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December18,2013

Security-Related Information
Withhold Under 10 CFR 2.390

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D. C. 20555

Serial No. NA3-13-018
Docket No. 52-017
COL/BCB

DOMINION VIRGINIA POWER
NORTH ANNA UNIT 3 COMBINED LICENSE APPLICATION
RESULTS OF RAI REVIEWS

In a letter dated July 31, 2013 (ML13221A504), Dominion committed to submit a table with the disposition of NRC Requests for Additional Information (RAI) and responses on the NA3 docket that are associated with the updated COLA content in the December 2013 COLA submission. That letter also included a commitment to provide revised RAI responses, where appropriate.

In a separate letter (Serial No. NA3-13-019) dated the same as this letter, Dominion forwarded Submissions 14 (Sensitive Unclassified Non-Safeguards Information (SUNSI) version) and 15 (Public version) of the NA3 ESBWR COLA to the NRC. To complete the commitments described above, Dominion reviewed four groups of RAIs for applicability to the NA3 ESBWR COLA:

- RAIs received by Dominion during the time that NA3 was designated as the ESBWR R-COLA
- RAIs received by Dominion during the time that NA3 was designated as a US-APWR S-COLA
- Comanche Peak Units 3 and 4 US-APWR RAIs that were endorsed by Dominion
- Enrico Fermi Unit 3 (EF3) ESBWR RAIs received by DTE Energy (DTE) after May 2010, when Dominion changed the NA3 technology selection from the ESBWR to the US-APWR design, and associated responses submitted through September 30, 2013.

The RAI reviews were performed with the objectives of: 1) determining the continued applicability of the RAI questions and responses to the NA3 ESBWR licensing basis, 2) determining whether a revised RAI response is required, and 3) ensuring the applicable RAIs are addressed in the COLA in a manner that maximizes consistency with the EF3 ESBWR COLA content and minimizes the need for future NA3 RAIs.

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ENCLOSURES 17 AND 18 OF THIS LETTER CONTAIN SECURITY-RELATED INFORMATION AND MUST BE PROTECTED ACCORDINGLY. UPON SEPARATION OF ENCLOSURES 17 AND 18, THIS LETTER IS DECONTROLLED.

This letter provides the results of Dominion's review of the RAIs associated with COLA content that was updated in Submissions 14 and 15. Enclosure 1 describes the approach, methodology, and definitions of terms used by Dominion in the review and disposition of the RAIs. Enclosures 2 through 5 document the results of the reviews for each of the four groups of RAIs described above.

The review and disposition of the RAIs listed in Enclosures 2 through 5 resulted in the need to revise 14 RAI responses. The revised RAI responses are provided in Enclosures 6 through 18.

In addition, the review of RAIs identified the need to provide updated computer code data files to support the staff's review of the COLA. The updated computer code data files are provided on compact discs (CD) in Enclosures 19 through 24. The computer code files are submitted in the native formats required by the software in which they may be used to support the staff's analysis. Therefore, the files on the enclosed CDs are not considered documents as defined in Section 2 of the NRC's "Guidance for Electronic Submissions to the NRC," Revision 6.1, dated May 27, 2011.

During the review of EF3 RAIs, Dominion concluded that two of the RAIs should be addressed in this letter to facilitate the staff's review of Submissions 14 and 15. The results of Dominion's review of these RAIs are provided in Enclosures 25 and 26.

In a letter dated August 30, 2013 (ML13247A394), Dominion submitted the results of its review of RAIs associated with COLA content that was updated in the July 2013 COLA submission. Enclosure 5 of that letter provided the results of the review of EF3 RAIs. In a letter to DTE Energy, dated November 14, 2013 (ML13297A191), the NRC identified RAI question numbers that had been mistakenly reused in EF3 RAI letters and assigned new numbers to correct the error. As a result, Dominion is revising certain EF3 RAI numbers listed in Enclosure 5 of Dominion's August 30, 2013 letter to be consistent with the new number assigned by the NRC. The revised RAI numbers are provided in Enclosure 27.

With these enclosures, Dominion's review of the RAIs associated with the COLA content that was updated in Submissions 14 and 15 is complete.

Please contact Regina Borsh at (804) 273-2247 (regina.borsh@dom.com) if you have questions.

Very truly yours,

Mark D. Sartain

Enclosures:

1. RAI Review Methodology
2. North Anna Unit 3 ESBWR R-COLA RAIs – Review Results
3. North Anna Unit 3 US-APWR S-COLA RAIs – Review Results
4. Endorsed Comanche Peak Units 3 and 4 US-APWR RAIs – Review Results
5. Enrico Fermi Unit 3 ESBWR RAIs – Review Results
6. Revised Response to NRC RAI Letter No. 50, Question 02.02.03-8
7. Revised Response to NRC RAI Letter No. 24, Question 02.04.12-1 and NRC RAI Letter No. 34, Question 02.04.12-2
8. Revised Response to NRC RAI Letter No. 53, Question 02.05.02-2
9. Revised Response to NRC RAI Letter No. 68, Question 02.05.02-3
10. Revised Response to NRC RAI Letter No. 64, Question 03.07.01-3
11. Revised Response to NRC RAI Letter No. 14, Question 03.07.02-1
12. Revised Response to NRC RAI Letter No. 9, Question 08.02-14
13. Revised Response to NRC RAI Letter No. 9, Question 08.02-15
14. Revised Response to NRC RAI Letter No. 54, Question 08.02-54
15. Revised Response to NRC RAI Letter No. 66, Question 08.02-59
16. Revised Response to NRC RAI Letter No. 36, Question 09.02.01-13
17. Revised Response to NRC RAI Letter No. 55, Question 13.06-30 (Security-Related Information)
18. Revised Response to NRC RAI Letter No. 55, Question 13.06-32 (Security-Related Information)
19. CD-ROM Containing SACTI Code Input and Output Files
20. CD-ROM Containing ARCON96 Code Input and Output Files
21. CD-ROM Containing XOQDOQ Code Input and Output Files
22. CD-ROM Containing HEC-RAS Code Input and Output Files
23. CD-ROM Containing LADTAP II Code Input and Output Files
24. CD-ROM Containing GASPAR II Code Input and Output Files
25. Review of Enrico Fermi Unit 3 Response to NRC RAI Letter No. 61, Question 01-4
26. Review of Enrico Fermi Unit 3 Response to NRC RAI Letter No. 69, Question 01-7 Sup. 1
27. Revised Enrico Fermi Unit 3 RAI Numbers

Commitments made by this letter:
None.

COMMONWEALTH OF VIRGINIA

COUNTY OF HENRICO

The foregoing document was acknowledged before me, in and for the County and Commonwealth aforesaid, today by Mark D. Sartain, who is Vice President-Nuclear Engineering and Development of Virginia Electric and Power Company (Dominion Virginia Power). He has affirmed before me that he is duly authorized to execute and file the foregoing document on behalf of the Company, and that the statements in the document are true to the best of his knowledge and belief.

Acknowledged before me this 18th day of December, 2013
My registration number is 112536 and my
Commission expires: April 30, 2015

Notary Public

cc with all Enclosures:

C. P. Patel, NRC

cc without Enclosures 19 through 24:

U. S. Nuclear Regulatory Commission, Region II
T. S. Dozier, NRC
G. J. Kolcum, NRC

ENCLOSURE 1

RAI Review Methodology

In a letter dated July 31, 2013 (ML13221A504), Dominion committed to submit a table with the disposition of NRC Requests for Additional Information (RAI) and responses on the NA3 docket that are associated with the COLA content that was updated in the December 2013 COLA submissions. To complete that commitment, Dominion reviewed four groups of RAIs for applicability to the North Anna Unit 3 (NA3) ESBWR COLA:

- RAIs received by Dominion during the time that NA3 was designated as the ESBWR R-COLA
- RAIs received by Dominion during the time that NA3 was designated as a US-APWR S-COLA
- Comanche Peak (CP) Units 3 and 4 US-APWR RAIs that were endorsed by Dominion
- Enrico Fermi Unit 3 (EF3) ESBWR RAIs received by DTE Energy (DTE) after May, 2010, when Dominion changed the NA3 technology selection from the ESBWR to the US-APWR design, and associated responses submitted through September 30, 2013

The RAI reviews were performed with the objectives of: 1) determining the continued applicability of the RAI questions and responses to the NA3 ESBWR licensing basis, 2) determining whether a revised RAI response is required, and 3) ensuring the applicable RAIs are addressed in the COLA in a manner that maximizes consistency with the EF3 ESBWR COLA content and minimizes the need for future NA3 RAIs.

The results of the RAI review for each of the four groups of RAIs described above is provided in Enclosures 2 through 5.

The RAI review results are summarized in a tabular format. The information provided in the table columns is described below:

RAI ID # – The RAI identification number assigned by the NRC staff.

