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November 18, 2008

Ms. Elinor Cunningham, Technical Assistance Project Manager
Division of New Reactor Licensing
Office of New Reactors
US Nuclear Regulatory Commission
Washington, DC 20555-0001

Dear Ms. Cunningham:

Subject: Draft Hydrology Safety Audit Trip Report Deliverable for JCN Q-4007, Task 35, Subtask 1b, "PNNL's Review of Levy County Combined Operating License Application in the Areas Relating to the Hydrologic Safety Analysis in SAR Sections 2.4.1 – 2.4.5 and 2.4.7 – 2.4.17" (TAC No. RX0338)

Attached is the Subtask 1b deliverable Draft Levy Hydrology Safety Audit Trip Report for "PNNL's Review of Levy County Combined Operating License Application in the Areas Relating to the Hydrologic Safety Analysis in SAR Sections 2.4.1 – 2.4.5 and 2.4.7 – 2.4.17", JCN Q-4007, Task 35, under BOA 53751 "New Reactors Design Certifications, Early Site Permit, Combined License, Environmental and Pre-Applications Activities Related to New Reactor License Applications". If there are no comments from NRC within two weeks PNNL will consider this a Final Trip Report.

If you have any questions, please call Rajiv Prasad at 509-375-2096 or Eva Eckert Hickey at 509-375-2065.

Sincerely,

Rajiv Prasad
Scientist
Hydrology Group
ENERGY & ENVIRONMENT DIRECTORATE

RP:ll

cc: E. Hickey
H. Jones

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Purpose of the trip:	The purpose of this trip and meetings was to conduct the hydrology safety site audit.			
Location:	Crystal River Training Facility 8200 West Venable Street Crystal River, FL 34429			
Dates:	Trip dates inclusive of travel: November 03-07, 2008			
Meeting Days:	Tuesday November 04 – Thursday November 06, 2008			
Attendees:	**NRC**:	Brian Anderson Henry Jones Nebiyu Tiruneh Mark McBride		
	PNNL:	Rajiv Prasad Vince Vermeul		
	USGS:	Eric Geist Jason Chaytor Patrick Lynett		
	CH2M Hill:	Amanda Berens Mitch Griffin Craig Sprinkle	Bryan Burkingstock George Howroyd Aditya Tyagi	Bill Elliott Jeff Lehnen Lorin Young
	Progress Energy:	Arun Kapur Paul Snead	Jim Nevill David Waters	
	Worley Parsons:	Kenneth Weise		
	Sargent and Lundy:	Gopal Komanduri		

Meeting summary:

Monday November 03, 2008: The PNNL staff traveled to Crystal River, FL and briefly met with the NRC and the USGS staff to discuss the logistics for the rest of the week.

Tuesday November 04, 2008: The PNNL staff arrived at the Crystal River Training Facility to participate in the hydrology safety audit. Progress Energy provided a guided site tour of the LNP site and the vicinity. This tour included visits to the on-site meteorological tower, the proposed locations of the two reactors, the Inglis Lock and the north embankment of the Cross Florida Barge Canal, and the Inglis Bypass Channel and Spillway. During the afternoon, the PNNL staff assisted the NRC staff in the discussion regarding surface water-related information needs. Notes regarding the discussion summary was electronically transcribed into the information needs table.

Wednesday November 05, 2008: The PNNL staff arrived at the Crystal River Training Facility. During the morning session, the PNNL staff assisted the NRC staff in the discussion regarding surface water-related information needs. Groundwater-related information needs were discussed briefly during the morning session and continued during the afternoon.

Thursday November 06, 2008: The PNNL and the NRC staff discussed the information needs and the summary of the discussion related to each with Progress Energy and its contractors to ensure that the discussions during the safety audit was properly captured. The PNNL and the NRC staff left the Crystal River Training Facility late in the morning. During the afternoon and the evening, the PNNL staff assisted the NRC staff in reviewing the information needs and the corresponding discussions to formulate draft potential RAIs. The NRC and the PNNL staff also worked on the pTER in order to incorporate the draft potential RAIs into the document.

Friday November 07, 2008: The PNNL and the NRC staff visited two locations on the Gulf coast to get a better understanding of the layouts of the existing Crystal River Energy Complex and the Cross Florida Barge Canal and their interactions with the Gulf. The PNNL staff traveled back to Richland, WA in the evening.

The information needs table with a brief summary of the discussions is enclosed. The information needs table also contains the draft potential RAIs that may be needed in the pTER to address staff needs and/or questions.

Serial No.	FSAR Section	Information Needs	Reviewer
1.	General	**Provide a subject matter expert (SME) to discuss the availability of the input/output files associated with the HEC-HMS and HEC-RAS model simulations.** **Applicant Response:** The input/output files associated with the HEC-HMS and HEC-RAS model simulations are available and will be provided to the NRC Team. Supporting Information: Calculation LNG-0000-X7C-009, Rev0 – "Probable Maximum Flood (PMF) for the LNP Site" **NRC Comments:** Calc packages in reading room; I/O files on Disc to NRC Document Control Desk RAI pending receipt of I/O Disc	H. Jones R. Prasad RAI 2.4.1-01
2.	General	**Please provide an SME to discuss the vertical units and contour interval used on topographic maps (e.g. 2.4.1-203, -204, and -205).** **Applicant Response:** LNP FSAR Figure 2.4.1-203 was developed from a United Stated Geologic Survey (USGS) topographic map with a vertical datum of NGVD 1929 and a contour interval of 5 feet. LNP FSAR Figures 2.4.1-204 and 2.4.1-205 were developed from the site grading and drainage plans which were created with a vertical datum of NAVD 1988 and a contour interval of 1 foot. These figures were developed from different sources because LNP FSAR Figure 2.4.1-203 shows topographic contours beyond the site and therefore beyond the area encompassed by the site grading and drainage plan. A 2-foot contour interval was used on LNP FSAR Figures 2.4.1-204 and 2.4.1-205 for clarity and readability. PEF received confirmation from SWFWMD that MSL refers to a datum of NGVD29. DCD 100 ft elev = plant floor 51 ft **NRC Comments:** NGVD29 is approximately 1 ft higher than NAVD88 on an average over the LNP site	M. McBride RAI 2.4.1-02

		An FSAR update is needed to clarify the use of the term MSL. Check maps to ensure datum, contour intervals and units are identified in contour maps. RAI	
3.	2.4.2	**Provide an SME to discuss section 2.4.2.2 where the flood design consideration is described.** **Applicant Response:** An SME will be available to discuss LNP FSAR Section 2.4.2.2. Flood design considerations for LNP safety-related structures are based on floods and flood waves caused by probable maximum events, such as the probable maximum flood (PMF), the probable maximum hurricane (PMH), and the probable maximum tsunami as detailed in LNP FSAR Subsections 2.4.3, 2.4.5, and 2.4.6, respectively, and high groundwater levels as detailed in LNP FSAR Subsection 2.4.12. In addition, Subsection 3.4.1 of the DCD discusses the protection of seismic Category I structures and safety-related systems against local floods. **NRC Comments:** Dynamic forces are considered – how? (Last sentence of first para of FSAR Section 2.4.2.2.) Clarification will be included in the FSAR. RAI	N. Tiruneh R. Prasad RAI 2.4.2-01
4.	2.4.2	**Provide and SME to discuss the plant grade elevation and datum mentioned in section 2.4.2.3.** **Applicant Response:** Plant grade elevation for LNP1, LNP2 and other safety related structures is 15.2 m (50 ft.) NAVD88 datum. The proposed floor elevations for LNP1, LNP2 and other safety related structures are 15.5 m (51 ft.), 1 ft. higher than plant grade elevation. **NRC Comments:** Is the plant grade subject to change? (use of the word "proposed.") PEF: if there is any change to grade design, FSAR will need to be updated. RAI – revision of the FSAR to remove the word "proposed"	N. Tiruneh R. Prasad RAI 2.4.2-02

5.	2.4.2	**Provide an SME to discuss the determination of time of concentration in section 2.4.2.3.** **Applicant Response:** Time of concentration for each drainage zone (A through G) is computed using Kirpich's formula. Per Kirpich's formula (Ref. 1), the time of concentration Tc = 0.0078 L0.77/ S0.385 where Tc = time of concentration in minutes L = Length of basin area measured along the water course in feet. S= Longitudinal slope along the direction of flow. Computed time of concentration is conservatively adjusted to next lower value in minutes. For this time of concentration, corresponding PMP intensity is calculated and peak runoff is computed using Rational method. Considering overflow over the peripheral road or railroad as a weir, the head of water over the weir is computed for each zone. See Attachment 1 for detailed computation and Grading and Drainage plan. Supporting Information: Handbook of Applied Hydrology, Ven Te Chow, McGRAW - HILL Book Company. **NRC Comments:** PEF will include description of methodology for estimating Tc and reference in the FSAR. Details of weirs would be included in the FSAR. Pending review of the calcs, may need details of backwater. RAI	N. Tiruneh R. Prasad RAI 2.4.2-03
6.	2.4.3	**Provide an SME to discuss the design basis flood determination.** **Applicant Response:** The design basis for flood determination has been described in LNP FSAR Subsection 2.4.3. The PMF determination is a stepwise procedure that involves the following steps: 1) Delineate Withlacoochee River Drainage Basin above the Inglis Dam of Lake Rousseau. 2) The PMP storm hyetograph for the Withlacoochee River Drainage Basin was developed using the criteria and step-by-step instructions given in HMR 51 and HMR 52. The PMP was developed by applying appropriate correction for distribution and antecedent rainfall	N. Tiruneh R. Prasad RAI 2.4.3-01

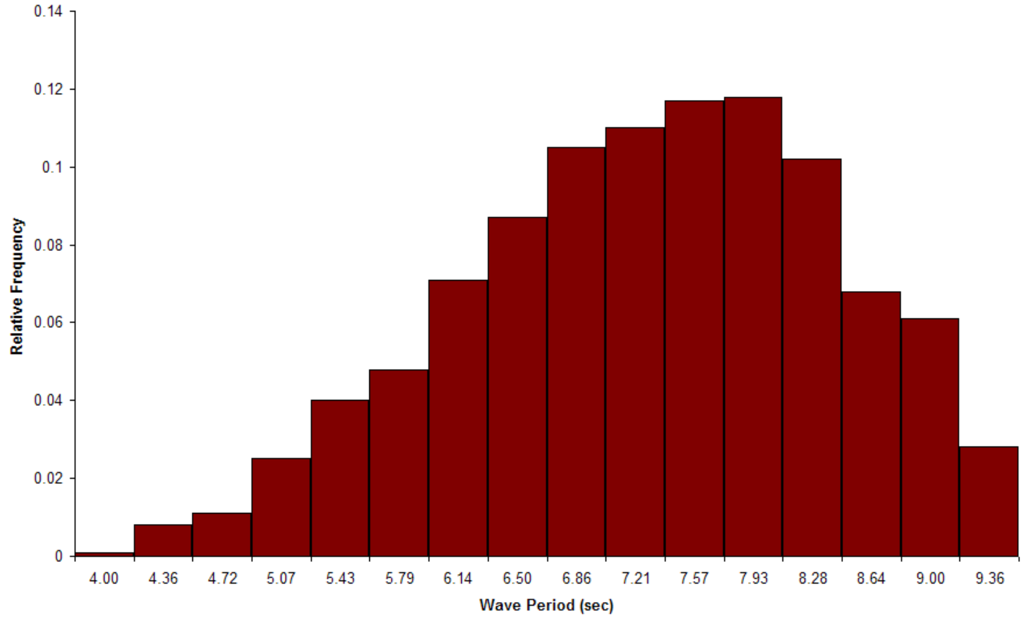
		according to the guidelines given in American National Standards Institute/American Nuclear Society (ANSI/ANS) -2.8-1992. 3) Unit-hydrograph theory was used as the runoff model for developing runoff hydrographs for various subbasins using sub-basin hydrological parameters required for developing a unit hydrograph. 4) The developed PMP storm hyetograph was applied to the unit hydrographs with the appropriate loss parameters using the Hydrologic Engineering Center-Hydrologic Modeling System (HEC-HMS) model to develop the estimated flood hydrographs for each subbasin, as well as for the entire drainage basin. 5) Inflow hydrographs from various subbasins were routed using the HEC-HMS model using appropriate routing parameters for various reaches to determine the combined inflow to Lake Rousseau. 6) After obtaining the combined inflow hydrograph, the PMF hydrograph was routed through the reservoir, spillway, and outlet works to estimate the maximum PMF stillwater level in Lake Rousseau. Supporting Information: Calculation LNG-0000-X7C-009, Rev0 – "Probable Maximum Flood Flood (PMF) for the LNP Site" **NRC Comments:** Clarify and explicitly state the design basis flood in the FSAR. PEF did not talk with USACE regarding loss rates. The methodology used is described in FSAR. Justify the use of a UH for Lake Rousseau. Staff to review the PMF calc package. RAI with FSAR update	
7.	2.4.3	**Provide an SME to discuss the unit hydrograph development and verification.** **Applicant Response:** Snyder's synthetic hydrograph method based on actual geometrical parameters and literature based lag coefficient (Ct) and peaking coefficient (Cp) values was used to develop unit hydrographs for various sub-basins. Typical values of Ct and Cp reported by Viessman (LNP FSAR Reference 2.4.3-211) for eastern Gulf of Mexico localities are 8.0 and 0.6, respectively. In this study, however, Cp was used to be 0.8 (Table 05 of LNG-0000-X7C-009, Rev0). LNP FSAR Figure 2.4.3-213 presents unit	N. Tiruneh R. Prasad RAI 2.4.3-02

		hydrographs for various sub-basins. Verification: Table 06 (LNG-0000-X7C-009,R0) compares the calculated and 95% upper bound (Figure 09 of LNG-0000-X7C-009,Rev0 or LNP FSAR Figure 2.4.3-216) of Flood Frequency based flood magnitudes for various events. Supporting Information: Calculation LNG-0000-X7C-009, Rev0 – "Probable Maximum Flood Flood (PMF) for the LNP Site" **NRC Comments:** **Justification to why Snyder's UH is applicable under PMF conditions for Levy Site.** **RAI**	
8.	2.4.3	**Provide an SME to discuss the basis for the determination of baseflow to Lake Rousseau.** **Applicant Response:** According to ANSI/ANS-2.8-1992 (LNP FSAR Reference 2.4.3-201), the mean monthly flow should be used as the base flow rate for the PMF analysis. The base flow rate to Lake Rousseau was conservatively equal to the mean monthly average flow of 28.5 m3/s (1008 cfs). This value was calculated based on the published USGS mean monthly flow statistics of Withlacoochee River from 1928 to 2006 near Holder (USGS Station 02313000). Supporting Information: Calculation LNG-0000-X7C-009, Rev0 – "Probable Maximum Flood Flood (PMF) for the LNP Site" **NRC Comments:** **Staff will review the calculation package.**	N. Tiruneh R. Prasad RAI 2.4.3-03
9.	2.4.4	**Provide an SME to discuss the choice for steady state simulation as compared to unsteady state simulation.**	N. Tiruneh R. Prasad

		Applicant Response: The main objective for conducting the hydraulic modeling was to determine the maximum flood elevation at the LNP site under a hypothetical scenario of dam failure during the PMF event. The maximum flood elevation at the LNP site will correspond to the situation when maximum discharge will be released from Lake Rousseau due to Dam failure. The flooding evaluation due to this situation can easily be analyzed by using a steady-state model. Because the steady state model considers a constant maximum flow of 60,000 cfs rather than the actual the hydrograph (Figure 15 of LNG-0000-X7C-009, Rev0), it gives the most conservative results. Additionally, the steady state model is easy in development and analysis and needs less data manipulation. Supporting Information: Calculation LNG-0000-X7C-009, Rev0 – "Probable Maximum Flood Flood (PMF) for the LNP Site" **NRC Comments:** **Staff will review the calculation package.**	RAI 2.4.4-02
10.	2.4.4	**Provide an SME to discuss how the inventory of dams for dam break analysis was performed.** **Applicant Response:** Please see LNP FSAR Subsections 2.4.3.3.4.2.1, 2.4.3.3.4.2.2, and 2.4.3.3.4.2.3 for the detailed information about Inglis Dam, and Inglis Bypass Channel Spillway and their operation. See discussion in LNP FSAR Subsection 2.4.4 for potential dam failure. For detailed calculation please see HEC-RAS output given in LNG-0000-X7C-009, Rev0. As far as the inventory of dams is concerned, inventory of dams presented in an ASCE article by David Froehlich (1995) on "Peak Outflow from Breached Embankment Dam" was reviewed and a mathematical expression for the peak outflow suggested by him was used. Supporting Information: 1) Calculation LNG-0000-X7C-009, Rev0 – "Probable Maximum Flood Flood (PMF) for the LNP Site" 2) Froehlich, D. (1995). ""Peak Outflow from Breached Embankment Dam," Journal of Water Resources Planning and management, ASCE Vol. 121(1). **NRC Comments:** Clarifications of any upstream and downstream dams or water control structures on the Withlacoochee	N. Tiruneh R. Prasad RAI 2.4.4-01

