PSEGESPeRAIPEm Resource

From: Chowdhury, Prosanta
Sent: Monday, October 29, 2012 10:16 AM
To: 'PSEGRAIResponses@pseg.com'
Cc: PSEGESPeRAIPEm Resource; 'James.Mallon@pseg.com'; 'David.Robillard@pseg.com'; Segala, John; Roach, Kevin; Clark, Phyllis; McLellan, Judith; Jones, Henry; Caverly, Jill
Subject: PSEG Site ESPA FINAL RAI 67 (eRAI 6615) SRP-02.04.05 (RHMB)
Attachments: PSEG Site ESPA Final RAI 67 (eRAI 6615).pdf

Please find attached RAI 67 for the PSEG Site ESP application. Following issuance of the draft of RAI 67 on September 28, 2012, a telecon was held on October 23, 2012, to provide clarification on Questions 02.04.05-12, 02.04.05-13, and 02.04.05-16, as requested by PSEG. During the telecon, you informed that you would not need clarification for Question 02.04.05-13, and that the verbal clarification provided by the staff for Question 02.04.05-12 was sufficient and no changes to this Question were needed. As a result of the discussion for Question 02.04.05-16, the staff has provided additional clarification by inserting in the last paragraph of this Question "(as presented in the HEC-RAS Model run screen shots pasted below)," and pasting five screen shots from the HEC-RAS Model run at the end of this Question. No other changes were necessary, and therefore, we are issuing this RAI as final.

The schedule we have established for review of your application assumes technically correct and complete responses within 30 calendar days of receipt of RAIs. For any RAIs that cannot be responded to within 30 calendar days, it is expected that a date for receipt of this information will be provided to the staff within the 30-calendar day period so that the staff can assess how this information will impact the published schedule.

If you have any questions, please contact me.

Prosanta Chowdhury
Project Manager
Licensing Branch 1 (LB1)
Division of New Reactor Licensing
Office of New Reactors
301-415-1647

Hearing Identifier: PSEG_Site_EarlySitePermit_RAI
Email Number: 142

Mail Envelope Properties (320204600EA7B9408FE833FF15E4FF7DB9ECE2C7B4)

Subject: PSEG Site ESPA FINAL RAI 67 (eRAI 6615) SRP-02.04.05 (RHMB)
Sent Date: 10/29/2012 10:16:17 AM
Received Date: 10/29/2012 10:16:22 AM
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Files	**Size**	**Date & Time**
MESSAGE	1559	10/29/2012 10:16:22 AM
PSEG Site ESPA Final RAI 67 (eRAI 6615).pdf	639354	

Options
Priority: Standard
Return Notification: No
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Sensitivity: Normal
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Recipients Received:

Request for Additional Information 67

Application Revision 1

FINAL

10/29/2012

PSEG Site ESP
PSEG Power LLC, PSEG Nuclear LLC
Docket No. 52-043
Review Section: 02.04.05 - Probable Maximum Surge and Seiche Flooding
Application Section: 2.4.5

QUESTIONS

02.04.05-12

Supplement to RAI 39, Question 2.4.5-6:

To show compliance with 10 CFR 52.17, PSEG should evaluate the storm surge induced by the PMH at the site as recommended by Regulatory Guide 1.59 and supplemented by current best practices. NUREG-0800, Standard Review Plan (SRP), Chapter 2.4.5, 'Probable Maximum Surge and Seiche Flooding,' establishes criteria that the NRC staff applies to evaluate whether PSEG meets the NRC's regulations. SSAR Sections 2.4.5.2.2.2 and 2.4.5.2.2.3 discuss application of the SLOSH storm surge model to develop the surge at the mouth of Delaware Bay and at the proposed project site.

In response to RAI 39, Question 2.4.5-6 (ML11349A356), PSEG provides information on the PMH storm parameters as referenced and some additional information on SLOSH storms applied in comparison. Since SLOSH applies MOM (maximum of maximums) analysis, NRC staff is unable to completely determine individual storm characteristics that produced the SLOSH results presented in the ESP application (Revision 1). The PSEG response to RAI 39, Question 2.4.5-6 also states that maximum SLOSH water level at the project site equals 22.8 ft-NAVD (SSAR page 2.4-77) which is still below the PMH surge estimates (Bodine/HEC-RAS/Wind Setup) after adding the 10% high tide (SSAR page 2.4-77). No additional SLOSH runs have been conducted by PSEG since the site safety audit.