NRC RAI Letter # – The RAI letter number assigned by the NRC staff.

RAI Subject – A brief statement of the subject of the RAI.

RAI Response Letter # – The serial number of the Dominion, DTE or Luminant letter providing the RAI response.

RAI Response Letter Date – The date that the RAI response letter was submitted to the NRC.

DOM Endorse Letter # – The letter number of the Dominion endorsement of the CP US-APWR R-COLA RAI response.

RAI or RAI Response Not Applicable – The RAI or RAI response is not applicable or the RAI response is not valid. This disposition includes RAI responses where a COLA markup is no longer valid, and the NA3 COLA provides the requested information. The updated COLA addresses the RAI. (See Note 1)

RAI Response Valid – The RAI question and RAI response are valid. Minor differences, such as "North Anna" rather than "Comanche Peak," may exist. (See Note 1)

RAI Response Requires Revision – The RAI question remains applicable. The RAI response provided information outside the COLA text, and this information is not valid in a substantive way (i.e., more than a name change). The RAI response has been revised to update the portion that is no longer valid. (See Note 1)

RAI Topic to be Addressed Outside COLA – This disposition is specific to EF3 R-COLA RAIs and endorsed CP R-COLA RAIs. This disposition is used when the RAI question is applicable, however the RAI response provided information outside the COLA content, and this information is not valid in a substantive way. The revised information is being submitted by Dominion outside the updated COLA. This also applies if CP or Fermi provided documentation outside of the COLA (e.g., Topical Report, calculation, etc.), which will also be provided by Dominion. (See Note 1)

RAI or RAI Response Addressed in COLA – This disposition is specific to EF3 R-COLA RAIs. The NA3 COLA incorporates the EF3 COLA content, or the NA3 COLA content meets the intent of the EF3 RAI response. (See Note 1)

COLA Change - Indicates whether or not a change to the NA3 COLA content was included in the December 2013 COLA submittal as a result of the RAI evaluation.

Note 1: In determining whether a specific RAI response is valid for the NA3 COLA, the response must be both "applicable" and "acceptable." RAIs that are not applicable include content that is specific to another facility, the facility's site, or the facility's application; or includes content that is not related to the ESBWR technology. A valid response may include references to another facility by name but the response text is otherwise applicable and acceptable. A response is considered applicable and acceptable if it is consistent with the existing Dominion strategy for the COLA content, including any commitments for future action.

Basis - Clarifies the logic for any RAI that is not dispositioned as valid.

- For dispositions "RAI Response Valid" or "RAI Response Addressed in COLA," the NA3 COLA reflects the COLA markups in the RAI response or meets the intent of the response and markups. The "Basis" column is typically left blank.

- For disposition "RAI Response Requires Revision" or "RAI Topic to be Addressed Outside COLA," the revised or additional information is included in this letter. The "Basis" field will refer to the appropriate letter enclosure.

- For disposition "RAI or RAI Response Not Applicable," the following options are used to provide additional information in the "Basis" and "COLA Change" fields:

  a) "Not applicable to ESBWR technology" – the RAI or RAI response is not valid because it is technology-dependent, specific to US-APWR, or driven by the US-APWR DCD content or COL Item. No COLA change is required for this RAI.

  b) "Not applicable to NA3" – the RAI or RAI response is not valid because it is specific to either CP or EF3 and does not apply to NA3. No COLA change is required for this RAI.

  c) "Superseded by another RAI response; refer to RAI XXYY- ZZ" – another RAI response supersedes this response. This is a possibility when supplemental responses have been submitted. The RAI question number is provided for the RAI that is superseding the original. No COLA change is required for this RAI.

  d) "Similar to a more appropriate RAI response; refer to {NA3, CP, or EF3} RAI XX-YY-ZZ" - another RAI that is similar to this RAI replaces this RAI response. The number of the more appropriate RAI response is referenced. No COLA change is required for this RAI.

  e) "NRC guidance or regulations revised" – updated NRC guidance or regulations have caused an RAI or RAI response to become outdated. The "COLA Change" field identifies whether or not an associated COLA change was made.

  f) "DCD revised" – a revision to the ESBWR DCD has caused an RAI or RAI response to become not applicable. The "COLA Change" field identifies whether or not an associated COLA change was made.

g) "COLA approach revised" – methodology (e.g., change in calculation analysis software and methodology) described in the COLA has been revised and has caused an RAI response to become not applicable. This entry also applies to non-technical approaches (e.g., the approach to address a non-technical COL item could be changed to follow the EF3 approach, which is more current). The "COLA Change" field identifies whether or not an associated COLA change was made.

h) "New information available" – new information has caused an RAI or RAI response to become not applicable and the new information will be provided in the COLA revision. The "COLA Change" field identifies whether or not an associated COLA change was made.

i) "Other – Explain" – another reason that cannot be otherwise categorized has caused an RAI or RAI response to become not applicable. The basis statement briefly explains why the RAI is no longer applicable. The "COLA Change" field identifies whether or not an associated COLA change was made.

Comments - Provides any information necessary to clarify the RAI disposition and basis. Comments may refer to a related RAI, point out minor differences between NA3 and EF3 or CP COLA content, or clarify the applicability of RAI responses that address multiple questions.

ENCLOSURE 2

North Anna Unit 3 ESBWR R-COLA RAIs

Review Results

North Anna Unit 3 ESBWR R-COLA RAIs – Review Results

RAI ID #	NRC RAI Letter #	RAI Subject	RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Valid	RAI Response Requires Revision	COLA Change	Basis	Comments
1-4	38	Proposed standard license conditions for 10 CFR Parts 30, 40, and 70	NA3-09-022RA	9/25/2009	X			Yes	COLA approach revised	
02.01.02-1	17	Control of WHTF	NAR-08-086R	8/28/2008		X		No		
02.02.03-1	25	Gasoline Explosion Hazards	NA3-08-118	10/20/2008	X			Yes	COLA approach revised	Item 1 is addressed in FSAR Table 2.2-205. Approach for Item 2 changed and response to Item 2 is no longer applicable (probability analysis is no longer required).
02.02.03-2	25	Evaluation of Potential Control Room Accidents	NA3-08-120	12/29/2008	X			No	Superseded by another RAI; refer to revised S-COLA RAI Response 02.02.03-8	
02.02.03-3	25	Evaporation Rate Sensitivity Analysis	NA3-08-120	12/29/2008	X			No	Superseded by another RAI response; refer to S-COLA RAI Response 02.02.03-8	
02.02.03-4	25	Sodium Hydroxide Quantities	NA3-08-118	10/20/2008		X		No		
02.02.03-5	33	Basis for Analysis/Screening Chemicals	NA3-09-016	5/27/2009	X			Yes	COLA approach revised.	FSAR Tables 2.2-204 and 205 provide dispo-sitions and basis.
02.02.03-6	33	Screening Criteria for Sodium Hydroxide	NA3-09-016	5/27/2009		X		No		

North Anna Unit 3 ESBWR R-COLA RAIs – Review Results

RAI ID #	NRC RAI Letter #	RAI Subject	RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Valid	RAI Response Requires Revision	COLA Change	Basis	Comments
02.02.03-7	34	Nitrogen Concentration at MCR Intake	NA3-09-013R	6/17/2009	X			No	Superseded by another RAI response; refer to S-COLA RAI Response 02.02.03-8	
02.03.01-1	17	Basis for wind speed value	NA3-08-086R	8/28/2008		X		No		
02.03.01-2	17	100 year/historic maximum and minimum temperatures	NA3-08-086R	8/28/2008		X		No		
02.03.01-3	17	Correct typographical error- omission of a negative sign on a temperature	NA3-08-086R	8/28/2008		X		No		
02.03.01-4	30	100-year coincident wet bulb temperature derivation	NA3-08-122R	12/3/2008		X		No		
02.03.02-1	2	SACTI analysis information and inputs	NA3-08-042	4/25/2008	X			Yes	DCD revised	The response is superseded by the information related to the potential impacts of the Unit 3 cooling tower provided in FSAR Revision 7, Section 2.3.2.3. Updated SACTI code input and output files are provided in Enclosure 19 of this letter.
02.03.02-2	17	SACTI salt deposition rates	NA3-08-086R	8/28/2008	X			No	COLA approach revised	

North Anna Unit 3 ESBWR R-COLA RAIs – Review Results

RAI ID #	NRC RAI Letter #	RAI Subject	RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Valid	RAI Response Requires Revision	COLA Change	Basis	Comments
02.03.04-1	3	ARCON96 input parameters	NA3-08-044	5/12/2008		X		No		
02.03.05-1	17	Explain difference in FSAR Table 2.3-17R from SSAR Table 2.3-17	NA3-08-116	10/17/2008	X			Yes	DCD revised	
02.03.05-2	19	Clarify differences between FSAR Table 2.3-16R and the ER	NA3-08-116	10/17/2008	X			Yes	DCD revised	
02.03.05-3	19	Revise FSAR 2.3.5 to include X/Q and D/Q values out to 50 miles	NA3-08-116	10/17/2008	X			Yes	DCD revised	
02.04.02-1	28	Locally-intense precipitation	NA3-08-106R	9/16/2008		X		Yes		Safety margin of 3" is updated in FSAR Section 2.4.2
02.04.02-2	33	PMP and Impact on RTNSS	NA3-09-010R	4/3/2009	X			Yes	New information available	For part "a", updated HEC-RAS code files are provided in Enclosure 22 of this letter. For part "b", the Unit 3 drainage design no longer includes a lateral weir from the south drainage ditch, so the question and response are no longer applicable. For parts "c" and "d", the information provided in the response is updated in FSAR Revision 7, Section 2.4.2.3.