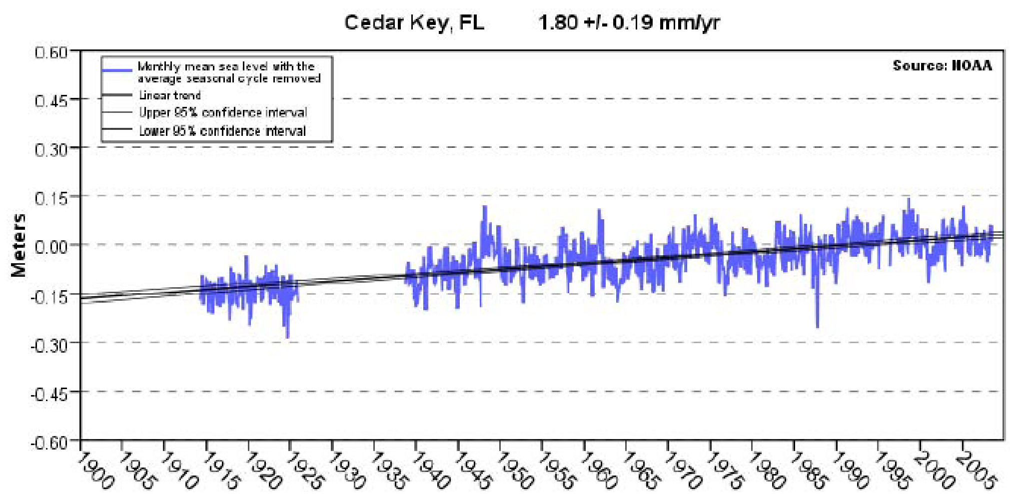
		system (existing or proposed). 2.4.1.2.8. Justify why the Inglis Dam break is the only scenario considered. Update to the FSAR.	
11.	2.4.5	**Provide an SME to discuss the estimation of storm surge under probable maximum hurricane conditions.** **Applicant Response:** Please see LNP FSAR Subsection 2.4.5.2.1 and Calculation LNG-0000-X7C-010, Rev0 for detailed discussion on PMH calculation. In brief, three different approaches have been used for PMH analysis as given below: 1. PMH Surge Level Determination Using Regulatory Guide 1.59 2. Storm Surge Analysis with SLOSH 3. PMH Surge Level Determination Using Hsu's Empirical Method Coastal line surge results obtained from the second and third approaches were used to determine a relationship between these two approaches. The obtained relationship was used to determine the expected PMH surge elevation at the coastal line. Further, the coastal line surge elevations for various categories of hurricanes were related to surge elevations at inland locations such as Yankeetown and Inglis, Florida. These relationships were utilized to determine the PMH surge elevation at the LNP site. Supporting Information: Calculation LNG-0000-X7C-010, Rev0 – "Probable Maximum Hurricane (LNP Site)" **NRC Comments:** **Staff will review the calculation package.**	H. Jones R. Prasad RAI 2.4.5-02 RAI 2.4.5-01 RAI 2.4.5-03 RAI 2.4.5-04 RAI 2.4.5-05
12.	2.4.5.2.6	**Provide an SME to discuss seismically/atmospheric-induced seiches in Lake Rousseau.** **Applicant Response:** 1) Please see LNP FSAR Subsection 2.4.5.2.6. 2) Lake Rousseau is not in seismically active area.	H. Jones R. Prasad RAI 2.4.5-06 (resonance

		3) Whether an earthquake will create seiches depends upon a number of earthquake specific parameters, including period or length of the seismic waves, earthquake location, and the style of fault rupture (e.g., dip-slip or strike-slip). Whether a seiche will cause damage can depend upon the size, shape and location of the body of water, storage tank strength, integrity of dam construction, underlying soil type, proximity of human-built safety structures, and local relief (variations in elevation). 4) There is no water body in the immediate vicinity of the LNP site. 5) With respect to dam failure due to seiches, amplitudes of seiche waves associated with earthquake ground motion have typically been less than 0.5 meters (1.64 ft) high. The elevation difference between Lake Rousseau and LNP site is about 20 ft. Therefore, the potential for flooding at the LNP site because of dam failure due to seiche effects can be considered insignificant. 6) As discussed in the LNP FSAR Subsection 2.4.4, the potential for the site to be inundated as a result of an earthquake-induced dam failure is negligible. Supporting Information: Calculation LNG-0000-X7C-009, Rev0 – "Probable Maximum Flood Flood (PMF) for the LNP Site" **NRC Comments:** **Clarification needs to be provided (supporting details) for both meteorological and seismic seiche and reference to FSAR section 2.5.** **Update to the FSAR**	question in Item 14 below also addressed in this RAI)
13.	2.4.5.3.1	**Provide an SME to discuss the estimation of the limiting wave period.** **Applicant Response:** The Gulf of Mexico is an open water body, therefore fetch length will be very large. So the wave growth will be duration-limited rather fetch-limited. According to EM 1110-2-1100(Part II) Chapter 2, the limiting wave period (Tp) is given as $T_P = 9.78\left(\frac{d}{g}\right)^{\frac{1}{2}}$	H. Jones R. Prasad RAI 2.4.5-07 RAI 2.4.5-08

		In which d = water depth (m), g = gravitational acceleration (m/s^2), and Tp = wave period in sec. Assuming variation in ground surface elevation from 1.5 m to 4.6 m (5 ft. to 15 ft.) and surge elevation from 6.1 m to 10.7 m (20 ft. to 35 ft.), the limiting wave period was determined using a Monte-Carlo simulation. As calculated in LNP FSAR Subsection 2.4.5.2.4, the obtained probability distribution is given below:  Based on the above plot, the limiting wave period can conservatively be assumed to be 10 seconds. Supporting Information: 1) Calculation LNG-0000-X7C-009, Rev0 – "Probable Maximum Flood (PMF) for the LNP Site" 2) U.S. Army Corps of Engineers, *Coastal Engineering Manual (CEM)*, Chapter 2, "Meteorology and Wave Climate," EM 1110-2-1100 (Part II), July 2003. **NRC Comments:** The reference to CEM needs to be included in the FSAR	
14.	2.4.5.4	**Provide a SME to discuss the approach in determining the possibility of resonance in Lake**	H. Jones

		Rousseau. **Applicant Response:** The LNP site is located 3 miles away from Lake Rousseau. It is unlikely that any resonance in Lake Rousseau will cause any flooding at the LNP site. a. Please see LNP FSAR Subsection 2.4.5.4. b. Response to Serial Number 12. **NRC Comments:** **Will be addressed in 12.**	R. Prasad (see Item 12 above)
15.	2.4.5	**Provide a SME to discuss the availability of the input/output files used during simulation of the hurricane scenarios with the Hsu model.** **Applicant Response:** Please refer to LNP FSAR Table 2.4.5-212 for input parameters used in Hsu model. Additionally, refer to the Calculation LNG-0000-X7C-010, Rev0 for detailed calculation procedure and model output. The digital file for conducting the calculation is also available. Supporting Information: 1) Calculation LNG-0000-X7C-009, Rev0 – "Probable Maximum Flood Flood (PMF) for the LNP Site" 2) Calculation LNG-0000-X7C-010, Rev0 – "Probable Maximum Hurricane (LNP Site)" **NRC Comments:** **The Hsu model references will be available in the reading room.**	H. Jones R. Prasad (NRC/PNNL can obtain these references independently)
16.	2.4.5	**Provide a SME to discuss the availability of the SLOSH input/output files used to compute the maximum storm surge heights.** **Applicant Response:** The SLOSH input/output files were obtained from Arthur Taylor, who can be contacted for further information at Arthur.taylor@noaa.gov. The SLOSH package webpage is found at the following URL: www.nws.noaa.gov/tdl/marine/slosh. The SLOSH input/output files used to compute the	H. Jones R. Prasad

		maximum storm surge heights are also available and a copy can also be provided. Additionally, refer to the Calculation LNG-0000-X7C 010, Rev0 for detailed calculation procedure and SLOSH model output. Supporting Information: Calculation LNG-0000-X7C-010, Rev0 – "Probable Maximum Hurricane (LNP Site)" **NRC Comments:** **Resolved.**	
17.	2.4.5	**Provide a SME to discuss any effort made to adjust PMH parameters in light of more recent hurricanes that have occurred since (30 years) the NOAA NWS charts were published.** **Applicant Response:** 1) Please refer to LNP FSAR Subsection 2.4.5.1.1 for a discussion on historic hurricane events. As far as adjustment of PMH parameters is concerned, no adjustment has been performed. The PMH corresponds to an event that is more severe than a category-5 hurricane and doesn't need any adjustment. 2) Please refer LNP FSAR Table 2.4.5-203 for parameters of the Probable Maximum Hurricane used in the PMH Analysis for the LNP Site. These parameters were taken from NOAA NWS (1979). Supporting Information: 1) Calculation LNG-0000-X7C-010, Rev0 – "Probable Maximum Hurricane (LNP Site)" 2) National Oceanic and Atmospheric Administration (NOAA), National Weather Service (NWS), "Meteorological Criteria for Standard Project Hurricane and Probable Maximum Hurricane Wind fields, Gulf and East Coasts of the United States," September 1979. **NRC Comments:** **Resolved.**	H. Jones R. Prasad
18.	2.4.5	**Provide a SME to discuss any effort made to adjust long-term sea level rises in addition to trends reported in the Gulf of Mexico based on recorded tidal levels at various NOAA tide gauges.**	H. Jones R. Prasad (see Item 6

		Applicant Response: As shown below, the adjustment due to long-term sea level rise in the Cedar Key datum is 0.59 feet in 100 years. This change doesn't make a significant impact on the resultant water elevation at the LNP site.  The mean sea level trend is 1.80 millimeters/year with a 95% confidence interval of +/- 0.19 mm/yr based on monthly mean sea level data from 1914 to 2006 which is equivalent to a change of 0.59 feet in 100 years. **NRC Comments:** RAI regarding consideration of long term sea level rise in the design basis flood determination (it will be linked to item no. 6).	above)
19.	2.4.6	**Provide a SME to discuss the availability of the geological maps, topographic maps, and Levy county site reconnaissance data used in the assessment of potential subaerial landslides near the site.** **Applicant Response:** LNP FSAR Figure 2.4.1-203 presents a topographic map of the site. The topographic gradient at the LNP site is approximately 50 ft/mile (1 percent). Based on the extremely low topographic grade of the LNP site, subaerial landslides are considered unlikely.	H. Jones

		Supporting Information: LNP FSAR Figure 2.4.1-203 – Topographic Map of the LNP Site **NRC Comments:** **Talking about off shore data – FDEM updating coastal maps – mostly terrestial data along the coast – some LIDAR data may be available – PEF does not have access to this data** RESOLVED	
20.	2.4.6	**Provide an SME to discuss the findings regarding potential hill-slope failure and the findings in Section 2.5 of the FSAR.** **Applicant Response:** LNP FSAR Figure 2.4.1-203 presents a topographic map of the site. The topographic gradient at the LNP site is approximately 10 ft/mile (.2 percent). As stated on LNP FSAR page 2.5-320, the LNP site grade will be at 15.5 m (51 ft.) NAVD88, with minor variations to allow drainage for an area of about 370 m by 390 m (1210 ft. by 1280 ft.) around the nuclear island. No permanent slopes will be present at the site that could adversely affect safety-related structures. Based on the extremely low topographic grade of the LNP site, hill-slope failure is considered unlikely. Supporting Information: LNP FSAR Figure 2.4.1-203 – Topographic Map of the LNP Site **NRC Comments:** **RG 1.206 has a section on hillslope failures – refer hillslope discussion from 2.5.5 (stability of slopes) into 2.4.6 – FSAR revision (annual). Clarify that hillslope failures will not impact the LNP, including a hillslope failure and wave action at Lake Rousseau.** **RAI is needed**	H. Jones
21.	2.4.6.1	**Provide an SME to discuss the inclusion of text related to the determination of the Probable Maximum Tsunami (according to RG 1.206), including the most reasonably severe geo-seismic event in determining the limiting tsunami-producing mechanism, as well as other discussion elements expected for this section.** **Applicant Response:** The intent of the PMT definition in LNP FSAR Subsection 2.4.6.1 was to provide a very broad definition of PMT rather than presenting a long discussion and replicating RG 1.206.	E. Geist

		Section C.I.2.4.6.1 of Regulatory Guideline (RG) 1.206 states the following with respect to determination of the Probable Maximum Tsunami: *The applicant should present the determination of the probable maximum tsunami, discussing consideration given to the most reasonably severe geoseismic activity possible (resulting from, for example, fractures, faults, landslides, or volcanism) in determining the limiting tsunami-producing mechanism. The geoseismic investigations used to identify potential tsunami sources and mechanisms and the resulting locations and mechanisms that could produce the controlling maximum tsunami at the site (from both local and distant generating mechanisms) should be summarized. The applicant should discuss the orientation of the site relative to the earthquake epicenter or generating mechanism, shape of the coastline, offshore land areas, hydrography, and stability of the coastal area (proneness of sliding) and how the applicant considered these factors in its analysis. Also hill-slope failure-generated tsunami-like waves on inland sites and the potential of an earthquake-induced tsunami on a large body of water, if relevant for the site, should be discussed.* Each of these topics has been given thorough consideration in the LNP FSAR, where relevant. LNP FSAR Subsection 2.4.6.3 begins the tsunami analysis by discussing potential tsunami sources, including general source mechanisms such as earthquakes, landslides, and volcanoes, source locations, and specific near-field and far-field sources capable of impacting the Gulf of Mexico. LNP FSAR Subsection 2.4.6.4 discusses the efficiency of tsunami generation for each mechanism in general, and with respect to sources capable of impacting the LNP site, given factors such as source proximity and historical observations. A general review of tsunami wave propagation is provided in LNP FSAR Subsection 2.4.6.4.2. The LNP FSAR references two government studies produced by the NOAA West Coast and Alaska Tsunami Warning Center and by the USGS, respectively, each of which has determined a similar set of potential PMT sources for the Gulf of Mexico. The LNP FSAR presents the methodology used for analysis in both studies, as well as the potential impacts to the Gulf Coast near the LNP site as a result of a tsunami generated by a proposed event at one of the specified sources. Where necessary, additional calculations were performed and described to provide a complete evaluation of the potential impacts to the LNP site for each tsunami source. **NRC Comments:** PEF has a broad definition of the PMT – NRC looking for a summary of the PMT including sources and water levels – FSAR Section 2.4.6 contains this discussion although not in FSAR Section 2.4.6.1 PEF: Summary is in FSAR Section 2.4.6.5.3	

		RAI to ask for a summary – no required FSAR revision	
22.	2.4.6.2	**Provide an SME to discuss the discrepancy between the statement that "…historically no Caribbean tsunami has impacted the United States Gulf Coast" (2.4.6.2.2, pg. 2.4-45) and the description of such events in the next section (2.4.6.2.3) and elsewhere in the report.** **Applicant Response:** In the above statement, "impact" is taken to mean "damaged." No Caribbean tsunami has produced verified damage to the U.S. Gulf Coast. As stated in LNP FSAR Subsection 2.4.6.2.3, two of the three documented tsunami events that have impacted the Gulf Coast originated in Puerto Rico. The event that occurred in May 1922 has a rating of "doubtful" in the NGDC database. The 1918 event was definitive, but no magnitude is associated with that event. The North Caribbean is clearly identified as a potential tsunami source on LNP FSAR page 2.48, Subsection 2.4.6.3.2. **NRC Comments:** PEF presented data from 1860-present – concluded based on this data that no Carribean tsunami affected the Gulf Coast – "impact" is meant to state that no damage occurred – impact is a runup of > 1m Definition of impact in 2.4.6.2.1 – "tsunami particularly dangerous if runup exceeds 1m" RAI – FSAR will be clarified with regard to the definition of "impact"	E. Geist
23.	2.4.6.2	**Provide an SME to discuss the location of Maximum Water Height measurements relative to the tsunami generator for the events listed in Table 2.4.6—202.** **Applicant Response:** LNP FSAR Table 2.4.6-202 provides a list of tsunami events that have impacted the Caribbean region. As indicated by the title of LNP FSAR Table 2.4.6-202, the general location of maximum water height measurements is in the Caribbean, however, specific locations are not known. Further, the exact locations of the maximum water height measurements for these events are not relevant to the discussion of observed tsunami impacts in the Gulf of Mexico. This table was presented to contrast LNP FSAR Table 2.4.6-203, which provides a list of tsunamis that have impacted the Gulf of Mexico. The two tables indicate that 45 tsunami events have impacted the Caribbean region while only 2 tsunami events have definitively impacted the Gulf Coast. This contrast lends support to the idea that distance and a sheltered physical layout serve to mitigate potential impacts of tsunamis in the Gulf Coast for tsunamigenic sources located outside of the Gulf of Mexico Coast.	E. Geist