Through independent confirmatory analysis, NRC staff determined that application of PMH storm parameters as input in the SLOSH model produces water surface elevations that exceed the publicly available SLOSH Display Program (V. 1.61g) data for Category 4 storms in the PSEG Site area. In order to show compliance with the requirements of 10 CFR 52.17 and evaluate the methods applied, NRC staff requests that PSEG provide an analysis of the PMH events using a conservative, current practice approach such as those predicted by a two-dimensional storm surge model (e.g., ADCIRC, FVCOM, SLOSH, other) with input from appropriate PMH scenarios and with resolution that captures the nuances of the bathymetry and topography near the project site. Note that, to account for wave-induced water level effects (wave setup), PSEG will likely need to couple a nearshore wave transformation model to a hydrodynamics model.

02.04.05-13

Supplement to RAI 39, Question 2.4.5-8:

To show compliance with 10 CFR 52.17, PSEG should evaluate the storm surge induced by the PMH at the site as recommended by Regulatory Guide 1.59 and supplemented by current best practices. NUREG-0800, Standard Review Plan (SRP), Chapter 2.4.5, 'Probable Maximum Surge and Seiche Flooding,' establishes criteria that the NRC staff applies to evaluate whether PSEG meets the NRC's regulations. SSAR Section 2.4.5.2.2.3 discusses application of the Kamphuis wind setup model to estimate wind-induced water level changes from the mouth of Delaware Bay (developed by the Bodine model) to the project site approximately 80 km (50 miles) inland.

In response to RAI 39, Question 2.4.5-8 (ML11349A356), PSEG provides equations and details of the analysis for the SSAR wind setup calculation. PSEG states that fetch development applies the longest possible fetch (53+ miles) and that the wind setup files are located in Enclosure 3. PSEG also discusses that the shape of bay/estuary is known to alter tide, surge propagation and height, and that the combined HEC-RAS/Wind Setup model results show amplification of surge (also indicated by a historical storm data). Finally, PSEG provides a comparison to SLOSH amplification that shows that the SLOSH model produces a similar (5.5 ft versus 6 ft) increase in storm surge from the bay mouth to the project site. However, the PSEG response to RAI 39, Question 2.4.5-8 does not provide a direct method for wind setup that includes shape of bay.

In order to show compliance with the requirements of 10 CFR 52.17 and evaluate the methods applied, NRC staff requests that PSEG provide:

(1) a discussion of depth values applied by the wind setup method. The PSEG response to RAI 39, Question 2.4.5-8 states that bathymetry along the fetch line is applied in the wind setup model, but the bathymetry values necessary to calculate the total water depth are not clearly provided. The wind setup calculation depends on the total water depth and the bathymetric location applied in the wind setup calculation is important (but not clearly demonstrated). The bathymetry across Delaware Bay varies significantly so the depth value can vary widely depending on where the value is chosen.

(2) a discussion of what wind speed averaging was applied to develop the wind speeds applied in the wind setup calculations. The PSEG response to RAI 39, Question 2.4.5-8 does not clearly describe the wind field averaging method applied in the application of the wind speeds within the wind setup calculation.

Note, using a conservative, current practice approach, such as those predicted by an execution of a two-dimensional storm surge model (e.g., SLOSH) with input from appropriate PMH scenarios, will account for the shape of the bay when developing wind-induced water level changes from the mouth of Delaware Bay to the project site approximately 80 km (50 miles) inland. This methodology will negate the need for combining multiple models and methods.

02.04.05-14

Supplement to RAI 39, Question 2.4.5-9:

To show compliance with 10 CFR 52.17, PSEG should evaluate the storm surge induced by the PMH at the site as recommended by Regulatory Guide 1.59 and supplemented by current best practices. NUREG-0800, Standard Review Plan (SRP), Chapter 2.4.5, 'Probable Maximum Surge and Seiche Flooding,' establishes criteria that the NRC staff applies to evaluate whether PSEG meets the NRC's regulations. SSAR Section 2.4.5.3.1 discusses the development of the wave runup at the PSEG Site.