North Anna Unit 3 ESBWR R-COLA RAIs – Review Results

RAI ID #	NRC RAI Letter #	RAI Subject	RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Valid	RAI Response Requires Revision	COLA Change	Basis	Comments
02.04.02-3	33	Hydraulic Jump / Ditch Discharges	NA3-09-010R	5/27/2009	X			Yes	New information available	
02.04.02-4	40	Verifying Grading/drainage Details with PMP Analysis	NA3-09-029R	9/25/2009		X		No		
02.04.02-5	40	Protection Against Flood	NA3-09-029R	9/25/2009	X			Yes	New information available	
02.04.02-6	40	Surveillance and Monitoring Requirements	NA3-09-029R	9/25/2009		X		No		
02.04.02-7	40	PMP Protective Measures	NA3-09-029R	9/25/2009	X			Yes	New information available	
02.04.12-1	24	MODFLOW Bases and OW-901 Questions	NA3-08-095R	9/19/2008			X	Yes	Revised response to this RAI question is provided in Enclosure 7 of this letter.	
02.04.12-2	34	Groundwater Level	NA3-09-013R	6/17/2009			X	No	Revised response to this RAI question is provided in Enclosure 7 of this letter.	
02.04.13-1	26	Use of Chelating Agent	NA3-08-104R	10/2/2008		X		No		
02.04.13-2	26	Kd Values	NA3-08-104R	10/2/2008	X			No	Superseded by another RAI response; refer to RAI 02.04.13-4	

North Anna Unit 3 ESBWR R-COLA RAIs – Review Results										
RAI ID #	NRC RAI Letter #	RAI Subject	RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Valid	RAI Response Requires Revision	COLA Change	Basis	Comments
02.04.13-3	26	Hydraulic Conductivity Value	NA3-08-104R	10/2/2008	X			No	Superseded by another RAI response; refer to RAI 02.04.13-4	
02.04.13-4	34	Hydraulic Conductivity and Kd Values	NA3-09-013RA	7/29/2009	X			Yes	New information available	
02.05.04-1	10	Justify Zone IIA cohesion value	NA3-08-059R	7/14/2008		X		No		
02.05.04-2	10	The comparison of median SWVs revealed that SWV values presented in FSAR are about 36 to 50 percent higher than SSAR values. Explain why such different values were obtained for the same site.	NA3-08-059R	7/14/2008		X		No		
02.05.04-3	10	Material and engineering properties of concrete fill	NA3-08-059R	7/14/2008		X		No		
02.05.04-4	10	Describe how to ensure backfill soil will meet or exceed requirements.	NA3-08-059R	7/14/2008	X			Yes	New information available	
02.05.04-5	10	Provide clarification between FSAR Figure 2.5-244 and Table 2.0-201	NA3-08-059R	7/14/2008	X			Yes	DCD revised	
02.05.04-6	10	Provide clarification of dynamic bearing capacity values between FSAR Table 2.0-201 and Table 2.5-215.	NA3-08-059R	7/14/2008		X		No		

North Anna Unit 3 ESBWR R-COLA RAIs – Review Results										
RAI ID #	NRC RAI Letter #	RAI Subject	RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Valid	RAI Response Requires Revision	COLA Change	Basis	Comments
02.05.04-7	10	FWSC Soil Backfill Analysis	NA3-08-059R	7/14/2008	X			Yes	New information available	
02.05.04-8	10	Factor of Safety for foundation sliding with use of mud mat.	NA3-08-059R	7/14/2008		X		No		
02.05.04-9	10	Please provide detailed information on the analysis when both at-rest and active seismic lateral earth pressure were involved.	NA3-08-059R	7/14/2008	X			Yes	New information available	
02.05.04-10	11	Explain apparent difference between SSAR and FSAR liquefaction settlement results.	NA3-08-063R	8/4/2008		X		No		
02.05.04-11	11	Justify why dynamic bearing capacity can be estimated by adding one third over static bearing capacity.	NA3-13-063R	8/4/2008	X			Yes	New information available	
02.05.04-12	34	Sup to 2.5.4-3: Concrete SWV - How to ensure properties will be what is assumed in analyses.	NA3-09-013RB	8/20/2009		X		No		
02.05.04-13	34	Sup to 2.5.4-4: FWSC SWV Backfill and proof of meeting these criteria	NA3-09-013R	7/17/2009	X			Yes	New information available	
02.05.04-14	34	Sup to 2.5.4-5: Provide min SWV for soil below the foundation so that the staff can evaluate the adequacy of backfill properties used in the site stability analysis.	NA3-09-013R	7/17/2009	X			Yes	New information available	

North Anna Unit 3 ESBWR R-COLA RAIs – Review Results

RAI ID #	NRC RAI Letter #	RAI Subject	RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Valid	RAI Response Requires Revision	COLA Change	Basis	Comments
02.05.04-15	34	Sup to 2.5.4-6: Clarify how the properties of concrete fill were determined and used in the allowable bearing capacity calculation.	NA3-09-013RB	8/20/2009		X		No		
02.05.04-16	34	Sup to 2.5.4-7b: Localized failure of FWSC foundation mat on top of granular backfill.	NA3-09-013R	7/17/2009	X			Yes	New Information available.	
02.05.04-17	34	Sup to 2.5.4-8: Justify and clarify the site-specific coefficient of friction used to calculate the site-specific factor of safety against sliding between the basemat and underlying material.	NA3-09-013R	6/17/2009	X			Yes	New information available	
02.05.04-18	34	Sup to 2.5.4-10: Explain why the SSAR estimated dynamic settlement was almost 3 times that estimated in the FSAR while there is only a 40 percent difference for peak ground accelerations.	NA3-09-013R	6/17/2009		X		Yes		

North Anna Unit 3 ESBWR R-COLA RAIs – Review Results

RAI ID #	NRC RAI Letter #	RAI Subject	RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Valid	RAI Response Requires Revision	COLA Change	Basis	Comments
02.05.04-19	34	Sup to 2.5.4-11: Provide details on what load combinations were used in the dynamic bearing capacity estimate, and why one and one third of static bearing capacity can be used as dynamic bearing capacity for this site without actual analysis.	NA3-09-013R	6/17/2009	X			Yes	New information available	
02.05.04-20	42	Sup to 2.5.4-13: Additional information required for backfill ITAAC	NA3-09-033R	11/4/2009	X			Yes	New information available	
02.05.04-21	42	Sup to 2.5.4-12: Provide a clear description of concrete fill properties in the FSAR or justify why such description is not needed.	NA3-09-033R	11/4/2009		X		Yes		
02.05.05-1	10	Clarify why two different types of soil were identified for the same boring and same CPT data (silty clays and clays vs. silty sand).	NA3-08-059R	7/14/2008		X		No		
02.05.05-2	10	Explain why only analysis results based on Bishop's method are presented for slope stability.	NA3-08-059R	7/14/2008		X		No		

North Anna Unit 3 ESBWR R-COLA RAIs – Review Results										
RAI ID #	NRC RAI Letter #	RAI Subject	RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Valid	RAI Response Requires Revision	COLA Change	Basis	Comments
02.05.05-3	10	Describe the impact of the possible maximum dynamic settlement of the slope soil on the slope stability and describe how the assumptions used by the pseudo-static methods were verified.	NA3-08-059R	7/14/2008		X		No		
03.07.01-1	14	Please identify the appropriate FSAR Sections and Figures that address ground motion time histories.	NA3-08-067R	8/12/2008	X			Yes	New Information available.	
03.07.01-2	37	NRC requests to specify in FSAR Section 3.7.1 both the site-specific SSE and the corresponding OBE which would be required for operating the plant and setting up the seismic instrumentation as required in FSAR Section 3.7.4.	NA3-09-021R	8/24/2009	X			Yes	New information available	
03.07.02-1	14	Provide identification and locations of each Category I, II, and nonseismic structures, including the distance between structures and the height of each structure	NA3-08-067RA	10/8/2008			X	No	Revised response to this RAI question is provided in Enclosure 11 of this letter.	
03.10-1	37	Seismic qualification implementation plan	NA3-09-021 RA	10/28/2009	X			Yes	COLA approach revised	