		With respect to observed tsunami events that impacted the Gulf Coast, LNP FSAR Subsection 2.4.6.2.3 provides affected locations in the Gulf Coast and the associated magnitude of the observed impacts. Supporting Information: 1) LNP FSAR Table 2.4.6-202 2) LNP FSAR Table 2.4.6-203 **NRC Comments:** Confusion arises where the table data is contained in the table– is the maximum height in the Gulf? PEF: location of maximum runup is unknown – this creates problems interpreting the value of this data RAI to clarify the location of the data in Table 2.4.6-203	
24.	2.4.6.2	**Provide an SME to discuss the potential for tsunami deposits at the Levy County site or nearby regions and how they would be distinguished from storm washover deposits. Additionally, the SME should be able to discuss whether there are geologically conducive locations for the deposition and preservation of tsunami deposits at the Levy County site or nearby regions.** **Applicant Response:** Simulations suggest that the maximum likely tsunami runup from one of these sources will be less than or equal to 5 m (16.4 ft.). Because the LNP safety-related facilities are at a higher elevation (nominal plant grade elevation of 15.2 m [50 ft.] NAVD88) and well inland (about 9 miles) from the Levy County coastline, it is not expected to be impacted by the probable maximum tsunami event. The PMT analysis has concluded that the PMT event would not impact the Levy Nuclear Plant site. This implies that there is no potential for tsunami deposits at the LNP site. **NRC Comments:** FSAR mentions that there are no records of tsunami deposits – NRC looking for clarification regarding prehistoric tsunamis and their records – PEF can clarify regarding absence of tsunami deposits in core borings – also nothing reported in current literature RAI to get a clarifying statement – a change in the FSAR is expected	J. Chaytor
25.	2.4.6.3	**Provide an SME to discuss submarine landslides in the Gulf of Mexico, other than East Breaks, as potential tsunami generators, including the Mississippi Canyon landslide, and landslides**	J. Chaytor

		along the Florida Escarpment and along the slope above the Florida Escarpment. **Applicant Response:** LNP FSAR Reference 2.4.6-214, *The Current State of Knowledge Regarding Potential Tsunami Sources Affecting U.S. Atlantic and Gulf Coasts, A Report to the Nuclear Regulatory Commission,* provides a review of available literature and information regarding landslides within the Gulf of Mexico as potential tsunami generators. While the Mississippi Canyon and Fan in the "canyon/fan province" was once a source of large landslides, the area has been inactive for more than 7,000 years. Similarly, the northern section of the Florida Escarpment in the "carbonate province" is considered to be relatively inactive. Details of the report are presented in LNP FSAR Subsection 2.4.6.3.2.2, and an excerpt from the executive summary is as follows: *Large landslides in the Gulf of Mexico are found in the submarine canyon and fan provinces extending from present (Mississippi) and former larger rivers that emptied into the Gulf. These large landslides were probably active before 7,000 years ago. In other areas, landslides continue to be active, probably because of salt movement, but are small and may not pose a tsunami hazard.* As such, the Mississippi Canyon and Florida Escarpment were not considered to be significant potential tsunami threats. Supporting Information: LNP FSAR Reference 2.4.6-214 **NRC Comments:** PEF: interpreted USGS report as stating landslides in the Gulf are currently inactive. USGS intent was to say we do not know if these escarpments are currently inactive. Why were these not considered as potential PMT generators? RAI – maybe combine several 2.4.6 tsunami info needs to write comprehensive RAI/RAIs. Quantitative analysis is required.	
26.	2.4.6.3	**Provide an SME to discuss the justification for apparent exclusion of the East Breaks landslide as a potential tsunami source generator (cf., pg. 2.4-58).** **Applicant Response:** The East Breaks Slump is considered as a potential tsunami source generator in LNP FSAR	J. Chaytor

		Subsection 2.4.6.4.1.2. It is concluded that a tsunami generated by a landslide at the East Breaks Slump would not impact the LNP site. Discussion of the East Breaks Slump is not included in LNP FSAR Subsection 2.4.6.3, which is limited to nine potential seismically generated tsunami events—four selected by the NOAA West Coast and Alaska Tsunami Warning Center (LNP FSAR Reference 2.4.6-225) and five by the USGS (LNP FSAR Reference 2.4.6-214)—that could produce "worst case" impacts to the Gulf of Mexico. Supporting Information: 1) LNP FSAR Reference 2.4.6-214 2) LNP FSAR Reference 2.4.6-217 3) LNP FSAR Reference 2.4.6-222 4) LNP FSAR Reference 2.4.6-225 **NRC Comments:** RAI (combined with #31) –update needed to the FSAR – clarify that East Break was indeed included and is the PMT source	
27.	2.4.6.3	**Provide an SME to discuss evidence for historic seismicity in the region of the Veracruz, Mexico earthquake scenario as stated in the report (pg 2.4-57).** **Applicant Response:** The USGS Earthquake Hazard Program website provides information regarding recent and historic seismicity near Veracruz, Mexico. (http://neic.usgs.gov/neis/bulletin/neic_xjel_h.html; see attached file: Veracruz_Seismicity.pdf) The site indicates that the most recent significant earthquake event near Veracruz had a magnitude of 3.8 and occurred at a depth of 41 km on Thursday, September 25, 2008. The majority of events that have taken place since 1990 have originated between 70 km and 300 km in depth. However, several weak, shallow earthquakes (<35 km in depth) also occurred during that time. Approximately 15-20 earthquakes of magnitude 7 or greater have been generated near Veracruz since 1900. Most of the events on the northern coastline have originated at depths greater than 75 km. However, several of the events on the southern coastline developed near a plate subduction zone and have originated within 35 km of sea level. Supporting Information: http://neic.usgs.gov/neis/bulletin/neic_xjel_h.html	E. Geist

		NRC Comments: The cited event was hypothetical. Clarification needed regarding why this region is considered active. RAI with possible revision to the FSAR	
28.	2.4.6.4	**Provide an SME to discuss the theoretical basis, assumptions (e.g., source parameterization), and applicability to the Levy County site for the tsunami attenuation function discussed on pg. 2.4-53 (Equation 2.4.6-1). Also make available the details of the Monte Carlo analysis used to estimate the maximum wave height and where the maximum wave height estimate is geographically located.** **Applicant Response:** LNP FSAR Equation 2.4.6-1 describes wave attenuation in the Caribbean as provided by Zaibo (2003) in "Estimation of Far-Field Tsunami Potential for the Caribbean coast Based on Numerical Simulation" (LNP FSAR Reference 2.4.6-222). As discussed in LNP FSAR Subsection 2.4.6.4.1.2: *Zaibo's (2003) (Reference 2.4-222) wave attenuation formula was used to determine the most likely maximum wave height that would be expected at the Levy County coastline as a result of this event. The formula is as follows:* $\frac{H(r)}{H_e} = 2\left(\frac{r}{D}\right)^{-\alpha}$ *(Equation 5; Reference 2.4-222)* *where He is the hydrodynamic source height, D is the source diameter, r is the distance from the source to the location of interest, and α is the attenuation ratio (Reference 2.4-222).* Zaibo (2003) validated this equation by comparing calculated results to observed wave heights produced by the 1867 Virgin tsunami at 3467 gridded points distributed across four zones in the Caribbean, including the great Antilles, Jamaica, the Lesser Antilles, and the Caribbean coasts of Central and South America. It has been inferred that the equation is equally applicable to the Gulf Coast region due to proximity. While it was determined that the function produces accurate results for source distances up to 1,000 km, results for distances greater than 1,000 km tend to be more conservative than observed values as seen in Figure 11 (below), page 219 of the paper (Zaibo 2003). In other words, calculated wave heights at points more than 1,000 km from the tsunami source are consistently greater than the observed wave heights. Because the LNP site is more than 1,000 km away from the tsunami source evaluated using this equation, it is clear that the attenuation results derived from this equation are	P. Lynett

conservative.

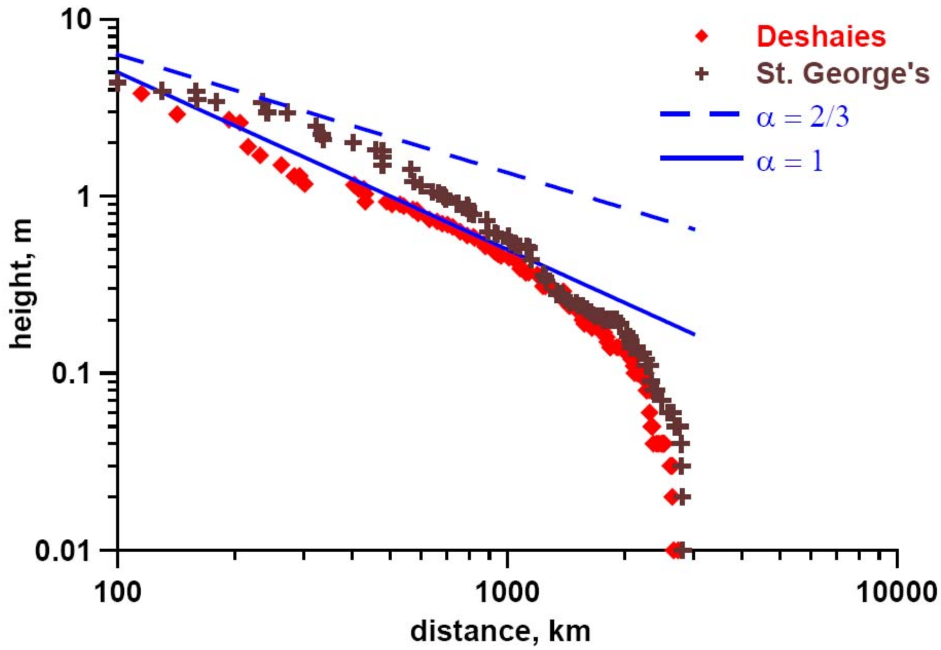


Figure 11. Computed tsunami height at Deshaies (Guadeloupe) and St. George's (Grenada) versus the distance to the source

According to the wave attenuation equation, wave height is dependent on several factors, including bottom irregularities, distance from source, wave height at source, and the diameter of the source. Attenuation is captured in one parameter, α, which produces minimum attenuation when equal to 0.67 and maximum attenuation when equal to -1. The parameterization of each of these variables is described in the FSAR as follows:

> *According to Trabant (Reference 2.4.6-217), the height, H_e is 7.6 m (24.9 ft.), while the source diameter is estimated as 37.5 km (23.3 mi.) — an average of the length (55 km [34.2 mi.]) and width (20 km [12.4 mi.]) of the slump area. The distance, r, from the slump site to the Levy County coastline has been approximated at 1000 km (621.4 mi.) (Reference 2.4.6-223). Finally, the attenuation ratio is to be given a value between 2/3 and 1.*

The details of the Monte Carlo analysis are available upon request.

		The geographic maximum water height location is the coastal area near the LNP site that features water depths from 20 to 150m. **NRC Comments:** Justify the use of this equation for East Breaks source and for LNP. PEF used a Monte Carlo simulation to estimate the parameter α for LNP site. Analysis should be site specific and tsunami source specific. RAI (combine with #30)	
29.	2.4.6.4	**Provide an SME to discuss the inconsistency of the statement that the Gulf of Mexico contains no sources of reverse faults (1st sentence, section 2.4.6.4.1.2, pg. 2.4-52) given the mechanism of the September 10, 2006 Mw=5.8 in the NE Gulf of Mexico (third sentence).** **Applicant Response:** The statement is correct and not inconsistent as the above question indicates. It is clearly mentioned in LNP FSAR Subsection 2.4.6.4.1.2, pg. 2.4-52 that the earthquake that occurred on September 10, 2006 in the NE Gulf of Mexico was generated by a “midplate” phenomenon rather than by a reverse fault mechanism. Further, LNP FSAR Subsection 2.4.6.4.1.2 describes that such events (like the September 10th “midplate” earthquake event) occur at great distance from faults and plate boundaries. These types of events are rare, and, unlike reverse faults, are not likely to produce a tsunami event. It is true that the Gulf of Mexico does not contain tectonic conditions, including subduction zones and sources of reverse faults, necessary to produce a tsunami via earthquake. Supporting Information: 1) LNP FSAR Reference 2.4.6-214 2) LNP FSAR Reference 2.4.6-216 **NRC Comments:** USGS website states that the cited fault may be a reverse fault. PEF will review the USGS focal mechanism and potentially revise the FSAR. RAI	E. Geist
30.	2.4.6.5	**Provide an SME to discuss the procedure for calculating tsunami propagation, runup, and inundation (i.e., tsunami water levels) at the Levy County site from offshore tsunami amplitude.**	P. Lynett

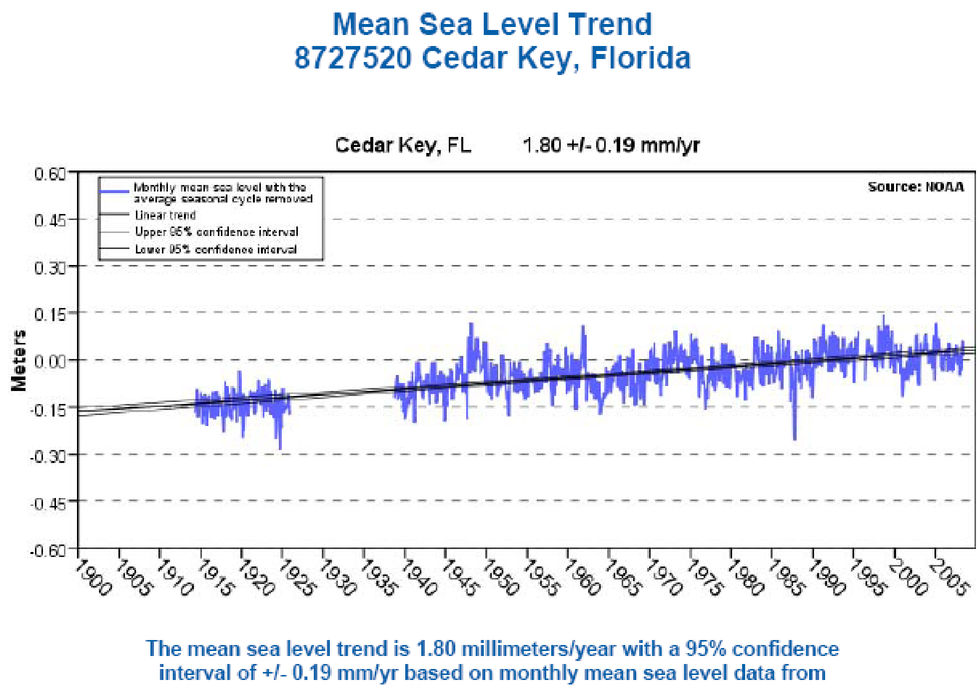
		Applicant Response: No modeling for tsunami propagation, runup, and inundation were performed, instead literature based studies were used to assess the impact of offshore tsunami amplitudes at the Levy County site. Three different methods used to determine tsunami wave propagation were referenced in the LNP FSAR. Two separate methods were used in two separate analyses conducted by the USGS and by the NOAA West Coast and Alaska Tsunami Warning Center, respectively. Method 1: The procedure for calculating tsunami propagation and runup for a potential tsunami originating at the East Breaks slump is described in LNP FSAR Subsection 2.4.6.4.1.2 as follows: *Zaibo's (2003) (Reference 2.4-222) wave attenuation formula was used to determine the most likely maximum wave height that would be expected at the Levy County coastline as a result of this event. The formula is as follows:* $\frac{H(r)}{H_e} = 2\left(\frac{r}{D}\right)^{-\alpha}$ *(Equation 5; Reference 2.4-222)* *where H_e is the hydrodynamic source height, D is the source diameter, r is the distance from the source to the location of interest, and α is the attenuation ratio (Reference 2.4-222).* Method 2: LNP FSAR Subsection 2.4.6.5.2 refers to results produced by Bill Knight of the NOAA West Coast and Alaska Tsunami Warning Center. According to Knight, the following procedure for determining wave propagation and runup were used (LNP FSAR Reference 2.4.6-225) in his assessment of PMT events: *Four initial sea level disturbances were created using Okada's formulas (1985) in conjunction with their associated hypothetical earthquakes. ...The 2D depth averaged model developed at the University of Alaska, Fairbanks (Kowalik et al., 2005) has been used to propagate the initial disturbance to all points along the US Gulf and Atlantic coasts. All computations were done on a uniform 15 second mesh, and 15 second bathymetric / elevation data was used wherever it was available (NOAA / NGDC). In regions where no data was available, bathymetry values were interpolated from the 1 minute Gebco dataset. The model space was a 40 degree square with radiation conditions applied in the open ocean and run-up conditions at the coast.*	

		Method 3: LNP FSAR Subsection 2.4.6.5.2 also refers to results produced by the USGS. In this case, only deep sea (depth = 250 m) wave heights were reported by the USGS. However, the USGS recommended method for estimating runup described below was applied for the purposes of this FSAR. According to the USGS (LNP FSAR Reference 2.4.6-214), propagation and runup were determined as follows: *Tsunami propagation was modeled using the linear long-wave equation, numerically implemented with a leap-frog, finite-difference algorithm. Only deep-ocean tsunami propagation is modeled, where linear theory is most applicable. Propagation across the continental shelf (specified by water depth less than 250 m) and runup are not modeled. As a very rough approximation, runup is approximately 3 times the tsunami amplitude at 250 m water depth, accounting for shoaling and runup amplification (Shuto, 1991; Satake, 1995, 2002), but not including energy dissipation from geometric spreading, bottom friction, and non-linear attenuation that is evident in the simulations of the Currituck landslide tsunami offshore Virginia, USA (Chapter 9). It is unclear whether the latter two dissipation mechanisms are as significant for far-field seismogenic tsunamis as they are for landslide tsunamis. Radiation boundary conditions are specified at the open-ocean boundaries, whereas reflection boundary conditions are specified at the 250 m isobath. The spatial grid size for the simulations is 2 arcminutes and the time step is 8 s, which satisfies the Courant-Friedrichs-Lewy stability criterion (Satake, 2002). Total propagation time for each simulation is 4.4-6.6 hours, which is sufficient to capture the first few waves at the 250 m isobath within the model domain.* For determining inundation potential of the LNP site, offshore wave amplitude and wave-runup values were added from these three analyses and then compared to the known elevation of the LNP site referencing a common datum.	