In order to show compliance with the requirements of 10 CFR 52.17 and evaluate the methods applied, NRC staff requests that PSEG provide the following:

(1) Clarification on the time of maximum still water level provided in response to RAI 39, Question 2.4.5-9. In the PSEG response to RAI 39 (ML11349A356), Question 2.4.5-9, the simulation time of maximum still water level (21.0 hours) does not match the maximum still water level in Table 2.4.5.1 in the SSAR (Revision 1) and Table RAI 39-9-2 (20.5 hours). PSEG also states the design flooding condition occurs at simulation time 21.5 hours when Table 2.4.5.1 in the SSAR and Table RAI 39-9-2 indicate 21.0 hours.

(2) The relationship between the two wind speeds listed in PSEG response to RAI 39, Question 2.4.5-9, Table 39-9-1 (Column 2 and Column 4).

02.04.05-15

Supplement to RAI 39, Question 2.4.5-10:

To show compliance with 10 CFR 52.17, PSEG should evaluate the wind-induced wave runup under PMH or PMWS winds with runup estimates based on USACE Coastal Engineering Manual equations and supplemented by current best practices. NUREG-0800, Standard Review Plan (SRP), Chapter 2.4.5, 'Probable Maximum Surge and Seiche Flooding,' establishes criteria that the NRC staff applies to evaluate whether the applicant meets the NRC's regulations. SSAR (Revision 1) Section 2.4.5.3.2 discusses the development of the wave runup estimate for the project site.

The PSEG response to RAI 39, Question 2.4.5-10 (ML11349A356), provides equations and discussion on the methods applied to develop wave runup at site. The discussion details wave height calculation (CEM), fetch calculation, wind speed adjustment (NWS 23), and runup calculation. However, the discussion provides only limited details of values applied in analysis; no table to show different scenarios, fetch directions, wind speeds, etc. The discussion ends with a final runup equation (D'Angremond and van Roode) with the addition of surface roughness coefficient (0.5 for rip-rap).

The NRC staff has concerns that fall within two different areas:

1. Overall, the wave height calculation methodology appears satisfactory. However, the PSEG response to RAI 39, Question 2.4.5-10 (Enclosure 1, Page 27, paragraph 2) indicates that the maximum wave height = $1.67H_{mo}$ and also equates the significant wave height with H_{mo}.
   i. H_{mo} is not equivalent to the significant wave height ($H_{1/3}$); however, the approximation $H_{mo} = H_{1/3}$ is common and acceptable.
   ii. CEM Equation II-1-132 (SSAR Reference 2.4.5-27, page II-1-74) gives the following relationships:
   $H_{1/100} = 1.67\ H_{1/3}$
   $H_{max} = 1.86\ H_{1/3}$

   The relationship between maximum wave height and significant wave height on Enclosure 1, Page 27, appears inaccurate; however, designing to $H_{1/100}$ (the 1% wave height) versus Hmax is generally acceptable.

In order to show compliance with the requirements of 10 CFR 52.17 and evaluate the methods applied, NRC staff requests that PSEG provide a reference to the $H_{max} = 1.67H_{1/3}$ relationship or update the SSAR to indicate the $H_{1/100}$ design.

2. Based on the NRC staff review of the PSEG response to RAI 39, Question 2.4.5-10, the runup equation (RAI 39-10-11) is derived from CEM Section II-4-4-a(1). The PSEG RAI response shows the runup estimates apply a roughness coefficient equal to 0.5 to this equation.

   i. The CEM equation applied calculates runup on beaches, while the estimate at the project site requires a

calculation for runup on a rubble structure. CEM Section VI-5-2 discusses more appropriate equations and calculations for runup on structures.