North Anna Unit 3 ESBWR R-COLA RAIs – Review Results

RAI ID #	NRC RAI Letter #	RAI Subject	RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Valid	RAI Response Requires Revision	COLA Change	Basis	Comments
06.02.01-1	6	ECCS Strainer Debris	NA3-08-053RA	12/18/2008		X		No		
06.02.04-1	6	Pipe Length Acceptance Criteria	NA3-08-053R	7/14/2008	X			Yes	DCD revised	
06.02.04-2	30	Location of Containment Isolation Valves	NA3-08-122R	12/3/2008		X		Yes		
08.02-1	9	Onsite power system figure	NA3-08-056R	7/28/2008	X			Yes	COLA approach revised	
08.02-2	9	Independence and separation of control and instrumentation cables	NA3-08-056R	7/28/2008		X		No		
08.02-3	9	MVA rating of the intermediate transformer	NA3-08-056R	7/28/2008		X		No		
08.02-4	9	Design features and/or insitu monitoring programs for underground cables	NA3-08-056R	7/28/2008	X			No	Superseded by another RAI response; refer to NA3 RAI 8.02-29.	
08.02-5	9	Bus rating	NA3-08-056R	7/28/2008		X		No		
08.02-6	9	Transformer protection	NA3-08-056R	7/28/2008		X		No		
08.02-7	9	Switchyard protective relaying	NA3-08-056R	7/28/2008		X		No		

North Anna Unit 3 ESBWR R-COLA RAIs – Review Results

RAI ID #	NRC RAI Letter #	RAI Subject	RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Valid	RAI Response Requires Revision	COLA Change	Basis	Comments
08.02-8	9	Industry standards for switchyard protection system, monitoring, maintenance and testing	NA3-08-056R	7/28/2008		X		No		
08.02-9	9	Transformer testing	NA3-08-056R	7/28/2008	X			Yes	COLA approach revised	
08.02-10	9	Multiple facility contingencies	NA3-08-056R	7/28/2008	X			No	Superseded by another RAI response; refer to NA3 RAI 8.02-31.	
08.02-11	9	Analysis of the 34.5 kV portion of the switchyard	NA3-08-056R	7/28/2008		X		No		
08.02-12	9	Grid availability	NA3-08-056R	7/28/2008		X		No		
08.02-13	9	Clarify the reference to technical specifications	NA3-08-056R	7/28/2008		X		No		
08.02-14	9	System impact study	NA3-08-056R	7/28/2008			X	No	Revised response to this RAI question is provided in Enclosure 12 of this letter.	New PJM study dates reflected in COLA; response basis valid
08.02-15	9	Grid frequency variation	NA3-08-056R	7/28/2008			X	No	Revised response to this RAI question is provided in Enclosure 13 of this letter.	
08.02-16	9	GDC 5 applicability	NA3-08-056R	7/28/2008	X			No	Superseded by another RAI response; refer to NA3 RAI 8.02-42.	

North Anna Unit 3 ESBWR R-COLA RAIs – Review Results										
RAI ID #	NRC RAI Letter #	RAI Subject	RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Valid	RAI Response Requires Revision	COLA Change	Basis	Comments
08.02-17	9	GDC 4 applicability	NA3-08-056R	7/28/2008		X		No		
08.02-18	9	GDC 2 applicability	NA3-08-056R	7/28/2008		X		No		
08.02-19	9	Compliance with the requirements of 10 CFR 50.65(a)(4)	NA3-08-056R	7/28/2008		X		No		
08.02-20	9	Applicability of BTP 8-3	NA3-08-056R	7/28/2008		X		No		
08.02-21	9	Applicability of BTP 8-5	NA3-08-056R	7/28/2008		X		No		
08.02-22	9	Applicability of BTP 8-6	NA3-08-056R	7/28/2008		X		No		
08.02-23	9	Reliability of the offsite power system	NA3-08-056R	7/28/2008		X		No		
08.02-24	9	Station ground grid	NA3-08-056R	7/28/2008	X			No	Superseded by another RAI response; refer to NA3 RAI 8.02-37.	
08.02-25	9	Surge protection and lightning protection of offsite power system	NA3-08-056R	7/28/2008		X		No		
08.02-26	9	Grid instability	NA3-08-056R	7/28/2008		X		No		
08.02-27	16	Reliability and stability analysis	NA3-08-085R	8/21/2008		X		No		NA3 RAI 8.02-64 revised the upper limit for switchyard voltage.

North Anna Unit 3 ESBWR R-COLA RAIs – Review Results

RAI ID #	NRC RAI Letter #	RAI Subject	RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Valid	RAI Response Requires Revision	COLA Change	Basis	Comments
08.02-28	16	Capacity and capability of offsite power system	NA3-08-085R	8/21/2008		X		No		
08.02-29	29	Monitoring for high voltage (230 kV) cable degradation	NA3-08-121R	12/1/2008		X		No		
08.02-30	29	Identify transformers on Figure 8.2-201	NA3-08-121R	12/1/2008		X		No		
08.02-31	29	Grid stability	NA3-08-121R	12/1/2008		X		No		
08.02-32	29	Grid stability	NA3-08-121R	12/1/2008		X		No		
08.02-33	29	GDC 2 applicability	NA3-08-121R	12/1/2008		X		No		
08.02-34	29	GDC 4 applicability	NA3-08-121R	12/1/2008		X		No		
08.02-35	29	GDC 5 applicability	NA3-08-121R	12/1/2008		X		No		
08.02-36	29	Applicability of the Maintenance Rule to switchyard equipment	NA3-08-121R	12/1/2008		X		No		
08.02-37	29	Grounding system	NA3-08-121R	12/1/2008		X		No		
08.02-38	32	Switchyard voltage and frequency	NA3-09-007R	3/18/2009		X		No		

North Anna Unit 3 ESBWR R-COLA RAIs – Review Results										
RAI ID #	NRC RAI Letter #	RAI Subject	RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Valid	RAI Response Requires Revision	COLA Change	Basis	Comments
08.02-39	35	Testing of underground cables	N/A	4/6/2009	X			No	Other	NRC staff determined that a response to this RAI is not necessary.
08.02-40	35	Submergence of low voltage power cables	N/A	4/6/2009	X			No	Other	NRC staff determined that a response to this RAI was not necessary.
08.03.02-1	11	Training and procedures to mitigate an SBO event	NA3-08-63	8/4/2008		X		No		
08.03.02-2	11	Conformance with, RG 1.41, RG 1.128 and RG 1.129	NA3-08-63	8/4/2008	X			Yes	DCD revision	
09.01.04-1	13	Personnel qualifications, training, and control programs for fuel handling personnel	NA3-08-066R	8/4/2008		X		No		
09.01.04-2	13	Program for interlocks and safety features for refueling operation	NA3-08-066R	8/4/2008		X		No		
09.01.05-1	13	Special lifting devices and commitments to ANSI N14.6	NA3-08-066R	8/4/2008		X		No		
09.01.05-2	13	Heavy load handling equipment and interlocks	NA3-08-066R	8/4/2008		X		No		
09.02.01-1	17	ITAAC to address factors regarding cooling tower performance capability	NA3-08-086R	8/28/2008	X			Yes	DCD revised	

North Anna Unit 3 ESBWR R-COLA RAIs – Review Results										
RAI ID #	**NRC RAI Letter #**	**RAI Subject**	**RAI Response Letter #**	**RAI Response Letter Date**	**RAI or RAI Response Not Applicable**	**RAI Response Valid**	**RAI Response Requires Revision**	**COLA Change**	**Basis**	**Comments**
09.02.01-2	17	Use of fiberglass reinforced polyester pipe (FRPP) in locations where the plant service water system piping is buried to preclude long-term corrosion	NA3-08-086R	8/28/2008		X		No		
09.02.01-3	17	Material specifications for parts of the PSWS, including those for the cooling towers and related components	NA3-08-086R	8/28/2008	X			Yes	Similar to a more appropriate RAI response; refer to NA3 RAIs 09.02.01-9 and 09.02.01-13	
09.02.01-4	17	Corrosion and fouling mechanisms and vulnerabilities that are anticipated based on industry operating experience and the plant-specific location, and programmatic controls that will be implemented to address these considerations and to assure that PSWS performance (including cooling towers) will not degrade over time.	NA3-08-086R	8/28/2008		X		No		
09.02.01-5	17	Indicate what part of the information in the FSAR is NAPS-CDI (such as with double brackets)	NA3-08-086R	8/28/2008		X		No		
09.02.01-6	17	Cooling tower performance – RTNSS functions	NA3-08-086R	8/28/2008		X		No		