Location	Mechanism	Magnitude	Offshore Wave Height	Estimated Runup	Validation of Source as Potential Tsunami Generator	Analysis Reference
West Cayman oceanic transform fault (also known as Swan Island fault)	Earthquake	Mw 8.35	13 cm (5.1 in)	39 cm (15.4 in)	Bird (2003)	USGS (2007)
East Cayman fault (also known as Oriente fault)	Earthquake	Mw 8.45	12 cm (4.72 in)	36 cm (14.2 in)	Bird (2003)	USGS (2007)
Northern Puerto Rico/Lesser Antilles	Earthquake	Mw 8.84	14 cm (5.5 in)	42 cm (16.5 in)	Bird (2003)	USGS (2007)
North Panama deformation belt	Earthquake	Mw 8.28	25 cm (9.8 in)	75 cm (29.5 in)	Bird (2003)	USGS (2007)
North Venezuela subduction zone	Earthquake	Mw 8.5	65 cm (25.6 in)	195 cm (76.8 in)	Bird (2003)	USGS (2007)
Puerto Rico trench (66W, 18N)	Earthquake	Mw 9.0	25 cm (9.8 in)	75 cm (29.5 in)	Bird (2003)	Knight (2006)
Caribbean Sea (85W, 21N) (translated from the Swan fault to mouth of Gulf near Cancun)	Earthquake	Mw 8.2	30 cm (11.8 in)	90 cm (35.4 in)	Bird (2003)	Knight (2006)
North Panama Deformed Belt (66W, 12N)	Earthquake	Mw 9.0	15 cm (5.9 in)	45 cm (17.7 in)	Bird (2003)	Knight (2006)
Gulf of Mexico, offshore of Veracruz (95W, 20N)	Earthquake	Mw 8.2	35 cm (13.8 in)	105 cm (41.3 in)	hypothetical	Knight (2006)
East Breaks Slump	Landslide	50 to 60 cubic kilometers (km^3)	1.68 m (5.5 ft)	5.04 m (16.5 ft)	Trabant (2001); tsunami claim not further supported	Trabant (2001), Zaibo (2003)

		Because the resulting runup values were significantly less than the LNP site elevation, it was concluded that the resulting tsunami wave would not impact the LNP site. As such, a detailed inundation analysis was not performed. **NRC Comments:** Linked to #28	
31.	2.4.6.5	**Provide an SME to clarify the source of the PMT for the Levy County site. Is it the East Breaks landslide with an estimated 1.68 m maximum wave height (pg. 2.4-53), the Venezuela earthquake with an estimated 1.95 m maximum runup height (pg. 2.4-58)?** **Applicant Response:** The source of the PMT event for the Levy County plant site is a near field landslide event. However, the occurrence of such an event is highly unlikely, as landslide events have not been a source of any tsunami that has been documented instrumentally or in the geologic record for the Gulf Coast. As such, a discussion of potential PMT events related to seismic activity as suggested by NOAA and USGS was also provided in the LNP FSAR. In addition to being unlikely, the tsunamigenic threat of near-field and far-field landslides within the Gulf of Mexico is difficult to characterize due to lack of information. However, for the purpose of this report, a conservative analysis of the East Breaks landslide as a tsunamigenic source was conducted to determine the potential worst case impacts from a landslide-generated tsunami. Analysis indicates that such an event could produce a tsunami with an offshore wave height of 1.68 m. As suggested by the	E. Geist

		USGS, runup can be calculated at 3 times the wave height value to produce a runup value of 5.04 m MSL (16.5 ft MSL, 5.1 m NAVD88, or 16.72 NAVD88). With respect to the LNP site, the impacts of a tsunami generated by the East Breaks slump would be greater than the impacts of a large earthquake originating in the Venezuela subduction zone. The most likely tsunami PMT sources as determined by the NOAA West Coast and Alaska Tsunami Warning Center (LNP FSAR Reference 2.4.6-214) and by the USGS (LNP FSAR Reference 2.4.6-225) were provided in LNP FSAR Subsection 2.4.6.5.2. The majority of these sources consist of regions of high seismicity in the Caribbean Sea that are capable of generating the large, shallow earthquakes that produce destructive tsunamis. There are no landslide sources included in the potential PMT sources. Analyses conducted by these two agencies suggests that the maximum impact to the Gulf Coast near the LNP site would be the result of an earthquake originating in the north Venezuela subduction zone (north coast of South America convergence zone). An earthquake in this region could potentially generate a tsunami with a runup height of 1.95 m MSL, as described on LNP FSAR page 2.4-58. However, the occurrence of this type of event is considered to be more likely than a near field landslide event. Supporting Information: 1) LNP FSAR Reference 2.4.6-214 2) LNP FSAR Reference 2.4.6-217 3) LNP FSAR Reference 2.4.6-225 **NRC Comments:** Combined with #26	
32.	2.4.6.5	**Provide an SME to discuss the value for 10% exceedance high-tide coincident with maximum tsunami water levels at the Levy County site**. **Applicant Response:** As presented in LNP FSAR Subsection 2.4.4, page 2.4-32, based on the U.S. NRC's Nuclear Regulatory Guide 1.59, Revision 2 (1977), the 10 percent exceedence antecedent high spring tide at the Crystal River coastline near the LNP site is taken as 1.80 m (5.92 ft) NAVD88 [which is equivalent to 1.3 m (4.3 ft.) mean low water (MLW), or 2.01 m (6.59 ft.) NGVD29]. The maximum water height associated with the 10% exceedance high-tide of 1.8 m NAVD88 coincident with probable maximum tsunami water levels at the Levy County site of 5.1 m NAVD88 is 6.9 m (22.6 ft) NAVD88. This value remains well below the nominal Levy Nuclear plant site grade elevation of 15.2 m [50 ft.] NAVD88, which is several miles inland from the coastline.	E. Geist

		NRC Comments: Clarifying statement that the 10% exceedance tide was used. RAI – update to the FSAR	
33.	2.4.6.5	**Provide an SME to discuss long-term sea-level rise coincident with maximum tsunami water levels at the Levy County site.** **Applicant Response:** Records provided by NOAA's Tides and Currents website indicate that mean sea level has risen at an average rate of 1.88 mm/yr at the Cedar Key, FL coastline since 1900.  Should sea level rise continue at the same rate, the additional water height accumulated in the next 100 years would be only 0.188 m (1.88 mm/yr * 100 years) (0.617 ft). As such, the maximum water height associated with the 10% exceedance high-tide of 1.8 m NAVD88 coincident with probable maximum tsunami water levels at the Levy County site of 5.1 m (16.7 ft) NAVD88 and considering the 0.188 m sea level rise would amount to 7.09m (23.3 ft) NAVD88. Again, this value remains well	E. Geist

		below the nominal Levy Nuclear plant site grade elevation of 15.2 m [50 ft.] NAVD88, which is several miles inland from the coastline. **NRC Comments:** **Provide the information to clarify the methodology including the time period.** RAI – FSAR update	
34.	2.4.12.1.2	**Please provide an SME to discuss groundwater chemistry at the site. (Water quality is described as "good" for potable water on p. 2.4-68.)** **Applicant Response:** Groundwater chemistry at the site is described in <u>LNP ER Section 2.3.3.2 GROUNDWATER</u> and summarized in <u>LNP ER Tables 2.3-50, 2.3-51, and 2.3-52</u>. **NRC Comments:** **Clarify ground water chemistry in the FSAR as being "good" relative to safety issues.**	M. McBride RAI 2.4.12-01
35.	2.4.12.1.3	**The current conceptual foundation design calls for substantial dewatering during construction to depths of approximately 100 ft, which will extend into the more permeable Upper Floridan aquifer. Please provide an SME to discuss the technical approach (e.g., well network configuration, discharge water handling) for dewatering this relatively high permeability aquifer.** **Applicant Response:** An SME will be provided to discuss the technical approach (e.g., well network configuration, discharge water handling) for dewatering this relatively high permeability aquifer. Reference: Section 2.5.4.5 Excavations and Backfill **NRC Comments:** **NRC will review the cited section.**	V. Vermeul Placeholder RAI 2.4.12-02
36.	2.4.12.1.3	**Please provide an SME to discuss why water supply wells will be spaced at least 750 ft apart (p. 2.4-69, first paragraph).**	M. McBride Placeholder

		Applicant Response: The spacing of supply wells and the number of supply wells to be used for fresh water supply at LNP and their projected impacts have been evaluated using a numerical groundwater flow model. The goal of the modeling was to refine a wellfield configuration that achieves the required water use quantities, while minimizing potential impacts to surrounding surface waters, wetlands, and adjacent offsite groundwater users. The modeling was performed using information exported from the Southwest Florida Water Management District (SWFWMD) District-wide Regulation Model, Version 2 (DWRM2). The results are presented in the a draft technical memorandum (338884-TMEM-074, REV.1). Exhibit 3 of that document presents the various wellfield configurations evaluated in addition to the current configuration. Supporting Information: Draft Technical Memorandum (338884-TMEM-074, REV.1) – "Revised Conceptual Wellfield Layout and Evaluation of Simulated Drawdown Impacts, Levy Nuclear Plant". **NRC Comments:** **The groundwater supply well modeling technical memo, 338884-TMEM-074, needs to be summarized in the update of the FSAR.** RAI	RAI 2.4.12-02
37.	2.4.12.2.1	**Well permit records were obtained from SRWMD covering a period of about 32 years (1976-2007) and from SWFWMD for about 38 years (1970-2007). However, Figures 2.4.12-206 to 2.4.12-210 show a much smaller density of wells in the area within the SRWMD. Please provide an SME to discuss the reasons for this difference in well density.** **Applicant Response:** The difference in well density between the Suwannee River Water Management District (SRWMD) and the Southwest Florida Water Management District (SWFWMD) is related to policy differences between the two water management districts. The SRWMD does not require that domestic wells be permitted. The SWFWMD requires that all wells, including domestic wells, be permitted. LNP FSAR Figures 2.4.12-206 to 2.4.12-210 are based on the permit records of both water management districts. These policies are discussed in LNP FSAR References 2.4.12-208 and 2.4.12-209.	M. McBride RAI 2.4.12-04

		NRC Comments-: **Provide a brief explanation in an update to the FSAR.**	
38.	2.4.12.2.1	**Please provide an SME to discuss LNP groundwater usage from the Upper Floridan aquifer in relation to a basin or subbasin scale water balance.** **Applicant Response:** The draft technical memorandum (TM) (338884-TMEM-074, REV.1) discussed in Serial Number 36 contains a discussion of existing incremental and potential cumulative pumping impacts on the nearby groundwater users, lakes, and springs within the LNP subbasin for surface water and groundwater interaction. As stated in the TM, the simulated future impacts to nearby water resources were evaluated for both daily average water use and maximum weekly water use (TM Exhibit 11). The modeling results did not project either an incremental or cumulative drawdown impact of 0.5 feet or more on any wetlands within the wellfield's area if influence. The projected Average Day LNP operation conditions decreased the model-simulated surficial and Floridan aquifer discharge into surface water cells used to represent rivers and lakes by approximately 1.2 mgd, or about 0.5% of the total flux. Under Average Day conditions, the LNP wellfield operations decreased the model-simulated discharge from the drain cells representing Little King and Big King springs by approximately 0.01 mgd, or about 0.3% of the total flux. Supporting Information: Draft Technical Memorandum (338884-TMEM-074, REV.1) – "Revised Conceptual Wellfield Layout and Evaluation of Simulated Drawdown Impacts, Levy Nuclear Plant", dated October 24, 2008. **NRC Comments:** Provide a discussion in the FSAR of the expected impacts of pumping at the nuclear islands.	V. Vermeul RAI 2.4.12-05
39.	2.4.12.2.2	**Please provide an SME to discuss boring logs for the piezometers and monitoring wells listed in Table 2.4.12-207.** **Applicant Response:** Boring logs associated with monitoring wells, observation wells, and the pumping well listed in Table 2.4.12-207 will be provided for review.	M. McBride Placeholder RAI 2.4.12-06

		NRC Comments: Please provide a copy for the reading room.	
40.	2.4.12.2.2	**Please provide an SME to discuss whether the topographic high of approximately 60 ft is located in the western portion of the LNP site as stated (p. 2.4-72, last paragraph, 6th line), or is east of the LNP site (and outside the site boundary) as suggested by Figure 2.4.1-203.** **Applicant Response:** There is a typographical error in the third sentence of the last paragraph on LNP FSAR Page 2.4-72. This sentence should read "The direction of groundwater flow is toward the west-southwest from a topographic high of approximately 18.3 m (60 ft.) NGVD29 in the ***eastern*** portion of the site toward a topographic low of approximately 10.7 m (30 ft.) NGVD29 in the southwest portion of the site (Figure 2.4.1-203)." **NRC Comments:** Correction needs to be made to the FSAR. Page 2.4-72 last paragraph, first sentence change elevation to depths.	M. McBride RAI 2.4.12-07
41.	2.4.12.2.2	**Please provide an SME to discuss the groundwater elevation monitoring data in relation to the historical seasonal variability in groundwater elevation throughout the basin.** **Applicant Response:** Historical groundwater elevation data were downloaded from the USGS website for four Floridan aquifer wells located near the LNP site. Groundwater elevation data were not available from the USGS website for surficial aquifer wells near the LNP site, however, the surficial and Floridan aquifers are hydraulically connected at the LNP site. The groundwater elevations recorded at the four USGS-monitored wells were compared to the groundwater elevations recorded from March 2007 through March 2008 at LNP surficial aquifer wells MW-13S and MW-15S. The standard deviation in the groundwater elevation data recorded at the four USGS-monitored wells varied from 0.97 to 2.6 feet over a period up to 44 years. The standard deviation in the groundwater elevation data recorded at LNP wells MW-13S and MW-15S was 1.17 and 1.18, feet respectively. The similarity in the standard deviation of the groundwater elevations recorded at LNP site wells over a one year period and the	V. Vermeul RAI 2.4.12-08

		groundwater elevations recorded at nearby wells over longer periods suggests that the LNP site wells display similar seasonable variability in groundwater elevations as have been observed historically near the site. In addition, similar trends in the groundwater elevation data recorded from March 2007 through March 2008 are present at both the LNP site and USGS-monitored wells. Supporting Information: 1) See Figure 1 – Locations of USGS-monitored Wells near the LNP Site 2) See Figure 2 – Historical Groundwater Elevation Data near the LNP Site **NRC Comments:** **Please provide the figures (reading room) and raw data with submittal of other modeling data. Also provide the water level data (historical and transducer data) in digital form.**	
42.	2.4.12.2.2	**Please provide an SME to discuss regional and basin scale groundwater gradients and flow directions. Please have available regional and/or basin-scale potentiometric contour maps for the surficial and Upper Floridan aquifers.** **Applicant Response:** LNP FSAR Reference 2.4.12-204 includes maps of the estimated pre-development potentiometric surface (page F-25) and the 1976 potentiometric surface of the Upper Floridan aquifer (page F-39). The regional pre-development and 1976 groundwater flow direction near the LNP site was generally west-southwest at an approximate gradient of 0.05 percent ,. Although no maps of the surficial aquifer potentiometric surface were identified, in the area of the LNP site, the surficial aquifer is thin (approximately 50 feet) and hydraulically connected to the Upper Floridan aquifer; therefore, the surficial aquifer potentiometric surface is expected to closely mimic than of the Upper Floridan aquifer. USGS Open File Report 2006-109, Potentiometric surface of the upper Floridan aquifer, West-Central Florida, May 2005. Supporting Information LNP FSAR Reference 2.4.12-204 – Ryder, Paul D., "Hydrology of the Floridan Aquifer System in West-Central Florida," Regional Aquifer-System Analysis, USGS Professional Paper 1403-F, 1985.	V. Vermeul

