson, NRO	
ACampbell,NRO	BHarvey, NRO	
RidsAcrsMailCtr Resource	MWillingham, NRO	

ADAMS Accession No.: ML17286A084 ***by input dated**

OFFICE	NRR/DLP/PBMB/PM	NRR/DLP/PBMB/LA	NRO/DSEA/RHM2/BC
NAME	FVega	SLent	CCook*
DATE	10/13/2017	10/13/2017	09/15/2017
OFFICE	NRR/DLP/PBMB/BC	NRR/DLP/PBMB/PM	
NAME	MShams	FVega	
DATE	10/14/2017	10/17/2017	

OFFICIAL RECORD COPY