ii. The roughness coefficient listed in the PSEG response to RAI 39, Question 2.4.5-10 does not apply to equation RAI 39-10-11. The roughness coefficient and method of application relates to formulas in CEM Section VI-5-2. The equations listed in CEM Section VI-5-2 have additional parameters when compared to the runup equation applied in the PSEG response to RAI 39, Question 2.4.5-10 (equations derived from CEM Section II-4-4-a(1)). The additional parameters may result in higher runup estimates, even when applied in combination with the roughness coefficient.

iii. The equation/discussion in the PSEG response to RAI 39, Question 2.4.5-10 does not indicate the exceedance level of the runup (e.g. 0.1 %, 2%, etc.). As listed in the PSEG response, the application of the roughness coefficient and the CEM Section II-4-4-a(1) formula would appear to give an exceedance level of 50% (i.e. 50% of incident waves will produce a higher runup).

In order to show compliance with the requirements of 10 CFR 52.17 and evaluate the methods applied, NRC staff requests that PSEG provide additional justification for the equation applied to develop the runup (i.e., justification for the use of a roughness coefficient with the CEM section II-4-4-a(1) equation). In addition, NRC staff requests that PSEG provide a discussion on the exceedance level of the runup estimate developed and the appropriateness of that exceedance level.

02.04.05-16

Supplemental Question

To show compliance with 10 CFR 52.17, PSEG should evaluate the storm surge induced by the PMH at the site as recommended by Regulatory Guide 1.59 and supplemented by current best practices. NUREG-0800, Standard Review Plan (SRP), Chapter 2.4.5, “Probable Maximum Surge and Seiche Flooding,” establishes criteria that the staff applies to evaluate whether PSEG meets the NRC regulations. SSAR (Revision 1) Sections 2.4.5.2.1 and 2.4.5.2.2 discuss application of the HEC-RAS model to propagate the storm surge at the mouth of Delaware Bay (developed by the Bodine model) to the project site approximately 80 km (50 mi) inland.

In response to RAI 25 (ML11179A080, June 23, 2011, and ML11195A163 (Supplemental), July 7, 2011), PSEG provided four DVDs with HEC-RAS related files, data, and a user's guide for data. Review of data indicates that some questions still remain.

After reviewing the Surface Water Digital Files User’s Guide (referenced in PSEG's Supplemental Response to RAI 25, dated July 7, 2011 (ML11195A163)), the NRC staff has the following comments and observations:

An NRC staff review of the HEC-RAS geometry file and model setup (i.e., MASTER.g01) shows the roadways leading to the two bridges are not included in the model. The surge flow could have been partially blocked by the roadways. PSEG possibly used an ineffective flow scheme (HEC-RAS model ineffective flow area method) instead. In order to show compliance with the requirements of 10 CFR 52.17 and evaluate the methods applied, the NRC staff requests that PSEG provide a discussion and justification for the model setup applied.