		NRC Comments: **The USGS reference will be added to the FSAR. NRC can obtain this publicly available document. RESOLVED**	
43.	2.4.12.2.2	**Please provide an SME to discuss possible locations where groundwater flowing near the site may discharge, and how these discharges may, in part, control the direction of groundwater flow to the west-southwest. To judge from Figure 2.4.1-206, such locations could include Spring Run, northwest of the site; the marshes south of Spring Run; and the Withlacoochee River, to the south.** **Applicant Response:** Figure 1 shows that the Withlacoochee River, Tenmile Creek, Spring Run, and the marshes south of Spring Run and Tenmile Creek, are within an area of groundwater discharge from the Floridan aquifer (1 to 5 in/year). The alignment of the Floridan aquifer recharge/discharge areas shown in Figure 1 suggests that these areas result from the topography of the land surface, with lower topographic areas intersecting the groundwater table and therefore acting as discharge areas, with the exception of the area near the Withlacoochee River. Discharging groundwater in these areas will generally move very slowly due to the low topographic gradient and as suggested by the presence of marshes around Tenmile Creek and Spring Run. Therefore, groundwater discharges to these areas are not likely to significantly affect groundwater flow directions from the LNP site. However, the Withlacoochee River and Cross Florida Barge Canal have the potential to provide substantial drainage of the Upper Floridan aquifer and therefore affect groundwater flow directions from the LNP site. Supporting Information: Figure 1 – Recharge and Discharge Areas of the Floridan Aquifer System **NRC Comments:** **Add some clarification to the FSAR regarding groundwater discharge areas.**	M. McBride RAI 2.4.12-09
44.	2.4.12.2.2	**Vertical gradients (Table 2.4.12-209) are calculated using five different combinations of the top, bottom, and midpoint of the pair of screens. Please provide an SME to discuss (1) which of these calculated gradients is most relevant to evaluating groundwater conditions at the site, and (2) whether presenting more than one calculated gradient is meaningful.**	M. McBride RAI 2.4.12-10

		Applicant Response: The SME believes vertical gradients calculated from the midpoint of the nested well pair screens are most relevant to evaluating groundwater conditions at the site. Presenting more than one calculated gradient is not necessary, because the wells have relatively short screens. An explanation concerning the calculation of vertical gradients using the EPA On-line Vertical Gradient Calculator between multiple points along well screens is provided at the website: http://www.epa.gov/athens/learn2model/part-two/onsite/vgradient02.htm Supporting information: 1) LNP FSAR Table 2.4.12-209 – "Summary of Groundwater Vertical Gradients within the LNP Site" 2) EPA On-line Vertical Gradient Calculator website **NRC Comments:** **Clarify by describing most conservative estimate of vertical gradient in update to FSAR**	
45.	2.4.12.2.2	**Please provide an SME to discuss the interpretation of vertical groundwater gradients, with particular reference to (1) p. 2.4-73, which states that the LNP site is "in a transitional area between upward and downward vertical gradients" on account of the low magnitudes of the vertical gradients, and (2) Table 2.4.12-209, in which the gradients are without exception downward.** **Applicant Response:** According to Floridan aquifer recharge/discharge information available from the Southwest Florida Water Management District's website, the USGS has identified the area where the LNP site is located as a recharge/discharge boundary of the Floridan aquifer (Figure 1). Site-specific vertical gradients observed quarterly from early 2007 through early 2008 were all downward and low in magnitude, ranging from 0.0002 to 0.018 ft/ft (Table 2.4.12-209), suggesting the potential for a reversal of gradient under past or future hydraulic conditions. Supporting information: 1) new Figure 1 – Recharge and Discharge Areas of the Floridan Aquifer System 2) LNP FSAR Table 2.4.12-209 – Summary of Groundwater Vertical Gradients within the LNP Site 3) Reference - http://www.swfwmd.state.fl.us/data/gis/layer_library/category/physical_sparse **NRC Comments:**	M. McBride RAI 2.4.12-11

		Provide clarification of the nature of the vertical gradients based on site data that may override regional maps	
46.	2.4.12.2.3	**Please provide an SME to discuss whether any spatial trend or regularities are evident in the hydraulic conductivities measured by the slug tests. Please have available a map showing the hydraulic conductivities plotted by slug test location to assist with this discussion.** **Applicant Response:** Five new figures were created showing hydraulic conductivities calculated from slug tests in onsite wells. The hydraulic conductivity values (in units of feet per day) vary by an order of magnitude across the site, but do not appear to show any spatial trend for either the surficial or bedrock (Upper Floridan aquifer) wells tested. Hydraulic conductivities in the surficial aquifer (range 0.9 ft/day to 28.6 ft/day) are slightly lower than in the upper bedrock aquifer (range 2.4 ft/day to 54.4 ft/day). Depositional and erosional features associated with each unit and variable well efficiencies are assumed to cause the observed variations in hydraulic conductivity. Supporting information: 1) LNP FSAR Table 2.4.12-210 – "Slug Test Results Data Reduction" 2) Newly created figures: Figure 1 through 5. **NRC Comments:** Address in FSAR that there is no spatial trend and consider use of additional figures; place Figures 1 through 5 in reading room for review.	M. McBride RAI 2.4.12-12
47.	2.4.12.2.3	**Please provide a SME to discuss slug testing results for the Upper Floridan aquifer and their apparent discrepancy with the estimated transmissivity range presented in Section 2.4.12.1.1. Average slug test results indicate transmissivity values that are approximately 30X lower than previously estimated values in the vicinity of the LPN site. The discussion should include an assessment of which values are most representative of actual site conditions.** **Applicant Response:** LNP FSAR Reference 2.4.12-204 states, "Model-derived transmissivities range from 17,000 ft^2/d in the southwest, where the freshwater section of the aquifer system becomes progressively thinner seaward, to nearly 13,000,000 ft^2/d near large springs in the north. Most transmissivities are in the range of 50,000 to 500,000 ft^2/d." This model-derived range of transmissivity estimates were presented in LNP FSAR Subsection 2.4.12.1.1 as general regional transmissitivies and are not site specific. According to the above quote, a transmissivity estimate of 17,000 ft^2/d was used to represent	V. Vermeul RAI 2.4.12-13

the LNP site. However, we recognized that differences in thicknesses of the Upper Floridan aquifer and in hydraulic conductivities may occur across the LNP site.

To measure the site transmissivity, additional aquifer tests were performed in the Upper Floridan during the summer of 2008 at the locations of LNP 1 and 2 (SHAW, Report Number: LNG-G1-X7S-001). Based on these tests, the transmissivity ranges from 41,400 to 211,400 gpd/ft or approximately 5,530 to 28,260 ft^2/d.

Figure 10 from LNP FSAR Reference 2.4.12-204 was used to estimate the thickness in the vicinity of the LNP safety-related structures. As shown on Figure 10, the thickness of the Upper Floridan aquifer is approximately 750 feet. The following tables calculate the transmissivity from slug test results performed in Upper Floridan monitoring wells and assuming an aquifer thickness of 750 feet.

Slug Test Results for Bedrock Wells

Well ID	Test Type	Hydraulic Conductivity (cm/sec)	Hydraulic Conductivity (ft/day)	Assumed Upper Floridan Aquifer Thickness (ft)	Transmissivity (ft^2/day)
MW-6D	In	1.5E-03	4.1	750	3,083
MW-8D	In	1.3E-03	3.8	750	2,849
MW-10D	In	4.1E-03	11.7	750	8,780
MW-12D	In	3.2E-03	9.0	750	6,739
MW-14D	In	8.7E-04	2.5	750	1,854
MW-16D	In	***1.9E-02***	***54.4***	750	***40,819***
OW-5	In	6.7E-03	19.1	750	14,308

Range of transmissivities from slug tests:

Minimum	Mean	Median	Geometric Mean	Maximum
1,854	11,205	6,739	6,629	**40,819**

Well ID	Test Type	Hydraulic Conductivity (cm/sec)	Hydraulic Conductivity (ft/day)	Assumed Upper Floridan Aquifer Thickness (ft)	Transmissivity (ft^2/day)
MW-6D	Out	1.3E-03	3.7	750	2,743
MW-8D	Out	1.3E-03	3.7	750	2,785
MW-10D	Out	3.0E-03	8.4	750	6,314
MW-12D	Out	2.7E-03	7.6	750	5,698
MW-14D	Out	8.3E-04	2.4	750	1,767
MW-16D	Out	1.7E-02	47.9	750	35,929
OW-5	Out	5.8E-03	16.4	750	12,288

Range of Transmissivities from Slug Tests:

Minimum	Mean	Median	Geometric Mean	Maximum
1,767	9,646	5,698	5,775	**35,929**

Results in these tables indicate that the average (mean) slug-test transmissivities are less than the literature value (17,000 ft^2/d), but within the lower range of the estimates derived from aquifer tests conducted in 2008. Also, the 2008 aquifer tests (SHAW, Report Number LNG-G1-X7S-001) showed the Upper Floridan exhibits some vertical variability in K – the deeper portion (250-500 ft bgs) of the Upper Floridan appears to have lower K than the shallower Upper Floridan (50-250 ft bgs).

Note that the average K estimated from slug tests was not used to estimate groundwater velocities in the Upper Floridan aquifer beneath the safety-related structures. To be conservative, the highest recorded hydraulic conductivity (54.4 ft/day) was used (LNP FSAR Table 2.4.12-212). This hydraulic conductivity corresponds to a transmissivity of 40,800 ft^2/d, which is more than the highest transmissivity obtained by aquifer tests. Transmissivity estimates associated with MW-16D (LNP 1) and OW-5 (LNP 2) are assumed to best represent actual site conditions beneath safety-related structures.

Supporting information:

		1) LNP FSAR Reference 2.4.12-204 – Ryder, Paul D., "Hydrology of the Floridan Aquifer System in West-Central Florida," Regional Aquifer-System Analysis, USGS Professional Paper 1403-F, 1985. 2) Report Number: LNG-G1-X7S-001 – "Report on the Ground Water Pumping Tests at the Locations of the Nuclear Islands", SHAW 3) LNP FSAR Table 2.4.12-210 – "Slug Test Results Data Reduction" 4) LNP FSAR Table 2.4.12-212 – "Groundwater Linear Flow Velocity" 5) LNP FSAR Subsection 2.4.12.1.1 **NRC Comments:** Add information in FSAR that is contained in cited report Report Number: LNG-G1-X7S-001, and justify use of numbers provided in summary response above, including use of 750 ft as aquifer thickness. Add information from LNP FSAR Reference 2.4.12-204 concerning use of 17,000 ft^2/d as representative of local conditions.	
48.	2.4.12.2.3	**Please provide an SME to discuss the how the pumping test was conducted and analyzed, including discussion of plots of drawdown against time.** **Applicant Response:** The following describes how the pumping test for the surficial aquifer was conducted: The aquifer test discussed in the FSAR was conducted within the surficial aquifer. Prior to conducting the constant rate test, a step-drawdown test was performed on the pumping well (PW-1). Results from the step-drawdown test were used to determine the maximum sustainable pumping rate during the aquifer test. Following the step-drawdown test, the water level in PW-1 was allowed to stabilize for at least 24 hours. Prior to beginning the aquifer test, water levels in observation wells near the pumping well were measured using a water-level indicator. After completion of the manual measurements, automated data loggers were placed in observation wells MW-13S, MW-14D, and OW-1 through OW-7. These data loggers were in place at least 24 hours before pumping started to record baseline groundwater fluctuations. A transducer was also placed in background monitoring well MW-7S to record changes in barometric pressure and groundwater levels during the pumping test. Manual water-level measurements were collected during the test, and at the conclusion of the test as a check on the data loggers. The aquifer test plan included the following procedures: 1. Drawdown was recorded by data loggers. Automated data loggers were installed in PW-1 and in	M. McBride RAI 2.4.12-14

		MW-13S, MW-14D, OW-1 through OW-7. 2. The pumped groundwater was conveyed through piping approximately 1000 feet down-gradient of the test area. 3. The flow rate remained constant for the entire test duration. An in-line flow meter was used to calculate the flow rate and total discharge. The pump discharge line was fitted with a ball valve to regulate the flow. Flow rates were checked periodically, adjusted as necessary, and recorded in the aquifer test logbook. 4. Once started, the pumping test continued for 72 hours. 5. After 72 hours, the pumping was halted and the recovery phase started. The data loggers were reset to record the water levels at the start of the recovery period. The recovery period lasted until water levels in the pumped well (PW-1) returned to at least 95% of the pre-test level. 6. The aquifer test data were analyzed using AquiferWIN32™ software. The analysis was performed using Neuman (1974) method. During the test, water levels were measured in wells screened in the Upper Floridan and these wells showed some drawdown, however the data were not used in the analysis. Information pertaining to how the pumping test was analyzed, including plots of drawdown against time, is located in LNP calculation package: LNG-0000-X7C-003 - "Calculation for Aquifer Test". The initial evaluation of drawdown data were analyzed using the Neuman (1974) method. Subsequently, an additional analysis using the MLU software was performed with associated information and matching curves provided in Serial number 49. Supporting information: 1) LNG-0000-X7C-003 - "Calculation for Aquifer Test" 2) LNP FSAR Figure 2.4.12-225 – "Aquifer Test Site, Location, and Orientation" **NRC Comments:** Provide additional justification for the approach taken in the FSAR.	
49.	2.4.12.2.3	**Transmissivities were calculated from the pumping test based on the vertical distance from the bottom of the well screen to the water table, rather than on the full thickness of the aquifer. The pumping test was therefore partially penetrating. Please provide an SME to discuss corrections that were made for partial penetration in the analysis of the pumping test.** **Applicant Response:**	M. McBride RAI 2.4.12-14

No corrections were made to the drawdown data because the Neuman (1974) analysis that was used includes the effects of partial penetration in an unconfined aquifer. Unfortunately, the analysis includes only drainage by gravity. In response to this question and #50 the team performed additional analysis of the test data using MLU (http://www.microfem.com/products), a commercial software for analyzing multi-layer aquifer systems.

Description of MLU

MLU (Multi-Layer Unsteady state) is a Windows™ application that can be used for drawdown calculations and inverse modeling (aquifer tests analysis) of transient well flow in layered aquifer systems and stratified aquifers. With MLU one can estimate selected aquifer parameters based on a best fit semi-analytical solution to measured time-distance-drawdown data. The automatic curve-fitting algorithm computes final optimized aquifer parameter data. Unlike other aquifer test analysis software, often supporting a wide variety of different solution types (e.g., Theis, Hantush, Neuman, Boulton, Papadopulos, Moench, etc.) for only one aquifer (or sporadically two), MLU is based on a single hybrid analytical-numerical solution technique for well flow that handles:

- Layered aquifer systems, i.e. multi-aquifer systems (aquifers and aquitards) and/or layered (stratified) aquifers,
- Confined, leaky and delayed yield aquifer conditions,
- Effects of aquifer and aquitard storativities,
- One or more pumping or injection wells,
- One or more pumping periods for each well,
- Finite diameter well screens in any selection of aquifer layers,
- Well bore storage and skin effect for each pumping well,
- Delayed observation well response.

Theoretical background information on the developed and applied analytical solution techniques for multiple aquifer systems has been published in e.g.: Journal of Hydrology 90, p. 231-249 (1987) and 225: p. 1-18 and p. 19-44 (1999). The applied non-linear regression technique is described in **Ground Water** (1985) 23, no.2, p. 247-253.

MLU can analyze data from a variety of tests, including variable discharge tests, recovery tests, step-drawdown tests, complex tests in multiple well fields and slug tests. It also handles partially-penetrating and large-diameter wells, bounded aquifers and double-porosity systems.

Test Evaluation

Well PW-1 was pumped at a nearly constant rate of 26.4 gpm for three days on April 13 through April 16, 2007. Drawdown was measured in 9 monitoring wells, the pumping well, and a "background' monitoring well. The data from all the wells (except the background well MW-7S) were input into MLU. Unlike typical aquifer testing procedures, where the drawdown curve for each well is matched to a type curve, MLU finds the best set of aquifer properties for ALL of the data. For the PW-1 test, drawdown data from 9 wells screened in three different aquifer zones are available. The results presented below show the aquifer properties that best fit all of the 9 drawdown curves. A graphical comparison of the observed and calculated (by MLU) drawdown curves are presented on Figure 1.

Our MLU analysis incorporated the thickness between the bottom of the bedrock monitoring wells and the base of the Upper Floridan. This was done to acknowledge that the bedrock wells are partially penetrating. The results of MLU analysis are summarized below.

	Thickness (ft)	Kh (ft/d)	Kv (ft/d)	T (ft2/d)	Leakance (1/d)	Storativity
surficial	35	29.2		1,022		2.60E-07
			1.36		0.033959	
intermediate zone	45	29.2		1,315		1.00E-04
			0.12		0.002545	
Upper Floridan	50	68.3		3,413		4.20E-08
			0.12		0.000322	
Upper Floridan	700	68.3		47,784		4.20E-08

Our analysis with MLU suggests that the contribution of water to the pumping well from the Upper Floridan was from vertical flow, not horizontal flow. Reruns of MLU showed very little sensitivity to different values of Kh for the Upper Floridan, i.e. the model output produced a reasonable fit to the test results. Our test of the surficial aquifer did not provide enough data to develop a reliable estimate of the Kh of the Upper Floridan. The MLU analysis will be discussed during the meeting.