North Anna Unit 3 ESBWR R-COLA RAIs – Review Results

RAI ID #	NRC RAI Letter #	RAI Subject	RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Valid	RAI Response Requires Revision	COLA Change	Basis	Comments
09.02.01-7	17	Describe how the design capability of the PSWS will be verified by the initial plant test program	NA3-08-086R	8/28/2008		X		No		
09.02.01-8	36	Additional ITAAC acceptance criteria that confirms BTU capability of the PSWS	NA3-09-017R	7/8/2009		X		Yes		
09.02.01-9	36	Describe in the FSAR Section 9.2.1 the specific composition or properties of materials to be used in the PSWS	NA3-09-017R	7/8/2009		X		Yes		
09.02.01-10	36	Design of the chemical control system, chemical addition system, or water treatment system for the PSWS; and how the PSWS (including AHS cooling towers) will be treated in accordance with 10 CFR 50.65, "Maintenance Rule"	NA3-09-017Ra	8/3/2009		X		Yes		
09.02.01-11	36	Clearly identify the plant-specific information that addresses the CDI	NA3-09-017R	7/8/2009		X		Yes		
09.02.01-12	36	PSWS preoperational testing, and AHS performance capability testing	NA3-09-017Ra	8/3/2009		X		Yes		

North Anna Unit 3 ESBWR R-COLA RAIs – Review Results

RAI ID #	NRC RAI Letter #	RAI Subject	RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Valid	RAI Response Requires Revision	COLA Change	Basis	Comments
09.02.01-13	36	Describe the special treatment quality assurance provisions applicable to supplemental quality class S/N for the FRP used in PSWS for RTNSS systems	NA3-09-017Ra	8/3/2009			X	Yes	Revised response to this RAI question is provided in Enclosure 16 of this letter.	
09.02.05-1	11	Procedures for available makeup sources seven days after an accident	NA3-08-063R	8/4/2008		X		No		
09.03.02-1	7	Correct the reference citation in FSAR Section 9.3.2.2	NA3-08-055R	7/23/2008		X		No		
09.05.01-1	8	Change process for new reactor fire protection programs	NA3-08-054R	7/23/2008	X			Yes	COLA approach revised	
09.05.01-2	8	Multiple spurious actuations that may prevent post-fire safe shutdown	NA3-08-054R	7/23/2008		X		No		
09.05.01-3	8	Deviations from regulatory requirements and guidance	NA3-08-054R	7/23/2008		X		No		
09.05.01-4	8	Methodology for verifying hose station coverage	NA3-08-054R	7/23/2008		X		No		
09.05.01-5	8	Program to control the fire hazard	NA3-08-054R	7/23/2008		X		No		
09.05.01-6	8	Restricting transient combustibles	NA3-08-054R	7/23/2008		X		No		

North Anna Unit 3 ESBWR R-COLA RAIs – Review Results

RAI ID #	NRC RAI Letter #	RAI Subject	RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Valid	RAI Response Requires Revision	COLA Change	Basis	Comments
09.05.01-7	8	Program to control the fire hazard presented by paper or other combustible materials	NA3-08-054R	7/23/2008		X		No		
09.05.01-8	8	Program to monitor and maintain an acceptable level of quality of their fire water sources	NA3-08-054R	7/23/2008	X			Yes	New information available	
09.05.01-9	8	NFPA 55	NA3-08-054R	7/23/2008		X		No		
09.05.01-10	8	Communications for safe shutdown capability	NA3-08-054R	7/23/2008		X		No		
09.05.01-11	8	Non-safety related areas with a QA FP program different than that described in Chapter 17	NA3-08-054R	7/23/2008		X		No		
09.05.01-12	8	Fire brigade leader training, knowledge and competence	NA3-08-054R	7/23/2008		X		No		
09.05.01-13	8	Administrative controls governing the use and storage of hazardous chemicals in the powerblock	NA3-08-054R	7/23/2008		X		No		
09.05.01-14	8	Administrative controls for storage of unused ion exchange resins in specific plant areas	NA3-08-054R	7/23/2008		X		No		
09.05.01-15	8	Use a "recognized" testing laboratory in accordance with RG 1.189	NA3-08-054R	7/23/2008		X		No		

North Anna Unit 3 ESBWR R-COLA RAIs – Review Results										
RAI ID #	NRC RAI Letter #	RAI Subject	RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Valid	RAI Response Requires Revision	COLA Change	Basis	Comments
09.05.01-16	20	Acceptance criteria for fire barrier penetration seals as well as the use and qualification of smoke dampers	NA3-08-090R	9/4/2008		X		No		
09.05.01-17	20	Fire water loads of the plant	NA3-08-090R	9/4/2008		X		No		
09.05.01-18	20	Procedures and/or plans for rapid identification of the specific cabinet/console that is on fire and rapid access to the cabinets/consoles for fire fighting	NA3-08-090R	9/4/2008		X		No		
09.05.04-1	13	Diesel fuel oil inventory procedures	NA3-08-066R	8/4/2008		X		No		
09.05.04-2	13	Diesel fuel oil inventory	NA3-08-066R	8/4/2008		X		No		
09.05.04-3	16	Procedures for fuel quantity monitoring	NA3-08-085R	8/21/2008		X		No		
09.05.04-4	16	Corrosion control for underground portions of the fuel oil transfer system	NA3-08-085R	8/21/2008		X		No		
09.05.04-5	16	Fuel oil testing and inspection	NA3-08-085R	8/21/2008		X		No		

North Anna Unit 3 ESBWR R-COLA RAIs – Review Results

RAI ID #	NRC RAI Letter #	RAI Subject	RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Valid	RAI Response Requires Revision	COLA Change	Basis	Comments
09.05.04-6	30	Internal and external corrosion protection methods for underground portions of the diesel generator fuel oil storage and transfer systems	NA3-08-122R	12/3/2008		X		No		
09.05.04-7	36	Diesel fuel oil inventory	NA3-09-017Ra	8/3/2009		X		Yes		
09.05.04-8	36	Industry standards for corrosion protection	NA3-09-017Ra	8/3/2009		X		Yes		
10.03.06-1	6	FAC Monitoring: Description for construction and schedule for constr. & operations	NA3-08-053R	7/14/2008		X		No		
10.03.06-2	6	FAC Program description clarifications	NA3-08-053R	7/14/2008		X		No		
10.04.05-1	12	CIRC piping code, hydraulic transients, failure effects	NA3-08-064R	8/7/2008		X		No		
10.04.05-2	12	Cooling tower failure analysis	NA3-08-064R	8/7/2008		X		No		
11.02-1	4	Updated Cost Benefit Analysis of LWMS	NA3-08-051	7/30/2008		X		Yes		Dose values are updated per DCD revision
11.02-2	7	LWMS sampling of non-radioactive systems upstream locations of radioactive systems	NA3-08-55R	7/23/2008		X		No		

North Anna Unit 3 ESBWR R-COLA RAIs – Review Results

RAI ID #	NRC RAI Letter #	RAI Subject	RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Valid	RAI Response Requires Revision	COLA Change	Basis	Comments
11.03-0	7	GWMC cost benefit analysis NEI Template 07-11	NA3-08-055R	7/23/2008		X		No		
11.03-1	7	Bypassing Offsite Gas	NA3-08-055R	7/23/2008		X		No		
11.03-2	30	Cost Benefit of GWMS	NA3-08-122R	12/3/2008		X		Yes		Dose values are updated per DCD revision
11.04-1A	4	Solid Waste - Cost Benefit Analysis	NA3-08-051	6/30/2008		X		No		
11.04-1B	4	Solid Waste - Process Control Program	NA3-08-051	6/30/2008	X			Yes	New information available	
11.04-2	7	SWMS: Sampling non-radioactive systems	NA3-08-055R	7/23/2008		X		No		
11.04-3	20	Low-level radioactive waste storage	NA3-08-090R	9/4/2008		X		Yes		Radwaste building changes are described in December COLA submittal
11.04-4	32	Revise description of SWMS	NA3-09-007R	3/18/2009		X		No		
11.05-1	4	Offsite Dose Calculation Manual	NA3-08-51	6/30/2007	X			Yes	New information available	
11.05-2	4	Process & Effluent Monitoring	NA3-08-51	6/30/2008		X		No		
11.05-3	7	FSAR vs. ER: ODCM and NEI 07-09	NA3-08-055R	7/23/2008		X		No		