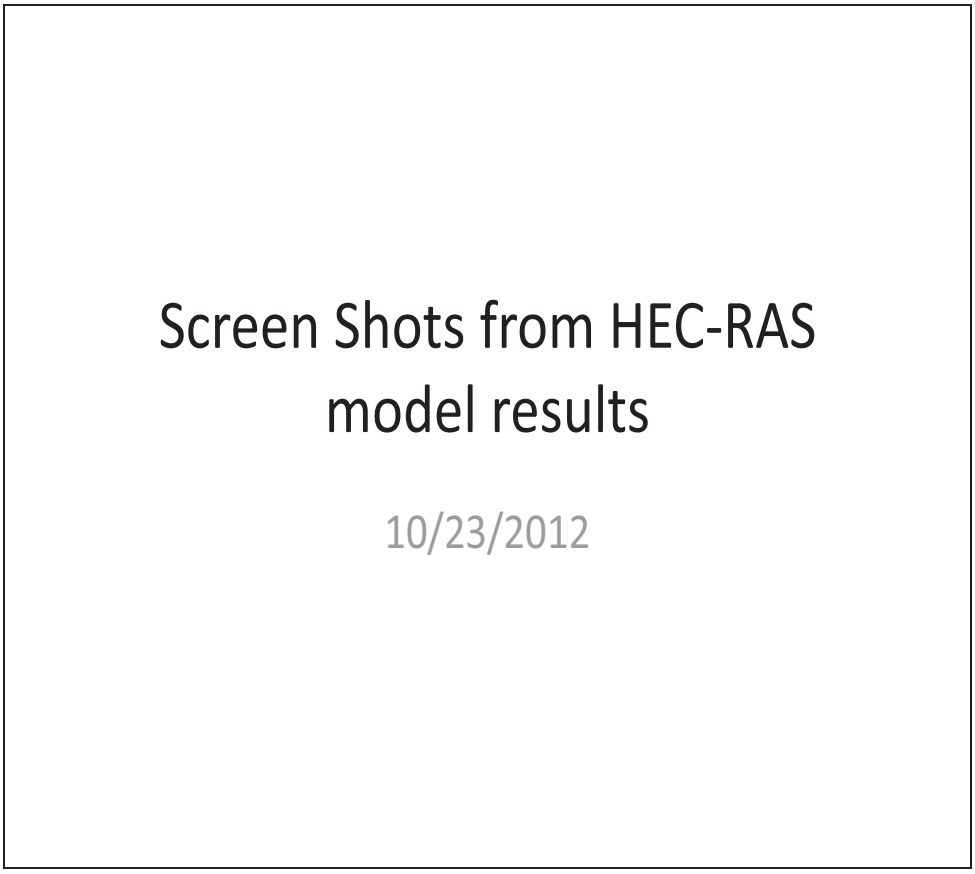
An NRC staff review of the unsteady HEC-RAS model (Delaware_River_Hydraulic_Model) surge calibration run (Plan: Surge_calibration_1933) provides the following comments and observations:

An NRC staff review of a PSEG animation of the longitudinal water surface profile appears to indicate model numerical instability during the simulation. The numerical instability occurs to a degree that could affect

calibration and model prediction values. In order to show compliance with the