Supporting information:
1) LNG-0000-X7C-003 - "Calculation for Aquifer Test"
2) MLU analysis data and match curves

NRC Comments:

Provide additional justification for the approach taken in the FSAR to support the position on analysis

		of pumping test.	
50.	2.4.12.2.3	**The pumping test was conducted in the surficial aquifer, which immediately overlies the Avon Park formation. Therefore the usual assumption that the aquifer is bounded below by an impermeable layer is invalid. Please provide an SME to discuss how this circumstance was accounted for in the analysis of the pumping test.** **Applicant Response:** The Neuman (1974) analysis assumes that vertical leakage occurs within the water table during the aquifer test. However, this method does not discriminate between upper leakage and downward leakage. Results from this analysis are provided in LNP FSAR Subsection 2.4.12.2.3. In response to these questions, we conducted additional analysis of the surficial aquifer test results using MLU (Multi-Layer Unsteady state) (http://www.microfem.com/products). MLU is able to estimate leakage from layers above and below the pumping layer. A description of the MLU analysis is provided in Serial number 49 and will be discussed during the meeting. Supporting information: 1) LNG-0000-X7C-003 - "Calculation for Aquifer Test" **NRC Comments:** Provide additional justification for the approach taken in the FSAR to support the position on analysis of pumping test, as discussed in Serial 49.	M. McBride RAI 2.4.12-14
51.	2.4.12.2.3	**Please provide an SME to discuss the hydraulic conductivities that correspond to the transmissivities reported in Table 2.4.12-211.** **Applicant Response:** Hydraulic conductivities that correspond to the transmissivities reported in LNP FSAR Table 2.4.12-211 are presented below.	M. McBride RAI 2.4.12-14

Surficial Aquifer Thickness Beneath the LNP Safety-related Structures

Bore-hole Number	**Depth to Top of Rock (ft)**	**Bore-hole Number**	**Depth to Top of Rock (ft)**	**Bore-hole Number**	**Depth to Top of Rock (ft)**	**Bore- hole Number**	**Depth to Top of Rock (ft)**
A-01	49	A-22A	46	B-20	81.5	E-07	70

A-02	56.5	A-23	55	B-21	82	E-08	70
A-03	43.5	A-24	61.8	B-22	80	GSC-02	51
A-04	55	A-24A	61.5	B-23	70.5	GSC-03	90
A-05	58	B-01	80	B-24	55	GSC-04	85
A-06	58.5	B-02	55.5	B-25	65	GSC-05	41
A-07	76	B-03	60	B-26	94.5	GSC-06	61.5
A-08	66	B-04	136	B-27	51	GSC-07A	56
A-09	38.5	B-04A	75	B-28	65	GSC-08	85
A-10	62	B-05	91	B-29	61	GSC-08A	77
A-11	35.5	B-06	66.5	B-30	70	GSC-09	80
A-12	45	B-07	137.5	B-30A	34	GSC-10	66
A-13	55	B-07A	125	D-01	76	GSC-11	109
A-14	66.2	B-08	51	D-02	35	GSC-12	85
A-14A	66	B-09	66	D-03	32	CT-01	86
A-15	40	B-10	61.5	D-04	60	CT-02	31.5
A-16	46	B-11	66.5	D-05	40.7	CT-03	35.5
A-17	51	B-12	60	D-06	36	CT-04	35
A-18	35.7	B-13	45	E-01	41	CT-05	45
A-18A	35.5	B-14	26	E-02	51	CT-06	71.5
A-19	56	B-15	61	E-03	60	CT-07	45
A-20	55	B-16	56	E-04	61.5	CT-08	41.5
A-21	49.6	B-17	51.5	E-05	95.5	IT-01	75
A-21A	50	B-18	46	E-06	81	IT-02	91
A-22	45.7	B-19	61.5				

Data from LNP FSAR Table 2.5.4.2-207

Minimum (ft)	Mean (ft)	Median (ft)	Geometric Mean (ft)	Maximum (ft)
26	**62**	**60**	**59**	**138**

LNP FSAR Table 2.4.12-211 Transmissivities

Minimum (ft^2/day)	Maximum (ft^2/day)
1300	**2200**

Hydraulic Conductivities Corresponding to the Aquifer Test Transmissivities (ft/day)

	Surficial Aquifer Thickness (ft)				
	Minimum	Mean	Median	Geometric Mean	Maximum
	26	62	60	59	138
Trans. (ft^2/day)	**Calculated K**				
1300	**50**	**21**	**22**	**22**	**9**
2200	**85**	**36**	**37**	**38**	**16**

Based on data from 98 borings located at LNP 1 and LNP 2, hydraulic conductivities corresponding to LNP FSAR Table 2.4.12-211 range from 9 to 85 ft/day with an average ranging from 21 to 36 ft/day.

Supporting information:
1) LNP FSAR Table 2.5.4.2-207 – "Estimated 'Top of Rock'"
2) LNP FSAR Table 2.4.12-211 – "Aquifer Test Results Data Reduction"
3) LNP FSAR Figure 2.5.4.2-201A – "Borehole Locations at LNP 1 & 2"

NRC Comments:

Summarize methodology and results of the calculations in this discussion in the FSAR and compare with results from MLU analysis, if presented.

52. 2.4.12.2.3

Please provide an SME to discuss selection of the hydraulic conductivity estimates used in the seepage velocity calculations, and whether these represent conservative estimates of groundwater velocity (e.g., use of the transmissivity estimate for the Upper Floridan aquifer presented in Section 2.4.12.1.1 would result in a groundwater velocity of more than 1 ft/d).

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RAI 2.4.12-15

Applicant Response:

The hydraulic conductivity estimates for the surficial and Upper Floridan aquifer used in the seepage velocity calculations as shown in LNP FSAR Table 2.4.12-212 are addressed below. Each aquifer is discussed separately.

Surficial Aquifer

LNP FSAR Reference 2.4.12-204 states, "The surficial deposits generally consist of sand, clayey sand, shell, and shelly marl. The thickness of the deposits was mapped for most of the study area by Wolansky, Spechler, and Buono (1979). The thickness ranges from nearly zero in the north (fig.3) to

		greater than 100 ft in southeastern Levy, eastern Sumter, eastern Hardee, and northeastern DeSoto Counties. The deposits are generally saturated to within a few feet of land surface in the south. North of Hillsborough and Polk Counties, the water table is progressively deeper below land surface. Here, the surficial deposits are thin and discontinuous over large areas. The transmissivity of the surficial aquifer varies according to saturated thickness and lithology. R. M. Wolansky (U.S. Geological Survey, written commun., 1980) reported five values of transmissivity for the surficial aquifer – an average of 205 ft^2/d at two sites in northwest Hillsborough County; 1,800 ft^2/d in southeast Hillsborough County; 270 ft^2/d in northeast Sarasota County; and 880 ft^2/d in southwest DeSoto County. Hutchinson (1978, p.22) reported a transmissivity of 2,200 ft^2/d for a site in southern Polk County. Wilson (1977, p.28) estimated an average transmissivity of about 1,100 ft^2/d for DeSoto and Hardee Counties." The descriptions above are presented as part of a regional study performed by the USGS and are not site specific. However, according to the above quote, a **surficial aquifer thickness of greater than 100 feet** would represent the LNP site which is located in southeastern Levy County. Also, **surficial aquifer transmissivities could range from 205 to 2,200 ft^2/d**. Using the information from the regional study, **hydraulic conductivities** for the surficial aquifer could range between **2.1 and 22 ft/day**. This range is similar to the range of hydraulic conductivities developed from tests and boring data from the LNP site. Site specific hydraulic conductivities for the surficial aquifer are presented in LNP FSAR Tables 2.4.12-210 and 2.4.12-211. Hydraulic conductivities presented in LNP FSAR Table 2.4.12-210 range from **0.9 to 28.6 ft/day** with an **average of 9.2 ft/day**; hydraulic conductivities corresponding to LNP FSAR Table 2.4.12-211 range from **9 to 85 ft/day** with an **average ranging from 21 to 36 ft/day**. The surficial aquifer K value used in LNP FSAR Table 2.4.12-212 is **28.6 ft/day,** a conservative estimate for the entire LNP site. The chosen K is greater than estimates provided in the USGS regional study, equal to the highest value from all slug tests across the LNP site, and in the range estimated from analysis of the onsite surficial aquifer test. The applicability of this K value will be discussed during the meeting. Please see Serial Numbers 46 and 51 for more information. ***Upper Floridan aquifer*** Serial Number 47 discusses slug testing results for the Upper Floridan aquifer. The K value for the Upper Floridan aquifer used in LNP FSAR Table 2.4.12-212 is **54.4 ft/day,** a conservative estimate for the entire LNP site. The chosen K is greater than an estimated hydraulic	

		conductivity of **23 ft/day** (calculated from the estimated transmissivity of 17,000 ft^2/d provided in the USGS regional study and greater than the K of **37.7 ft/day** calculated from the transmissivity of 28,260 ft^2/d estimated from the onsite Upper Floridan aquifer tests [Report Number: LNG-G1-X7S-001]). The applicability of this K value will be discussed in the meeting. Supporting information: 1) LNP FSAR Reference 2.4.12-204 – Ryder, Paul D., "Hydrology of the Floridan Aquifer System in West-Central Florida," Regional Aquifer-System Analysis, USGS Professional Paper 1403-F, 1985. 2) LNP FSAR Table 2.4.12-210 – "Slug Test Results Data Reduction" 3) LNP FSAR Table 2.4.12-211 – "Aquifer Test Results Data Reduction" 4) LNP FSAR Table 2.4.12-212 – "Groundwater Linear Flow Velocity" 5) Report Number: LNG-G1-X7S-001 – "Report on the Ground Water Pumping Tests at the Locations of the Nuclear Islands", SHAW **NRC Comments:** Provide additional justification for the approach taken in the FSAR to support the position on analysis of pumping test, as discussed in Serial 49.	
53.	2.4.12.2.3	**Please provide an SME to discuss how effective porosity values used in the evaluation are representative of conditions in the carbonate rock aquifer and what implications lower values would have seepage velocity calculations.** **Applicant Response:** An effective porosity value of **0.15** for carbonate rock was used to calculate seepage velocities in LNP FSAR Table 2.4.12-212. Calculation LNG-0000-X7C-006, Rev0 explains the chosen value: "The seepage velocity and Darcy flux estimates for the bedrock aquifer were calculated using an effective porosity of **0.15**. The effective porosity of **0.15** chosen based on area specific data referenced from the Groundwater Protection and Siting Ordinance Hernando County, FL. The use of the effective porosity of **0.15** was also validated in **Radiological Assessment** (1993) which gave an arithmetic mean of **0.14** for limestone and in the **Principles of Groundwater Engineering** (1991) which suggest an effective porosity range of **0.01 to 0.25** for limestone." Depositional and erosional features associated with the LNP site and surrounding area may cause spatial and vertical variations in effective porosity; however, based on area specific data, an effective porosity for carbonate rocks of **0.15** is considered conservative for the entire LNP site. For the meeting, we calculated maximum seepage velocities assuming lower and higher values of effective porosity using appropriate data from LNP FSAR Table 2.4.12-212. Note that the calculations	V. Vermeul RAI 2.4.12-16

below are based on the maximum hydraulic conductivity (54.4 ft/day) derived from site specific aquifer (slug) tests.

Groundwater Linear Flow Velocity in the Upper Floridan Aquifer

Monitoring Wells			Water Level Gauging Date	Effective Porosity [n_e]	Seepage Velocity [v_x] (feet/day)	Effective Porosity [n_e]	Seepage Velocity [v_x] (feet/day)
MW-6D	-	MW-8D	6-Mar-07	0.05	**0.5**	0.10	**0.3**
MW-12D	-	MW-8D	6-Mar-07	0.05	**0.6**	0.10	**0.3**
MW-12D	-	MW-16D	6-Mar-07	0.05	**0.7**	0.10	**0.4**
MW-6D	-	MW-8D	14-Jun-07	0.05	**0.4**	0.10	**0.2**
MW-12D	-	MW-8D	14-Jun-07	0.05	**0.6**	0.10	**0.3**
MW-12D	-	MW-16D	14-Jun-07	0.05	**0.8**	0.10	**0.4**
MW-6D	-	MW-8D	13-Sep-07	0.05	**0.5**	0.10	**0.2**
MW-12D	-	MW-8D	13-Sep-07	0.05	**0.6**	0.10	**0.3**
MW-12D	-	MW-16D	13-Sep-07	0.05	**0.7**	0.10	**0.4**
MW-6D	-	MW-8D	4-Dec-07	0.05	**0.4**	0.10	**0.2**
MW-12D	-	MW-8D	4-Dec-07	0.05	**0.6**	0.10	**0.3**
MW-12D	-	MW-16D	4-Dec-07	0.05	**0.8**	0.10	**0.4**
					Minimum		**Minimum**
					0.4		0.2
					Maximum		**Maximum**
					0.8		0.4
					Mean		**Mean**
					0.6		0.3

Monitoring Wells	Water Level Gauging Date	Effective Porosity [n_e]	Seepage Velocity [v_x] (feet/day)	Effective Porosity [n_e]	Seepage Velocity [v_x] (feet/day)

MW-6D	-	MW-8D	6-Mar-07	0.15	**0.2**	0.20	**0.1**
MW-12D	-	MW-8D	6-Mar-07	0.15	**0.2**	0.20	**0.1**
MW-12D	-	MW-16D	6-Mar-07	0.15	**0.2**	0.20	**0.2**
MW-6D	-	MW-8D	14-Jun-07	0.15	**0.1**	0.20	**0.1**
MW-12D	-	MW-8D	14-Jun-07	0.15	**0.2**	0.20	**0.1**
MW-12D	-	MW-16D	14-Jun-07	0.15	**0.3**	0.20	**0.2**
MW-6D	-	MW-8D	13-Sep-07	0.15	**0.2**	0.20	**0.1**
MW-12D	-	MW-8D	13-Sep-07	0.15	**0.2**	0.20	**0.1**
MW-12D	-	MW-16D	13-Sep-07	0.15	**0.2**	0.20	**0.2**
MW-6D	-	MW-8D	4-Dec-07	0.15	**0.1**	0.20	**0.1**
MW-12D	-	MW-8D	4-Dec-07	0.15	**0.2**	0.20	**0.1**
MW-12D	-	MW-16D	4-Dec-07	0.15	**0.3**	0.20	**0.2**
					Minimum		**Minimum**
					0.1		0.1
					Maximum		**Maximum**
					0.3		0.2
					Mean		**Mean**
					0.2		0.2

The calculations show the maximum estimated seepage velocity for the site is 0.8 ft/day. This value is only 0.5 ft/day more than the maximum seepage value calculated using an effective velocity of 0.15. We believe these differences are insignificant for safety calculations.

Supporting information:
1) Calculation LNG-0000-X7C-006, Rev0 – "Groundwater Velocity and Flux Calculations"
2) LNP FSAR Table 2.4.12-210 – "Slug Test Results Data Reduction"
3) LNP FSAR Table 2.4.12-212 – "Groundwater Linear Flow Velocity"
4) LNP FSAR Reference 2.4.12-204 – Ryder, Paul D., "Hydrology of the Floridan Aquifer System in West-Central Florida," Regional Aquifer-System Analysis, USGS Professional Paper 1403-F, 1985.

NRC Comments:

Place supporting information (pertinent references from calculations) in the reading room for NRC review.