North Anna Unit 3 ESBWR R-COLA RAIs – Review Results

RAI ID #	NRC RAI Letter #	RAI Subject	RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Valid	RAI Response Requires Revision	COLA Change	Basis	Comments
11.05-4	26	CST Basin Sampling provisions	NA3-08-104R	10/2/2008		X		No		
11.05-5	32	Sampling of Batch Liquid Release added	NA3-09-007R	3/18/2009		X		No		
12.01-1	27	Update Commitment to Final Version of NEI 07-03	NA3-08-105R	10/3/2008		X		Yes		
12.01-2	27	ALARA Procedures for Use of Inclined Fuel	NA3-08-105R	10/3/2008		X		No		
12.01-3	27	Update Commitment to Final Version of NEI 07-08	NA3-08-105R	10/3/2008		X		Yes		
12.02-1	1	Address inconsistency in offsite doses from gaseous effluents for the child thyroid	NA3-08-043	4/28/2008	X			Yes	New information available	
12.02-2	11	Dose Analysis and EPA Standards	NA3-08-063R	8/4/2008	X			Yes	New information available	
12.02-3	16	Liquid Doses Offsite	NA3-08-085R	8/21/2008	X			Yes	New information available	
12.02-4	24	Address COL Item 12.2-4-A in FSAR	NA3-08-095R	9/19/2008		X		No		
12.02-5	24	FSAR Section 12.5 Clarification	NA3-08-095R	9/19/2008		X		No		Response is valid except that NEI 07-03 is now NEI 07-03A.
12.02-6	24	Additional Contained Source Uses	NA3-08-095R	9/19/2008		X		No		

North Anna Unit 3 ESBWR R-COLA RAIs – Review Results										
RAI ID #	NRC RAI Letter #	RAI Subject	RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Valid	RAI Response Requires Revision	COLA Change	Basis	Comments
12.02-7	24	Source Shielding Requirements	NA3-08-095R	9/19/2008		X		No		
12.02-8	24	Check Sources Integral to Monitors	NA3-08-095R	9/19/2008		X		No		
12.02-9	24	Cf-252 Source Placement and Duration	NA3-08-095R	9/19/2008		X		No		
12.02-10	25	Inconsistency in gaseous effluent doses between tables 12.2-18bR, -201, -203	NA3-08-116	10/17/2008	X			Yes	DCD revision	
12.02-11	30	Clarify Information In Section 12 Tables	NA3-08-122R	12/3/2008	X			Yes	New information available	
12.02-12	30	Dose Contributions	NA3-08-122R	12/3/2008		X		Yes		
12.02-13	33	Citation for ESP Variance	NA3-09-010R	4/3/2009		X		No		
12.03-12.04-1	24	Placement and Number of Portable RAMs	NA3-08-095R	9/19/2008		X		No		Except that NEI 07-03 is now NEI 07-03A
12.03-12.04-2	24	Very High Radiation Area Drawings	NA3-08-095R	9/19/2008		X		No		Section 12.5.4.4 has been updated by response to RAI 12.03-12.04-11
12.03-12.04-3	24	Zinc Injection System Justification	NA3-08-095R	9/19/2008	X			No	Other- zinc injection to be used	
12.03-12.04-4	24	DCD and FSAR Chapter 12 Consistency	NA3-08-095R	9/19/2008		X		No		

North Anna Unit 3 ESBWR R-COLA RAIs – Review Results

RAI ID #	NRC RAI Letter #	RAI Subject	RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Valid	RAI Response Requires Revision	COLA Change	Basis	Comments
12.03-12.04-5	27	Impact of TLD relocations on construction worker doses	NA3-08-105R	10/3/2008	X			Yes	New information available	
12.03-12.04-6	27	Dose to construction workers from ISFSI	NA3-08-105R	10/3/2008	X			Yes	New information available	
12.03-12.04-7	27	Size of construction workforce	NA3-08-105R	10/3/2008	X			Yes	New information available	
12.03-12.04-8	27	Describe Operational Programs for Meeting 10CFR 20.1406(a) Requirements	NA3-08-105R	10/3/2008		X		Yes		Except that NEI 08-08 is now NEI 08-08A
12.03-12.04-9	30	Editorial Corrections in Chap 12	NA3-08-122R	12/3/2008		X		Yes		Except that RG 1.16 has been withdrawn
12.03-12.04-10	31	Zinc Injection System	NA3-09-005R	2/10/2009	X			No	Other- zinc injection used	
12.03-12.04-11	31	Very High Radiation Areas	NA3-09-005R	2/10/2009		X		Yes		
12.03-12.04-12	37	ALARA for Construction Workers	NA3-09-021R	8/24/2009		X		No		
12.03-12.04-13	44	Design Objectives and Guidance in RG 4.21	NA3-09-040R	2/4/2010		X		Yes		Except NEI 08-08 is now NEI 08-08A
12.05-1	24	Airborne Iodine Concentration Instruments	NA3-08-095R	9/19/2008		X		Yes		Except NEI 07-03 is now NEI 07-03A
12.05-2	24	Site-Specific Alterations to NEI 07-03	NA3-08-095R	9/19/2008		X		No		Except NEI 07-03 is now NEI 07-03A

North Anna Unit 3 ESBWR R-COLA RAIs – Review Results

RAI ID #	NRC RAI Letter #	RAI Subject	RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Valid	RAI Response Requires Revision	COLA Change	Basis	Comments
12.05-3	24	Radiation Protection Program Milestones	NA3-08-095R	9/19/2008		X		Yes		Except that NEI 07-03 is now NEI 07-03A
15.06.05-1	25	Dose Evaluation Factors	NA3-08-116	10/17/2008	X			Yes	DCD revised	
ER Section 10.4-1	Accession Number ML0816305 83	Cost-benefit analysis	NA3-08-079R	7/17/2008	X			Yes	COLA approach revised	Updated information provided as needed in ER Chapter 10
ER Section 2.4-2	Accession Number ML0816305 83	Provide latest on-site wetland and stream evaluation	NA3-08-079R	7/17/2008		X		No		Joint Permit Application updated as needed with changes to response
ER Section 2.4-3	Accession Number ML0816305 83	Provide map of habitat types along the Ladysmith transmission corridor and proportion of each habitat type along the right-of-way	NA3-08-079R	7/17/2008		X		No		
ER Section 3.4-1	Accession Number ML0816305 83	Intake Design	NA3-08-079R	7/17/2008		X		No		
NRC RAI 05-03 BTP-1	26	Fracture Toughness Requirements.	NA3-08-104R	10/2/2008	X			Yes	DCD Revised.	

ENCLOSURE 3

North Anna Unit 3 US-APWR S-COLA RAIs

Review Results

North Anna Unit 3 US-APWR S-COLA RAIs – Review Results											
RAI ID #	**NRC RAI Letter #**	**RAI Subject**	**NA3 S-COLA RAI Response Letter #**	**RAI Response Letter Date**	**RAI or RAI Response Not Applicable**	**RAI Response Valid**	**RAI Response Requires Revision**	**COLA Change**	**Basis**	**Comments**
01.05-1	102	Potential Impacts of CEUS-SSC Model	NA3-12-016R	7/30/2012	X			Yes	New Information Available	
01.05-2	102	Reliable spent fuel pool instrumentation	NA3-12-016R	7/30/2012	X			No	Similar to a more appropriate RAI response; refer to EF3 ESBWR RAI 01.05-4	
01.05-3	102	Enhancing emergency preparedness	NA3-12-016R	7/30/2012	X			No	Similar to a more appropriate RAI response; refer to EF3 ESBWR RAI 13.03-91.	
02.02.03-8	50	MCR Chemical Concentration ALOHA Model Inputs and Assumptions	NA3-10-032R	1/10/2011			X	Yes	Revised response to this RAI question is provided in Enclosure 6 of this letter.	
02.02.03-9	50	On-site Chemical Explosions Analysis Inputs and Assumptions For Ethanol	NA3-10-032R	1/10/2011	X			No	Not applicable to ESBWR technology	
02.03.01-5	49	Tornado parameters variance	NA3-10-031R	1/10/2011	X			No	Not applicable to ESBWR technology	
02.03.01-6	71	100-year return period minimum dry bulb temperature	NA3-11-028R	6/16/2011		X		Yes		

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02.03.02-3	49	SACTI code files	NA3-10-031R	1/10/2011	X			No	Not applicable to ESBWR technology	The response is superseded by the information related to the potential impacts of the Unit 3 cooling tower provided in FSAR Revision 7, Section 2.3.2.3. Updated SACTI code input and output files are provided in Enclosure 19 of this letter.
02.03.04-2	49	ARCON96 Input/Output Files	NA3-10-031R	1/10/2011	X			No	Not applicable to ESBWR technology	Updated ARCON96 code input and output files are provided in Enclosure 20 of this letter.
02.03.04-2-S1	49	ARCON96 Input and Output Files	NA3-10-031RA	2/18/2011	X			No	Not applicable to ESBWR technology	The portions of the response related to US-APWR technology are superseded. The information in the response on the ARCON96 inputs and assumptions remains valid except that for Item "5," refer to the ESBWR-specific information in DCD Appendix 2A. Updated ARCON96 code input and output files are provided in Enclosure 20 of this letter and reflect the adjustments to convert ESBWR DCD source and receptor directions in DCD Appendix 2A from ESBWR plant North to true North for the Unit 3 site.