requirements of 10 CFR 52.17 and evaluate the methods applied, the NRC staff requests that PSEG describe any steps taken steps to minimize the model instabilities. If steps were taken to reduce model instabilities, please describe how these steps affected the model calibration.

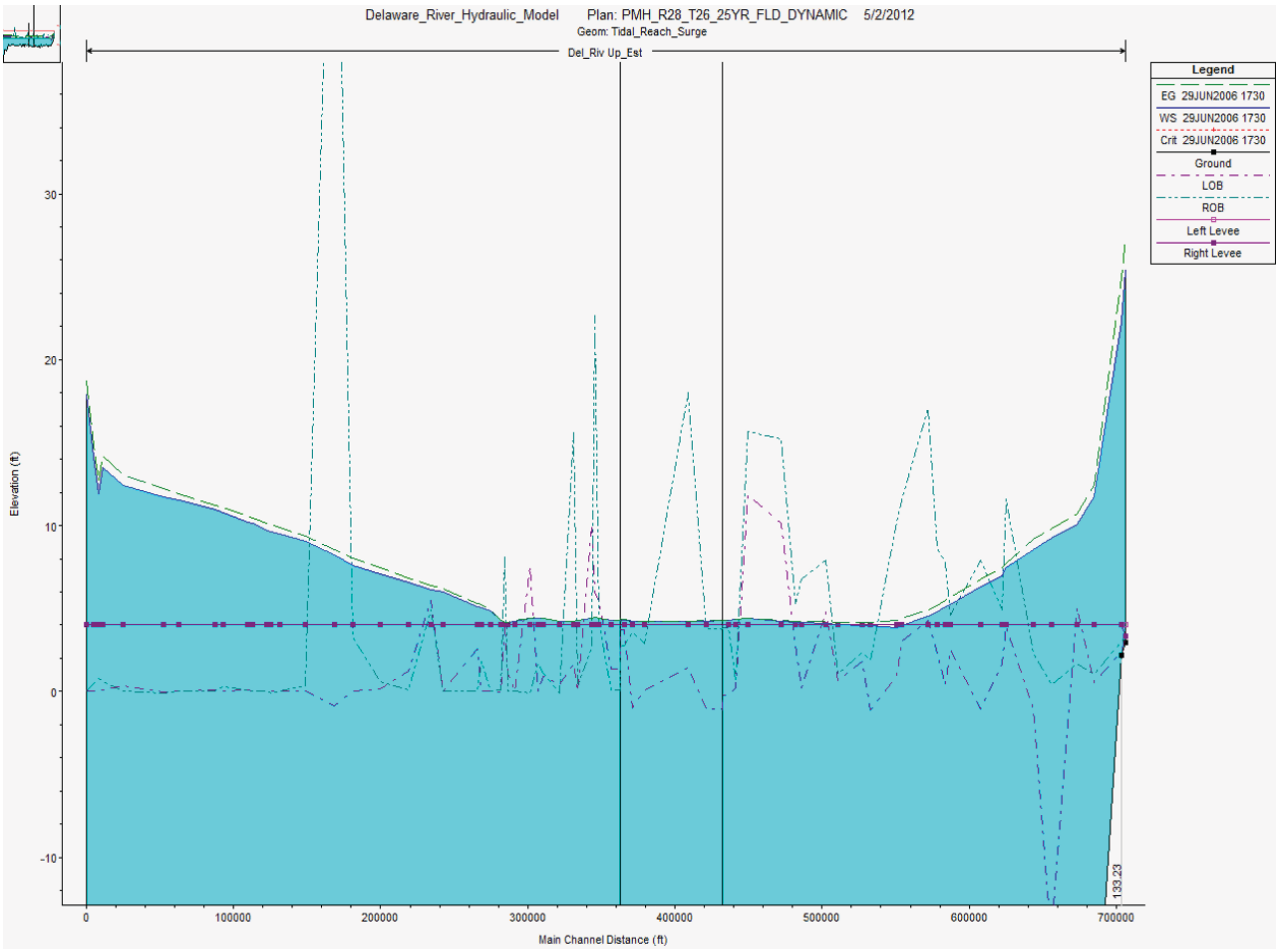
An NRC staff review of the unsteady HEC-RAS model (Delaware_River_Hydraulic_Model) Probable Maximum Hurricane (PMH) surge run (Plan: PMH_R28_T26_25YR_FLD_DYNAMIC) provides the following comments and observations:

> The PSEG animation of the longitudinal water surface profile appears to indicate model numerical instability during the simulation. The instability appears very pronounced just before the passing of the peak surge wave for the PMH surge run (as presented in the HEC-RAS Model run screen shots pasted below). In order to show compliance with the requirements of 10 CFR 52.17 and evaluate the methods applied, the NRC staff requests that PSEG describe any steps taken steps to minimize the model instabilities. If steps were taken to reduce model instabilities, please describe how these steps affected the model results.

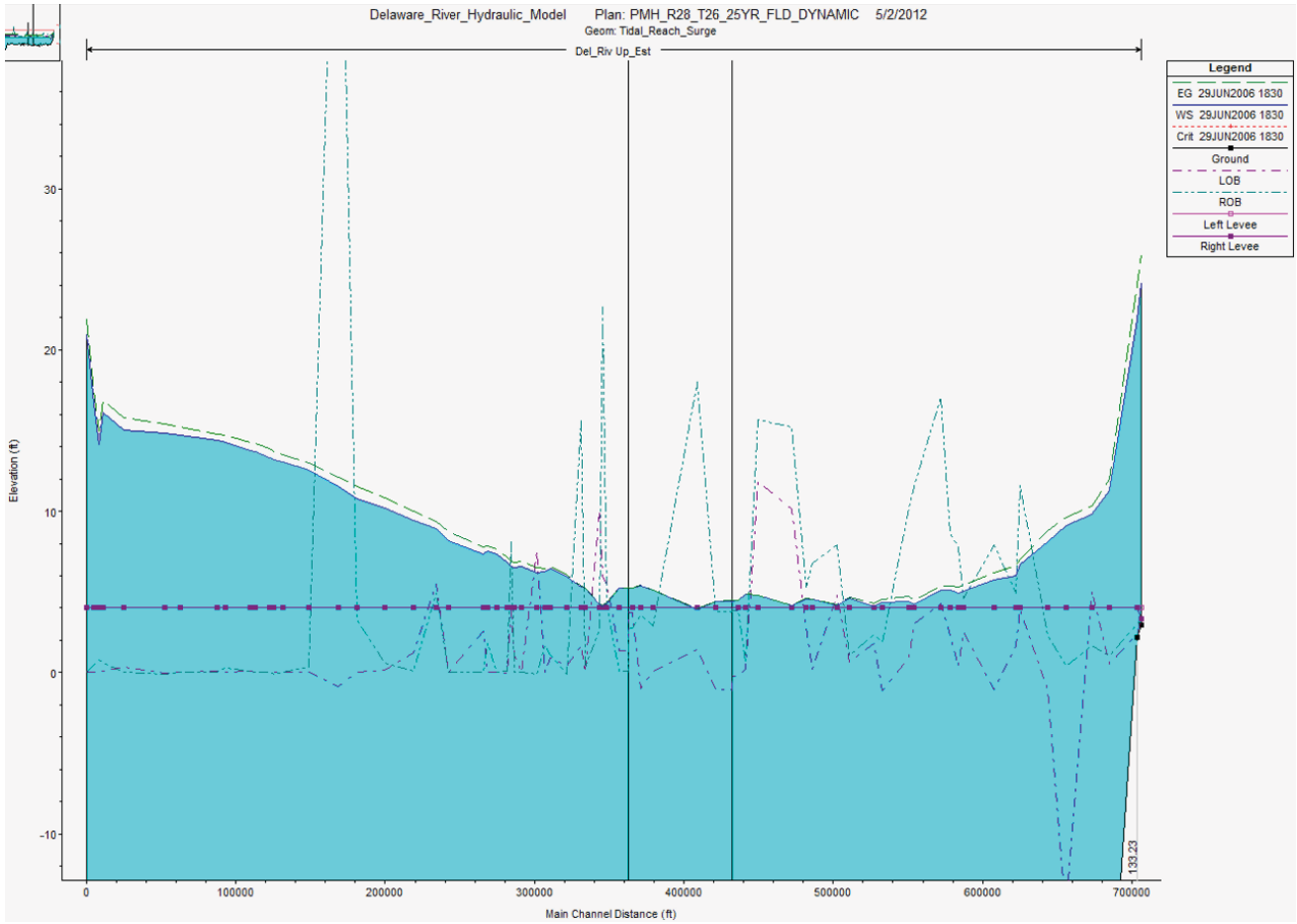


Notes

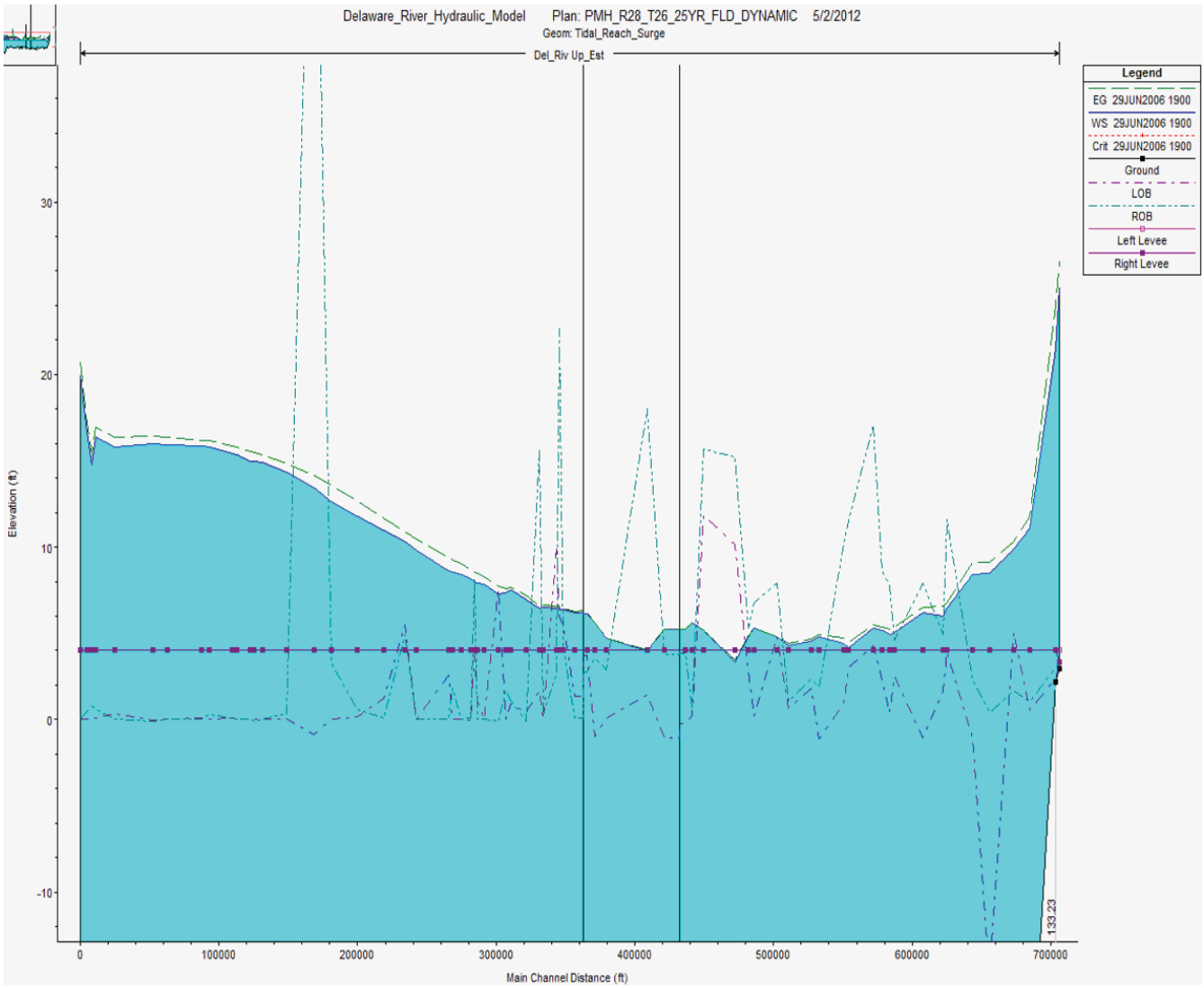
- Screen shots from the animation of the longitudinal water surface
  - Applied data from PSEG provided output file for the Plan "PMH_R28_T26_25Yr_FLD_DYNAMIC"
- Screen shots show possible model instability near boundary and in the middle of the model (near project area)



Questionable results near Main Channel Distance 0 to 10,000 ft (June 29 17:30)



Questionable results near Main Channel Distance 340,000 ft (June 29 18:30)



Questionable results near Main Channel Distance 450,000 ft (June 29 19:00)

02.04.05-17

Supplement to RAI 39, Question 2.4.5-7:

To show compliance with 10 CFR 52.17, PSEG should evaluate the storm surge induced by the PMH at the site as recommended by Regulatory Guide 1.59 and supplemented by current best practices. NUREG-0800, Standard Review Plan (SRP), Chapter 2.4.5, 'Probable Maximum Surge and Seiche Flooding,' establishes criteria that the NRC staff applies to evaluate whether PSEG meets the NRC's regulations. SSAR Section 2.4.5.2.2.3 discuss application of the HEC-RAS model to propagate the storm surge at the mouth of Delaware Bay (developed by the Bodine model) to the PSEG project site approximately 80 km (50 miles) inland.

The PSEG response to RAI 39, Question 2.4.5-7 (ML11329A069) lists HEC-RAS model upgrades in V4.1 not found in V4.0 (applied in the SSAR analysis). The PSEG response also states that only two model corrections in V4.1 could affect results for analysis (related to bridge crossings). Comparison of output for bridge crossing data developed with V4.1 and V4.0 versions of code indicate identical curves. PSEG did not conduct model results comparison between more recent HEC-RAS versions and the model used for the SSAR. Instead, PSEG relied on the development of bridge curves with each model version and on documented differences between the versions.

In order to show compliance with the requirements of 10 CFR 52.17 and evaluate the methods applied, NRC staff requests that PSEG provide a discussion of their V4.0 HEC-RAS model compared to the latest HEC-RAS model version to confirm that there is no effect to any of the HEC-RAS model results from recent software updates.