54.	2.4.12.2.3	**Please provide an SME to discuss the use of a porous media concept for estimating seepage**	V. Vermeul

		velocity and whether preferential flow paths associated with fracturing and solution cavities in carbonate rock aquifers should be considered when developing conservative estimates of groundwater velocity. **Applicant Response:** The lack of springs in the vicinity of the site indicates an immature karst system. This suggests that the bedrock acts as porous media rather than conduit flow system. Supporting information: 1) Quinlan, J., Groundwater Monitoring in Karst Terranes, EPA 600/X-89/050. Additional references to be determined **NRC Comments:** Provide references in reading room RAI	RAI 2.4.12-17
55.	2.4.12.2.4	**The SWFWMD estimated that, in 2005, a total of 7.677 mgd of water was used within its portion of Levy County. The LNP would use between 1.269 mgd and 5.848 mgd (from 17% to 76% of this total), and this pumping would be concentrated in a small area. Please provide an SME to discuss the potential effects of this pumping on groundwater levels, surface water, and other water users in the affected area.** **Applicant Response:** As stated on LNP FSAR page 2.4-74, as of 2005, the Southwest Florida Water Management District (SWFWMD) had permitted approximately 21.956 mgd of nondomestic groundwater use in that portion of Levy County that falls within the SWFWMD. In 2005, the SWFWMD estimates that approximately only 7.677 mgd of the permitted capacity was used. The LNP site would use an average of 1.269 mgd and a maximum of 5.848 mgd of groundwater (an average of 6% of 2005 permitted capacity and a maximum of 27% of 2005 permitted capacity). Accounting for LNP site water use, the total water use in that portion of Levy County that falls within the SWFWMD would still be less than 14 mgd, approximately 8 mgd less than the permitted capacity in 2005. SWFWMD requires that applicants for Water Use Permits evaluate the potential effects of pumping on groundwater and surface water levels and water users. The effects of pumping up to 21.956 mgd of groundwater from that portion of Levy County that falls within the SWFWMD have already been evaluated and deemed acceptable by the SWFWMD.	M. McBride RAI 2.4.12-18

		NRC Comments: Clarify discussion in the FSAR.	
56.	2.4.12.2.4	**Please provide an SME to discuss why dewatering for excavation is expected to have minimal effects on groundwater.** **Applicant Response:** An SME will be provided to discuss why dewatering for excavation is expected to have minimal effects on groundwater. **NRC Comments:** **Combined with item no 35.**	M. McBride RAI 2.4.12-02
57.	2.4.12.4	**Please provide an SME to discuss substantive content of the four monitoring programs identified here. Possible subjects for discussion include possible locations for monitoring wells and surface water sampling points, field measurements during sampling, sample analytes, sampling schedule, and how results will be interpreted.** **Applicant Response:** Details for the LNP monitoring programs as described in LNP FSAR Subsection 2.4.12.4 are provided in LNP ER Chapter 6. **NRC Comments:** NRC staff to review ER Chapter 6.	M. McBride RAI 2.4.12-20
58.	2.4.12.5	**Please provide an SME to discuss historical groundwater elevations at the site and the expected impacts of construction on surface recharge and groundwater elevations at the site. Discussions should include impacts associated with altered surface conditions, stormwater drainage ditches, and retention ponds.** **Applicant Response:** Historical groundwater elevations for the site are discussed in Serial Number 41.	V. Vermeul RAI 2.4.12-21

		Details for the expected impacts of construction on surface recharge and groundwater elevations at the site are provided in LNP ER Chapter 5. Discussion was held regarding why groundwater elevations are not an issue with regard to DCD requirements post-construction, citing impervious areas, drainage, design within diaphragm walls, elevated grade above current grade level. **NRC Comments:** Clarify in the FSAR why groundwater elevation is not an issue with regard to safety. Also clarify in 2.4.12 the post-construction groundwater pathway that is used in the analysis in 2.4.13.	
59.	2.4.12.5	**Please provide an SME to discuss how the process employed for the site maximum groundwater elevation assessment is the most conservative plausible conceptual model.** **Applicant Response:** As stated on LNP FSAR pages 2.4-72 and 2.4-73: 1) Groundwater elevation measurements were collected at monitoring wells installed in the surficial and Upper Floridan aquifers and located within and around the footprint of safety-related structures. These measurements thereby take into account spatial variability (both horizontal and vertical) in groundwater elevations at safety-related structures. 2) Groundwater elevation measurements were collected quarterly at all monitoring wells and twice daily at surficial aquifer monitoring wells installed within the footprint of safety-related structures between March 2007 and March 2008. These measurements thereby take into account the temporal variability in groundwater elevations at safety-related structures. In addition, historical groundwater elevation data were downloaded from the USGS website for four Floridan aquifer wells located near the LNP site. Groundwater elevation data were not available from the USGS website for surficial aquifer wells near the LNP site; however, the surficial and Floridan aquifers are hydraulically connected at the LNP site. The average groundwater elevation recorded from March 2007 through March 2008 at three of the four Floridan aquifer wells was within one foot of the historical average groundwater elevation recorded at these wells (up to a 44 year record). The average groundwater elevation recorded from March 2007 through March 2008 at the fourth Floridan aquifer well was within approximately 3 feet of the historical average groundwater elevation recorded at this well (27 year record). As stated on LNP FSAR page 2.4-73, groundwater elevations observed at the LNP site are more than seven feet below the nominal plant grade elevation and more than eight feet below the nominal plant floor elevation. Therefore, future long-term variations in groundwater	V. Vermeul RAI 2.4.12-00

		elevation are not expected to significantly alter the average groundwater elevation observed at the LNP site during 2007 and 2008. Supporting Information: 1) See Figure 1 – Locations of USGS-monitored Wells near the LNP Site 2) See Figure 2 – Historical Groundwater Elevation Data near the LNP Site **NRC Comments:** See Serial 58 comments.	
60.	2.4.13.2	**Please provide an SME to discuss the total thickness of the Floridan Aquifer (and in particular the Upper Floridan) at the site. The thickness of the Floridan Aquifer is described as being more than 250 ft on p. 2.4-79, 3rd paragraph. However, Figure 2.5.1-250 shows a thickness of more than 345 ft for the Avon Park Formation alone.** **Applicant Response:** On LNP FSAR page 2.4-79, the productive interval of the Floridan aquifer is described as being at least 250 feet thick. On LNP FSAR page 2.4-68 it is stated that the deep AD-series borings at the site were drilled to depths of approximately 500 feet bgs and did not encounter the confining unit between the Upper and Lower Floridan aquifers, indicating that the Upper Floridan aquifer is at least 400 to 450 feet thick at the LNP site (depending on the thickness of the surficial aquifer). LNP FSAR Figure 2.5.1-250 supports this statement by showing the geology encountered by the on-site borings and identifying the thickness of the Avon Park Formation of the Upper Floridan aquifer as 300 to 375 feet thick. Since the bottom of the upper Floridan aquifer was not reached in any onsite boring from ground surface to a depth of 500 feet bgs, the exact thickness of the upper Floridan aquifer is not known at the site. To better understand the thickness of the upper Floridan aquifer, Figure 10 from LNP FSAR Reference 2.4.12-204 was used to estimate the thickness in the vicinity of the LNP safety-related structures. As shown on Figure 10, the thickness of the upper Floridan aquifer is **approximately 750 feet**. Supporting Information: 1) LNP FSAR Figure 2.5.1-250 – "Generalized Section Showing Stratigraphic Units at the LNP Site" 2) Figure 10 from LNP FSAR Reference 2.4.12-204 – Ryder, Paul D., "Hydrology of the Floridan Aquifer System in West-Central Florida," Regional Aquifer-System Analysis, USGS Professional Paper 1403-F, 1985. **NRC Comments:**	M. McBride RAI 2.4.13-01

		Clarify the discussion in the FSAR.	
61.	2.4.13.2	**Please provide an SME to discuss the impacts of the proposed groundwater withdrawals from the Upper Floridan aquifer on the potentiometric surface and whether contaminants are still expected to flow away from the water supply wells (p. 2.4-79, 3rd paragraph) under pumping conditions (i.e., will the release fall outside the capture zone of the LNP water supply wells).** **Applicant Response:** An SME will be provided to discuss the impacts of the proposed groundwater withdrawals from the Upper Floridan aquifer on the potentiometric surface and whether contaminants are still expected to flow away from the water supply wells under pumping conditions. **NRC Comments:** See Serial 38, and clarify the impact on potential transport to the wellfield in the FSAR.	V. Vermeul RAI 2.4.13-02
62.	2.4.13.2	**Please provide an SME to discuss why assuming a release to the top of the Floridan Aquifer is conservative (p. 2.4-79, 5th paragraph). In particular, we would like to discuss whether a release to the surficial aquifer could discharge to surface water, including marshes or ditches at LNP, closer than the nearest well, which the analysis assumes to be the nearest point of exposure.** **Applicant Response:** <u>LNP FSAR Subsection 2.4.12.1.2</u> states the site is relatively level with no rivers, streams, or major drainage features on-site. There are some wetlands on-site consisting mostly of cypress swamps and depressional marshes. These wetlands provide recharge to the surficial and Floridan aquifers. <u>LNP ER Subsection 2.4.1.1</u> indicates the on-site cypress swamps and wetland marshes are poorly drained with water standing at or above ground surface much of the year. These swamps and marshes are for the most part isolated basins in stands of planted pine. The possible addition of small amounts of percolated contaminated groundwater is not significant since it ultimately goes to recharge with any collected precipitation or water. In any event, the waters are largely constrained to isolated basins and are not used as a private water supply. <u>LNP FSAR Figure 2.4.1-205</u> shows that the bottom of the drainage ditches are above elevation 42.5 feet NAVD88 in the expected direction of contaminated groundwater flow. <u>LNP FSAR Figures 2.4.12-223 and -224</u> provide groundwater surface levels measured continuously over a one year period in two LNP test wells, each in the center of the nuclear islands. The data show the groundwater surface is consistently below elevation 41 feet NAVD88 except for brief increases to about an elevation of 42 feet NAVD88 in the spring.	M. McBride RAI 2.4.13-03

		Discussion was held regarding discussion on p. 2.4-79, 5th paragraph, and a figure was presented showing groundwater level contours with and without LNP withdrawal. **NRC Comments:** Clarify the discussion in the FSAR including the potential impacts of uncertainty in hydraulic parameters. Provide the groundwater level countours figure in reading room.	
63.	2.4.13.2.1	**Please provide an SME to discuss whether use of the one-dimensional advection-dispersion equation for solute transport in porous media, and the assumption of complete mixing over the full aquifer thickness, represents a conservative approach for modeling radionuclide transport in this carbonate rock aquifer.** **Applicant Response:** LNP FSAR Table 2.4.12-212 seepage velocities were based on Darcy fluxes. Advection-dispersion equation (ADE) models are acceptable when the seepage velocities and hydraulic conductivities are based on Darcian flow through the aquifer rock. Darcian flow is accepted for porous and fractured media including limestone. Gelhar and Schulze-Makuch in their separate reviews of dispersivity do not dispute the validity of using the ADE to characterize dispersivity from field or test concentrations for porous and fracture media. In particular, Schulze-Makuch observes that heterogeneities such as fractures, vugs, and conduits in carbonates increase the dispersivity relative to the matrix medium alone. Darcian conditions may not exist in limestone if flow in large conduits becomes significantly great. A typical conceptual model consists of a lower permeable matrix with water moving through smaller conduits to larger ones and then releasing at springs. Within this model, two major types of flow can occur. Conduit flow is characteristic of spring and cave spring flow. The flow is usually turbulent. Diffuse flow is indicative of less developed karstic systems with poorly integrated pores, joints, and tubes. The flow is laminar and Darcy's law holds (Quinlan). The turbidity of groundwater springs after large storms or precipitation is an expeditious way of differentiating between the two types of flows in carbonate aquifers. LNP FSAR Section 2.4.12.1.2 stated that the geo-hydrological investigations at the site identified no streams or other major drainage features, such as springs. Based on the lack of springs, the flow at the LNP site appears to be more diffuse and Darcian models can be accepted. A unidirectional model in the direction of flow is used to calculate the maximum receptor dose. Any	V. Vermeul RAI 2.4.13-04

		receptor positioned outside of the postulated flow path will have smaller maximum radionuclide concentrations at the same distance from the spill. <u>LNP FSAR Section 2.4.13.2</u> states the productive thickness of the Floridan aquifer is at least 250 feet. This value is less than the full aquifer's thickness, but comparable to actual residential well depths near the site. <u>LNP FSAR Section 2.4.12.1.2</u> identifies the first 100 to 300 feet bgs as the most productive region of the aquifer. <u>LNP FSAR Section 2.5.4</u> describes boring activities that did not encounter the MCU to a depth of 500 feet bgs. Therefore, the upper Floridan aquifer is greater than 500 feet deep beneath the LNP site. <u>LNG-0000-GLC-003, Table 2</u>, identifies public water supply wells near the site. Several wells were 230 to 250 feet bgs. <u>LNG-0000-GLC-003, Table 5</u>, shows the radionuclide concentration can be considered mixed over the 250-foot thickness at 2 km from the spill. A mixed release is defined in NUREG/CR-3332 as within 10% of being vertically mixed in the assumed thickness (i.e., 250 ft used here, not the full aquifer thickness). Supporting Information: 1) <u>Gelhar, L., et al,</u> A Critical Review of Data on Field-Scale Dispersion in Aquifers, Water Resour Res., vol 28, no 7, pp 1955-1974. 2) <u>Schulz-Makuch, D.</u>, Longitudinal Dispersivity Data and Implications for Scaling Behavior, Groundwater, vol 43, no. 3, pp 443-456. 3) <u>Quinlan, J.</u>, Groundwater Monitoring in Karst Terranes, EPA 600/X-89/050. 4) <u>LNG-0000-GLC-003</u>, Evaluation of Liquid Radwaste Tank Failure. 5) <u>NUREG/CR-3332</u>, Radiological Assessment – A textbook on Environmental Dose Consequences. **NRC Comments:** Clarify the FSAR to address that the release begins as a point source at the top of the Floridan aquifer, and verify contaminant was well-mixed in the aquifer at the location of the receptor well, in the calculation.	
64.	2.4.13.2.1	**Please provide an SME to discuss the software used to evaluate the model described in this section, and in particular the validation and verification of this software.** **Applicant Response:** The results are calculated in EXCEL as part of an engineering calculation package. The calculation was performed and design verified in accordance with the WorleyParsons nuclear quality program	M. McBride Placeholder RAI 2.4.13-05

		procedures in effect for Joint Venture Team's support of PEF's LNP COLA. Supporting Information: 1) LNG-0000-GLC-003, Evaluation of Liquid Radwaste Tank Failure. **NRC Comments:** Place supporting calculation in the reading room	
65.	2.4.13.2.1	**Please provide an SME to discuss the sources of the model parameters listed in Table 2.4.13-203.** **Applicant Response:** Hydraulic conductivities are maximum surficial and Floridan aquifer values. The data appear in LNP FSAR Table 2.4.12-210 from the on-site measurements described in LNP FSAR Subsection 2.4.12. LNP FSAR Table 2.4.12-212 is the source of the effective porosities. LNP FSAR Table 2.4.12-212 is the source of the maximum head gradients. Seepage velocities in LNP FSAR Table 2.4.13-203 use maximum K, maximum dh/dl, and effective porosities for surficial and Floridan aquifers. All values are from LNP FSAR Table 2.4.12-212. LNP FSAR Table 2.4.12-201 is the source for the bulk soil density. Floridan density is based on the range of limestone densities in Walton, Principles of Groundwater Engineering. LNP FSAR Section 2.4.13.2.2 gives the basis of the Kd for Cs and Sr. LNP FSAR Section 2.4.13.2.2 gives the basis for the minimum dispersivity. Transport times were calculated for the tabulated transport distance to the well and river receptors. (The distance used is shown immediately above the Kd values in LNP FSAR Table 2.4.13-203). The transport (advective) time uses the seepage velocity and the retardation factor. The retardation factor is defined in LNP FSAR Equation 2.4.13-2. To clarify LNP FSAR Table 2.4.13-203, consider the well 2 km from a spill for the Floridan aquifer shown in the second column: Kd = 1 ml/g for Sr, ρ = 2.4 g/cc, n_e = 0.15, Therefore, Rd = (1 + ρ/n_e Kd) = 17. Seepage velocity is U = 0.26 ft/d (or U = 0.08m /d). Transport time = 2 km / U*Rd = 425,000 d or ~1200 y as shown. The other transport times are developed similarly in the table. **NRC Comments:** Clarify FSAR sources of information provided in Table 2.4.13-203.	M. McBride RAI 2.4.13-06