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02.03.05-4	49	XOQDOQ Input/Output Files	NA3-10-031R	1/10/2011	X			No	Not applicable to ESBWR technology	The response is superseded by the XOQDOQ input data and assumptions that are applicable to the ESBWR technology at the Unit 3 site. See FSAR Revision 7, Section 2.3.5.1 for the inputs and assumptions. Updated XOQDOQ code input and output files are provided in Enclosure 21 of this letter.
02.04.02-8	63	Reported design basis flood elevation is lower than the maximum flood elevation from the local PMP.	NA3-11-018R	5/3/2011	X			Yes	New Information Available	
02.04.02-9	63	Locations of supercritical velocities and hydraulic jumps for modified storm water management system	NA3-11-018R	5/3/2011	X			Yes	New Information Available	
02.04.02-9-S1	63	Provide a figure showing Super-Critical flow and hydraulic jump locations	NA3-11-018RA	8/10/2011	X			Yes	New Information Available	
02.04.12-3	103	Maximum groundwater elevation	NA3-12-019R	10/23/2012		X		Yes		Except maximum groundwater value is specific to reactor technology

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02.05.02-1	53	Justify GMRS at hard rock at El.145' and provide Vs for GMRS.	NA3-10-035R	1/28/2011	X			Yes	New Information Available	
02.05.02-1-S1	53	Markups for 02.05.02-1: Justification of GMRS determination and description of SRA	NA3-10-035RA	3/22/2011	X			Yes	New Information Available	
02.05.02-2	53	Justify assumption of uniformity of layers based on borings and Vs profiles in relation to 1-D analysis and describe how the SRA will adequately capture site variability.	NA3-10-035R	1/28/2011			X	Yes	Revised response to this RAI question is provided in Enclosure 8 of this letter.	
02.05.02-3	68	Provide a table of layer thicknesses, shear-wave velocities, and densities, and identify the type of shear modulus and damping curves used for all site amplification calculations.	NA3-11-025R	8/25/2011			X	Yes	Revised response to this RAI question is provided in Enclosure 9 of this letter.	

North Anna Unit 3 US-APWR S-COLA RAIs – Review Results										
RAI ID #	**NRC RAI Letter #**	**RAI Subject**	**NA3 S-COLA RAI Response Letter #**	**RAI Response Letter Date**	**RAI or RAI Response Not Applicable**	**RAI Response Valid**	**RAI Response Requires Revision**	**COLA Change**	**Basis**	**Comments**
02.05.02-3-S1	68	Provide the SWV input files used in calculation.	NA3-11-025RA	12/5/2011			X	No	Revised response to this RAI question is provided in Enclosure 9 of this letter.	
02.05.02-3-S2	68	Clarify how information was used in the idealized SWV profiles for the sensitivity study of Q02.05.02-3. Idealized Vs profiles for boreholes 8-901, 8-907, and 8-909, as well as boreholes M10 and M30, should be considered for addition to the FSAR.	NA3-11-025RB	2/8/2012			X	Yes	Revised response to this RAI question is provided in Enclosure 9 of this letter.	
02.05.02-4	88	Assess the adequacy of the EPRI SOG seismic source model in light of the Mineral EQ. Review the adequacy of each EST model, and provide assessment of ground shaking (and address the impact on GMRS).	NA3-11-061R	2/13/2012	X			Yes	New Information Available	

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RAI ID #	NRC RAI Letter #	RAI Subject	NA3 S-COLA RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Valid	RAI Response Requires Revision	COLA Change	Basis	Comments
02.05.02-5	94	Provide a schedule for when the assessment discussed in the Part 21 notification will be completed and available for staff review.	NA3-11-061R	2/13/2012	X			Yes	New Information Available	
02.05.04-22	59	Since thermal cracking can be an issue for a large concrete mass, describe how the concrete fill will be placed to reduce thermal cracking distress. Also describe methods to ensure the long term strength and stability of the concrete.	NA3-11-009RA	4/4/2011		X		Yes		
02.05.04-23	59	Settlement calculations of seismic Category 1 structures and foundations.	NA3-11-009R	3/7/2011		X		No		

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RAI ID #	NRC RAI Letter #	RAI Subject	NA3 S-COLA RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Valid	RAI Response Requires Revision	COLA Change	Basis	Comments
02.05.04-24	59	The staff did not find a comparison between the total lateral earth pressure (static and dynamic) and the standard plant design. Provide this comparison of the site-specific values to the standard design.	NA3-11-009RA	4/4/2011	X			No	Not applicable to ESBWR technology	
02.05.04-25	82	Describe and justify how to assure that the fill concrete will attain the SWV used in the FIRS calculations of at least 7,000 ft/s.	NA3-11-049R	10/20/2011		X		Yes		
03.07.01-3	64	SASSI (computer code) uniformity assumption applicability	NA3-11-019R	8/22/2011			X	Yes	Revised response to this RAI question is provided in Enclosure 10 of this letter.	
03.07.01-4	64	Use of SSE damping values vs OBE damping values in calculating ISRS for Category 1 structures.	NA3-11-019R	8/22/2011	X			Yes	COLA approach revised	

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03.07.01-5	81	Development of SWV profiles	NA3-11-048R	2/8/2012	X			No	Not applicable to ESBWR technology	
03.07.01-5-S1	81	Development of SWV profiles.	NA3-11-048RA	5/31/2012	X			No	Not applicable to ESBWR technology	
03.07.01-6	81	Please provide a description discussing how each of the PBSRS profiles were developed and describe the process for developing the profiles along the East side of the plant's footprints (e.g., ESWP Tunnel and East PS/B) since there are no P-S suspension logging measurements in this area.	NA3-11-048R	2/8/2012	X			No	Not applicable to ESBWR	
03.07.02-2	64	Site-specific SSI analyses of Unit 3 R/B complex.	NA3-11-019R	8/22/2011	X			No	Not applicable to ESBWR technology	

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03.07.02-3	64	Soil-structure interaction related to seismic SSI analyses of standard plant Cat. I structures	NA3-11-019R	8/22/2011	X			No	Not applicable to ESBWR technology	
03.07.02-4	64	Soil-structure interaction related to seismic SSI analyses of site-specific Cat. I structures	NA3-11-019R	8/22/2011	X			No	Not applicable to ESBWR technology	
03.07.02-5	64	Full range of possible element connectivity in a 3D model not addressed	NA3-11-019R	8/22/2011	X			No	Not applicable to ESBWR technology	
03.07.02-6	64	A model cut-off frequency less than 50 Hz may underestimate seismic demands in the high-frequency range.	No Response Submitted		X			No	Not applicable to ESBWR technology	
03.07.02-7	64	ISRS developed from combining embedded and incoherent response	No Response Submitted		X			No	Not applicable to ESBWR technology	

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03.07.02-8	64	SSSI between the R/B complex and adjacent structures including the Aux. Building, PS/Bs, and the Turbine Building	No Response Submitted		X			No	Not applicable to ESBWR technology	
03.07.02-9	64	Effects of soil-structure separation and sliding on the results of seismic SSI analyses	NA3-11-019R	8/22/2011	X			No	Not applicable to ESBWR technology	
03.07.04-1	83	Considering the subsurface complexity and varying ground surface elevation of the site, specify the location you are planning	NA3-11-052R	10/12/2011	X			No	Not applicable to ESBWR technology	
03.08.04-1	74	Interface detail between the seismic Category I ESWPT foundation and the concrete shear keys	No Response		X			No	Not applicable to ESBWR technology	

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03.08.04-2	74	Performance specification for EWSPT, UHSRS, PSFSVs, and Other Site-Specific Structures expansion/isolation joints	NA3-11-037R	8/25/2011	X			No	Not applicable to ESBWR technology	
03.08.04-3	74	ESWPT, dowels and shear key are only present at the portion of the tunnel adjacent to the east PS/B.	NA3-11-037R	8/25/2011	X			No	Not applicable to ESBWR technology	
03.08.04-4	74	UHSRS - basins separate or connected? Text and figure in Subsection 3.8.4.1.3.2 appear in conflict.	NA3-11-037R	8/25/2011	X			No	Not applicable to ESBWR technology	
03.08.04-5	74	Thickness and support for wall 5 ft above basemat and 54 ft from exterior face of northern exterior wall of UHS	NA3-11-037R	8/25/2011	X			No	Not applicable to ESBWR technology	
03.08.04-6	74	ESWPT - contradicting statements regarding soil embedment	NA3-11-037R	8/25/2011	X			No	Not applicable to ESBWR technology	