66.	2.4.13.2.1	**Please provide an SME to discuss (1) the flow paths that are assumed in this discussion of radionuclide transport and (2) the shape and extent of the calculated radionuclide plume resulting from the transport processes.** **Applicant Response:** LNP FSAR Figure 2.4.12-213 shows that the nearest private wells are WSW (1.7 mi) and SW (2 mi). LNP FSAR Table 2.4.12-206 gives the distances from the nearest private wells to LNP. LNP FSAR Figures 2.4.12-216, -218, and -220 show groundwater flow within the Upper Floridan aquifer is SW; LNP FSAR Figure 2.4.12-222 shows groundwater flow is WSW. LNP FSAR Subsection 2.3.14.2 (last 2 paragraphs) describes the cases examined: (1) A hypothetical, nearby well located on the site boundary to obtain a bounding (max) concentration for all public and private well users. Distance to the well is 2 km. (2) The Lower Withlacoochee River although there is no public or private use of the river as a supply of potable water. Distance to the river is 7 km. The well and river locations are in the same direction (SW) as groundwater flow. Straight line flow paths to both locations are used to maximize concentrations. The concentrations positioned to either-side of the straight-line flow path are Gaussian-distributed with the maximum concentrations occurring along the centerline. LNP FSAR Section 2.4.13.2.1 discusses the activity entering the river. Here the maximum rate of radionuclide activity crossing an infinite plane at the river is first calculated (i.e., 7 km from the spill and at right angles to the groundwater flow). The activity crossing the plane is integrated over the entire (infinite) plane to determine the total rate activity enters the river (see LNP FSAR Equation 2.4.13-5). The distribution at the river edge is unimportant since all activity is assumed to enter the river. **NRC Comments:** Resolved.	M. McBride
67.	2.4.13.2.2	**Please provide an SME to discuss how arrival times for the surficial aquifer shown in Table 2.4.13-203 were calculated, given that the radionuclide release was assumed to occur at the top of the Floridan Aquifer rather than in the surficial aquifer.** **Applicant Response:** The surficial aquifer arrival times were calculated in the same manner as the Floridan aquifer. The	M. McBride

		times were provided in LNP FSAR Table 2.4.13-203 for both aquifers with the intent of demonstrating transport through the Upper Floridan aquifer could reach the Lower Withlacoochee River before a similar release in the surficial aquifer. Of particular interest was the comparison of the travel times without retardation. Consider a transport distance of 7 km through the surficial aquifer as shown in LNP FSAR Table 2.4.13-203. With respect to the table: Kd = 2 ml/g for Sr, ρ = 1.4 g/cc, n_e = 0.20, Therefore, Rd = (1 + ρ/n_e Kd) = 15. Seepage velocity is U = 0.15 ft/d (or U = 0.05m/d). Transport time = 7 km / U*Rd = 2.1E6 d or ~5700 y as shown. **NRC Comments:** Resolved	
68.	2.4.13.2.2	**p. 2.4-83, 1st paragraph: Please provide an SME to discuss the variation in radionuclide concentrations with time at the Withlacoochee River and the location of the nearest resident, and in particular the time at which the first detectable concentrations of radionuclides are modeled as reaching these locations.** **Applicant Response:** LNP FSAR Subsection 2.4.13.2.3 shows the maximum radionuclide concentrations for well and river locations. The acceptance criteria used for groundwater radiological analyses is to meet the annual dose limits to an unrestricted member of the public in 10CFR20, Appendix B, Table 2. LNP FSAR Tables 2.4.13-204 and -205 show the maximum concentrations at the river and well meet 10CFR20, Appendix B, criteria. Radionuclide concentrations at any other time are less than the maximum values in LNP FSAR Tables 2.4.13-204 and -205. Therefore, 10CFR20, Appendix B limits are also satisfied for all other times: the time-dependent distribution is not important to demonstrating compliance to the acceptance criteria when maximum concentrations are used. LNG-0000-GLC-003, Figures 1 and 2, shows the tritium concentrations in the river and in the well as functions of time. **NRC Comments:** Clarify in the FSAR the discussion of tritium concentration as a function of time.	M. McBride RAI 2.4.13-07
69.	2.4.13.2.2	**Please provide an SME to discuss the NRC requirement that values for K_d used in the assessment of the impact of the release of radioactive liquid effluent to the groundwater need to be measured from site specific sediments and groundwater. Explain why using literature values of K_d is consistent with the requirements for site-specific measurements in 10 CFR 100.20(C)(3).**	V. Vermeul RAI 2.4.13-08

		Applicant Response: Well concentrations shown in LNP FSAR Table 2.4.13-205 were calculated using Kd values shown in LNP FSAR Table 2.4.13-203 for Cs and Sr. LNP FSAR Subsection 2.4.13.2.2 identifies the basis used including LNP FSAR Table 2.4.12-201, NRCS soils data, and EPA-402-R99-004. SRP 2.4.13, part III.3 states that detailed consideration of site-specific properties are needed unless the uncertainty can be offset by conservatisms in the applicant's assessment. In particular, absorption studies may not be needed if any retardation of contaminant migration is negligible. Groundwater models determined that minimal values of Kd for Cs and Sr were needed to meet 10 CFR 20, Appendix B criteria. Rather than use an arbitrary, smallest possible Kd that approached negligible retardation, it was considered more appropriate to use literature based values that had reasonable technical basis, benefited from EPA's review, and demonstrated that the small values needed were easily realized. The Kd values used in LNP FSAR Subsection 2.4.13 will be validated with LNP-specific testing. Supporting Information: 1) EPA-402-R99-004, Understanding Variation in Partition Coefficient Kd Values. 2) NRCS Soil Data Mart, Levy County FL. **NRC Comments:** RAI addressing site-specific Kd will be issued.	
70.	2.4.13.2.2	**Please provide an SME to discuss the potential impacts of chelating agents on K_d values and the associated impact on radionuclide transport.** **Applicant Response:** Chelating agents can adversely affect the sorption of radionuclides onto soil and porous rock. Essentially, the Kd value for a radionuclide may be reduced if a chelating agent is present. LNP FSAR Table 2.4.13-203 shows that retardation was not credited for nuclides except for Cs and Sr. Complexation of metal cations by the chelating agent occurs primarily with the transition metals. However, Cs and Sr are not transition metals. Kd for Cs is not expected to be impacted because complexation of single valence Cs+ is poor in soils	V. Vermeul RAI 2.4.13-09

		since it competes with higher valence ions. Kd for Sr is more likely than Cs to be impacted in the presence of chelating agents due to its Sr++ valence. Also, EPA-402-R99-004 advises that some carbonates can act as inorganic chelates. Reduction of Kd = 1 ml/g for Sr used in the Floridan analysis is unlikely. This Kd was taken from raw data tabulated in EPA-402-R99-004 because limestone was identified as the soil type. It was the minimum value for limestone. Natural organic materials in some soils may act as chelating agents. Kd testing (see Serial Number 69, above) with site soils and groundwater specimens should confirm suitability of Kd. Supporting Information: EPA-402-R99-004, Understanding Variation in Partition Coefficient Kd Values. **NRC Comments:** RAI addressing chelating agents will be issued.	
71.	2.4.13.2.3	**Please provide an SME to discuss the dilution factors and activity concentrations in the Lower Withlacoochee River shown in Table 2.4.13-204, in particular whether the values represent groundwater near the river or whether they include dilution in the river.** **Applicant Response:** LNP FSAR Table 2.4.13-204 shows the dilution factor for concentrations in the Lower Withlacoochee River. The factor includes the river flow, radiodecay, and retardation (for Cs and Sr, only). LNP FSAR Subsection 2.4.13.2.1 discusses the activity entering the river. The maximum rate of radionuclide activity crossing an infinite plane at the river is calculated (i.e., 7 km from the spill and at right angles to the groundwater flow). The rate of activity entering the river is then diluted by the river's flow Q to get the maximum concentration in the river (see LNP FSAR Equation 2.4.13-6). LNP FSAR Subsection 2.4.13.2 (last paragraph) gives the river flow. LNP FSAR Subsection 2.4.13.2.3 (2nd paragraph) identifies that the long transport time with the resultant decay prior to reaching the river is the dominant contributor to the dilution factor shown in the tables. LNG-0000-GLC-003, Tables 3 and 5, show the radiodecay contribution to the dilution factors shown in LNP FSAR Tables 2.4.13-204 and -205, respectively. **NRC Comments:**	M. McBride

		Resolved.	
72.	2.4.13.2.3	**Please provide an SME to discuss the potential impacts of 1) higher seepage velocities (see information need #'s 52 and 53), 2) incomplete mixing over the full saturated thickness of the Upper Floridan aquifer, 3) preferential flow in fractures and solution cavities within this carbonate rock aquifer, and 4) K_d and dispersivity values, on the bounding activity concentration results shown in Table 2.4.13-205.** **Applicant Response:** Higher seepage velocities cause the radionuclide concentrations to increase. Doubling the seepage velocity is expected to result in acceptable ECLs in LNP FSAR Table 2.4.13-205 for the well. The response to Serial Number 63 clarifies that the full saturated aquifer thickness was not used. The 250-foot thickness used in the analysis corresponded to well depths near the site. The response to Serial Number 69 identified that minimal Kds for Cs and Sr are needed. Decreasing the Kd values have little impact because of the distances and transport times involved. On-site hydraulic conductivity measurements are macroscopic and are indicative of overall conditions in a representative elementary volume of the aquifer. Any such measurement includes spatial averaging of several interacting effects such as porosity and flow behavior (for example, porous and conduit flow). See response to Serial Number 63, also. The conceptual model of a lower permeable matrix with water in a network of conduits also can result in mechanisms that delay transport. Sequestration of contaminants can occur with flow from the conduit network back in to carbonate matrix, for example, when the conduits network is at higher pressure after a rain storm (Loper). This mechanism increases the opportunity for sorption and increased residence times in the carbonate matrix. Minimal dispersivity is assumed. A unity value, while limiting the spread, maximizes the concentrations along the centerline. Literature data shows that dispersivity is scale dependent increasing with distance. Typically, longitudinal dispersivity is observed in the range of 10 to 30 meters in limestone and carbonate aquifers (see Gelhar and Schulze-Makuch). Use of larger dispersivity will result in smaller (less conservative) concentrations than shown in LNP FSAR Table 2.4.13-205. Supporting Information: 1) Citations for Gelhar and Schulze-Makuch in Serial Number 63. 2) Loper, D., Steps Toward Better Models of Transport in Karstic Aquifers, USGS Karst Interest Group, 2001.	V. Vermeul

		NRC Comments: Reference Serials 52, 53, 63, 69	
73.	2.4.13.2.3	**Please provide an SME to discuss how the process employed for the radionuclide transport assessment is the most conservative plausible conceptual model.** **Applicant Response:** Generally, the subsurface information and investigations presented in LNP FSAR Subsection 2.4.12 were used as the basis of the conceptual models and parameters in LNP FSAR Subsection 2.4.13. As part of the process of developing a most conservative, radionuclide transport assessment, an independent literature review was performed of the Floridan aquifer system's regional hydrologic environment and water usage (LNG-0000-GLC-003): • Florida Department of Natural Resources (FDNR) Hydro-geologic and hydro-geochemistry survey reports • Florida Department of Environmental Protection Source Water Protection (wells) • USGS Groundwater Atlas • USGS water usage data in Florida counties • USGS river and spillway flow • NRCS soil data information Data used from the on-site investigations reported in LNP FSAR Subsection 2.4.12: • Groundwater potentiometric surfaces for surficial and Upper Floridan aquifers • Hydraulic gradients, hydraulic conductivities, and maximum linear flow velocities for surficial and Upper Floridan aquifers • Vertical gradients between surficial and Upper Floridan aquifers • Subsurface conditions including confirmation of aquifer media and depth The development of conceptual models recognized the need to accommodate ranges of parametric values applicable to site conditions. Hence, worst-case assumptions and parameters were used for groundwater models. In addition worst-case release assumptions per USNRC BTP 11-6 and worst-case AP1000 radwaste tank radionuclide sources were used. Finally, the models were evaluated routinely to gain understanding of the interaction among parameters, assumptions, and pathways.	V. Vermeul RAI 2.4.13-00

		The process focused on developing two conservative conceptual models that bound radionuclide transport and dose consequences. The first model was for groundwater obtained from wells which is the overarching concern near LNP. An evaluation of the Lower Withlacoochee River was also made as an alternate consideration. For users of well water, the process of developing the most conservative conceptual model for radionuclide transport and evaluation of dose consequences is described below. Conceptual subsurface pathway considerations included: • Release to the surficial path based on the auxiliary building lowest floor elevation at 34 feet bgs to the surficial aquifer (LNP FSAR Subsection 2.4.13.2, 1st par.) • Site investigations show the boundary between surficial and Upper Floridan aquifers is not well defined near LNP (LNP FSAR Subsection 2.4.13.2, 3rd par, LNP FSAR Subsection 2.4.12.1.2). • Site data show downward vertical gradients from the surficial aquifer to the Upper Floridan aquifer over the entire site (LNP FSAR Table 2.4.12-209). • Contaminant pathways could include (1) surficial aquifer or (2) migration into Upper Floridan aquifer or (3) migration in both aquifers as contaminants are carried from the spill location. • Temporal concept: over long periods contaminant migration from the surficial aquifer to the Upper Floridan aquifer is expected due to the persistence of downward vertical gradients (LNP FSAR Subsection 2.4.13.2, 6th par). • Groundwater flow paths are in similar directions: Upper Floridan aquifer toward the SW and WSW and the surficial aquifer toward the WSW (LNP FSAR Figures 2.4.12-215 to -222). • Seepage velocities are greater in the Upper Floridan aquifer than the surficial aquifer (LNP FSAR Tables 2.4.12-212 and 2.4.13-203). Conceptual well user locations included: • Site wells for potable drinking water are NNW of LNP 2 with contaminated flow away from the wells (LNP FSAR Subsection 2.4.13.2, 4th par.). • Off-site private wells are identified 1.7 and 2 miles away in the direction of groundwater flow (LNP FSAR Table 2.4.12-206). • Off-site public wells are farther away or not in the direction of groundwater flow	

		(LNG-0000-GLC-003, Table 2). • Radionuclide concentrations at the private wells will be greater and bound concentrations at public wells based on proximity and direction (LNG-0000-GLC-003, sec 4). • All wells are permitted and must use drinking water from the Floridan aquifer (LNP FSAR Subsection 2.4.12.2.1). • Reject the existence of an unknown surface water user nearer than private well users based on PEF site survey (LNP FSAR Subsection 2.4.12.2.1, LNG-0000-GLC-003, sec 3). Alternative considerations in development of a most conservative conceptual scenario included: • The site boundary does not extend to a natural barrier or to Hwy 19 to the southwest. Future wells could be constructed closer than the nearest survey data (LNP FSAR Figure 2.4.12-213). • Reject the nearest private well in favor of a nearer, "analytical" well on the site boundary. This action makes allowances for future users and predicts more conservative concentrations. • Seepage velocities are greater in the Floridan aquifer than surficial aquifer. • Water wells are screened within the Floridan aquifer. The well's casing would preclude the surficial aquifer from having a significant impact on well concentrations. • Reject the realistic assumption of radionuclide transport that first enters the surficial aquifer and later enters the Floridan aquifer. Assume the entire release and transport scenario is in the Floridan aquifer to maximize concentrations (LNP FSAR Section 2.4.13.2, 6th par, LNG-0000-GLC-003, sec. 3). LNP FSAR Subsection 2.4.13.2 qualitatively describes the model; LNP FSAR Subsection 2.4.13.2.1 describes the well analytical model. The process of developing the most conservative conceptual model for evaluating transport of radionuclides and dose consequences to surface water is described below. Conceptual subsurface pathway considerations included: • The subsurface release and initial migration through the surficial and Floridan aquifers are similar to the well scenarios described above.	

- The Lower Withlacoochee River traverses the southwest sector near LNP.
- The river flows to the Gulf of Mexico with freshwater supplied to it from the Inglis Bypass Channel's spillway (LNP FSAR Subsection 2.4.13.2, 8th par).
- Streamlines originating from the surficial aquifer can surface in the river (LNG-0000-GLC-003, sec 4).
- Lack of a confining unit between the surficial and Upper Floridan aquifers means that streamlines originating from Upper Floridan aquifer may also surface in the river (LNG-0000-GLC-003, sec 4).

Conceptual user conditions included:

- The nearest river point is located in the SW sector approximately 7 km from LNP (LNP FSAR Subsection 2.4.13.2, 8th par).
- There are no known users of the river for domestic or public water supplies.
- The main source of dilution flow in the river is the fresh water supplied from the Inglis Bypass Channel (LNP FSAR Section 2.4.13.2, 8th par).
- Temporal concept: the minimum average monthly flow within the Inglis Bypass Channel is assumed (LNP FSAR Subsection 2.4.13.2, 8th par).

Alternative considerations in development of a conceptual scenario included:

- The Lower Withlacoochee River might be used for irrigation downstream of where the discharge from the Inglis Bypass Channel enters the river. Eventually, the river becomes too brackish for use.
- Reject that the river does not need to be analyzed because there are no domestic or public supplies taken from it. Accept alternate users (LNG-0000-GLC-003, sec. 4).
- Kds are comparable for both aquifers; no retardation of tritium occurs in either aquifer (LNP FSAR Table 2.4.13-203).
- Seepage velocity is greater in the Upper Floridan aquifer.
- Assume all contaminants are released to and transport through the Upper Floridan aquifer. This assumption is more conservative although less likely than transport through the surficial aquifer or through both aquifers. In either of the latter cases, lesser consequences are anticipated (LNP FSAR Subsection 2.4.13.2.1).
- Confirm the conservatism of using the Upper Floridan aquifer only by also analyzing

		the surficial aquifer contribution (LNG-0000-GLC-003, Table 4). LNP FSAR Subsection 2.4.13.2 qualitatively describes the model; LNP FSAR Subsection 2.4.13.2.1 describes the river's analytical model. For the most conservative well and surface water scenarios, the impact of spatial and temporal variations were evaluated or incorporated in the models. Spatial variations considered and included: • Maximum values of site hydraulic conductivity are used (LNP FSAR Table 2.4.13-203). • Maximum hydraulic heads are used to calculate pore velocities (LNP FSAR Table 2.4.13-203). • Straight-line groundwater flow and shortest distances are used to minimize travel time (LNP FSAR Subsection 2.4.13.2.1). • Accommodate variations in soils and unit backfill use of conservatively shorter distance between release and receptor (LNG-0000-GLC-003, sec 3). Temporal variations included: • Groundwater level releases are always below the groundwater surface level. (The immediate release is never held-up due to a release initially to an unsaturated region.) • Groundwater flow is in the same direction throughout the seasons. • Maximum annual hydraulic head is assumed, independent of seasons. • The minimum monthly Lower Withlacoochee River flow is used to eliminate seasonal surface water flow variations. A discussion was held regarding why the surficial aquifer is not the most conservative pathway. Discussion included that overland flow is not a plausible conservative pathway and raw water supply wells do not impact the most plausible conservative flow path. **NRC Comments:** Clarify discussion in the FSAR as to why conceptual model is the most conservative.	