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03.08.04-7	74	ESWPT - spring stiffnesses	No Response Submitted		X			No	Not applicable to ESBWR technology	
03.08.04-8	74	ESWPT - Ko values used to calculate static soil pressures	NA3-11-037R	8/25/2011	X			No	Not applicable to ESBWR technology	
03.08.04-9	74	UHSRS - Explain in detail how the rocking soil springs were calculated.	No Response Submitted		X			No	Not applicable to ESBWR technology	
03.08.04-10	74	UHSRS - vertical spring value used and resulting largest bending in the base mat.	No Response Submitted		X			No	Not applicable to ESBWR technology	
03.08.04-11	74	UHSRS - Clarify statement regarding secondary static analysis.	No Response Submitted		X			No	Not applicable to ESBWR technology	
03.08.04-12	74	PSFSVs - FSAR did not cite the ACI code and guide used in the design.	NA3-11-037R	8/25/2011	X			No	Not applicable to ESBWR technology	
03.08.04-13	74	UHSRS - how are seismic loads transmitted in the tunnel area.	NA3-11-037R	8/25/2011	X			No	Not applicable to ESBWR technology	

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03.08.04-14	74	Part 11 contains values of 6 soil springs. Describe how these values were obtained.	No Response Submitted		X			No	Not applicable to ESBWR technology	
03.08.04-15	74	Part 11, Provide justification for modeling methodology used for walls and slabs in SASSI and ANSYS models.	No Response Submitted		X			No	Not applicable to ESBWR technology	
03.08.04-16	74	SSI analysis for UHSRS neglected the embedment effects of the engineered backfill.	No Response Submitted		X			No	Not applicable to ESBWR technology	
03.08.04-17	74	Part 11, SSI Analysis - high level of design stresses that justifies the use of higher SSE damping values	NA3-11-037R	8/25/2011	X			No	Not applicable to ESBWR technology	
03.08.04-18	74	Part 11, SASSI model and ANSYS design model - impulse effect due to the base rocking motion is not captured.	No Response Submitted		X			No	Not applicable to ESBWR technology	

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03.08.04-19	74	Numerical data for the fundamental frequency of the liquid-tank system	No Response Submitted		X			No	Not applicable to ESBWR technology	
03.08.04-20	74	Use of a constant modal damping ratio equal to 5% in ANSYS for UHSRS FE Model Material Properties.	NA3-11-037R	8/25/2011	X			No	Not applicable to ESBWR technology	
03.08.04-21	74	Use of zero unit weight for steel elements of SASSI model for UHSRS FE Model Material Properties.	NA3-11-037R	8/25/2011	X			No	Not applicable to ESBWR technology	
03.08.04-22	74	Amplification effects due to out-of-plane flexibility of walls and slabs, SASSI FE Model Peak Accelerations at Key UHSRS Loc.	NA3-11-037R	8/25/2011	X			No	Not applicable to ESBWR technology	
03.08.04-23	74	Part 11, "SASSI FE Model Peak Accelerations at Key UHSRS Locations," Definitions of avg peak accl. and peak acceleration.	No Response Submitted		X			No	Not applicable to ESBWR technology	

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03.08.04-24	74	Ratio of allowable bearing capacity to bearing pressure assoc. with UHSRS building for static case is questioned by staff	NA3-11-037R	8/25/2011	X			No	Not applicable to ESBWR technology	
03.08.04-25	74	Part 11, Table 3.0-10. Are values for bearing pressures listed in the table with or without buoyancy force due to water?	NA3-11-037R	8/25/2011	X			No	Not applicable to ESBWR technology	
03.08.04-26	74	Part 11, "PSFSV" Alteration to concrete properties with respect to stress or strain of slabs and walls	No Response Submitted		X			No	Not applicable to ESBWR technology	
03.08.04-27	74	Part 11, "PSFSV" Was fuel-tank interaction considered in the modeling?	No Response Submitted		X			No	Not applicable to ESBWR technology	

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03.08.04-28	74	Part 11, Addt'l. margins introduced in the design of the reinforced concrete members of the PSFSV	No Response Submitted		X			No	Not applicable to ESBWR technology	
03.08.04-29	74	Part 11, "SASSI SSI Model and Analysis," Seismic response of PSFSV warrants use of higher SSE damping values.	NA3-11-037R	8/25/2011	X			No	Not applicable to ESBWR technology	
03.08.04-30	74	Justify the two cases with cut-off frequency at 25 Hz assoc with ESWPT and the UHSRS Pipe Chase SSI Analysis in Part 11.	NA3-11-037R	8/25/2011	X			No	Not applicable to ESBWR technology	
03.08.04-31	74	Part 11, Add a column for mode shape in Table 5.0-12, ESWPT Dynamic Properties.	NA3-11-037R	8/25/2011	X			No	Not applicable to ESBWR technology	

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03.08.04-32	74	Part 11, Table 5.0-14, "Load Combinations and Factor of Safety for ESWPT - with or without buoyancy force due to water?	NA3-11-037R	8/25/2011	X			No	Not applicable to ESBWR technology	
03.08.04-33	74	ESWPT - Stiffness of soil spring and establishment of stiffness in each of the 3 orthogonal directions.	No Response Submitted		X			No	Not applicable to ESBWR technology	
03.08.04-34	101	Structural Engineering Branch 1 (AP1000/EPR Projects) (SEB1)	No Response Submitted		X			No	Not applicable to ESBWR technology	
03.08.04-35	101	Stiffness of the ultimate heat sink related structures	No Response Submitted		X			No	Not applicable to ESBWR technology	
03.08.04-36	101	Mode shapes for the ESWPT	No Response Submitted		X			No	Not applicable to ESBWR technology	
03.08.05-1	75	Rebar sizes and spacing related to the UHSRS and PSFSVs.	No Response Submitted		X			No	Not applicable to ESBWR technology	

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03.08.05-2	75	Bearing capacity for safety-related buildings.	NA3-11-038R	8/15/2011	X			No	Not applicable to ESBWR technology	
03.08.05-3	75	1.1 factor of safety against sliding for the PSFSVs.	NA3-11-038R	8/15/2011	X			No	Not applicable to ESBWR technology	
03.08.05-4	75	Explain the meaning of SHEAR #9@24" + @24 labeled for the shear reinforcement (stirrup).	NA3-11-038R	8/15/2011	X			No	Not applicable to ESBWR technology	
03.08.05-5	75	Reinforcement in the PS/B basemats. Provide spacing requirements for #11 rebar.	NA3-11-038R	8/15/2011	X			No	Not applicable to ESBWR technology	
03.09.06-8	61	License conditions for implementation of the IST	NA3-11-011R	3/22/2011	X			No	Similar to a more appropriate RAI response; refer to EF3 ESBWR RAI 14.02-4.	
03.12-1	51	Piping systems compliance with GDC 2.	NA3-10-033R	1/10/2011	X			No	Not applicable to ESBWR technology	
06.04-1	70	Satisfy RG 1.196 Position 2.5 during life cycle of NA3	NA3-11-027R	6/13/2011		X		No		DCD and FSAR references will be updated

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06.04-2	70	Hazardous chemical · dispersion	NA3-11-027R	6/13/2011	X			No	Not applicable to ESBWR technology	
06.04-3	70	Operator actions upon sensing the presence of toxic chemicals versus asphyxiates	NA3-11-027RA	7/18/2011	X			No	Not applicable to ESBWR technology	
06.04-4	70	Procedures for dealing with toxic gas.	NA3-11-027R	7/13/2011	X			No	Not applicable to ESBWR technology	
06.04-5	70	RG 1. 78 evaluation in the FSAR for the refrigerants to be used.	NA3-11-027RA	7/18/2011	X			No	Not applicable to ESBWR technology	
06.04-6	87	Explain if a dike in the Turbine building is required for 40% dimethylamine solution.	NA3-11-060R	12/12/2011	X			No	Not applicable to ESBWR technology	
06.04-7	87	Justification of carbon dioxide dispersion model.	NA3-11-060R	12/12/2011		X		No		
08.02-40	54	Unit voltage limit Technical Specifications	NA3-11-003R	3/17/2011	X			No	Not applicable to ESBWR technology	

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08.02-41	54	Switchyard interface agreement	NA3-11-003R	3/17/2011	X			No	COLA approach revised	
08.02-42	54	GDC 5 applicability	NA3-11-003RA	5/12/2011		X		Yes		
08.02-43	54	Ratings of transformers, breakers, transmission lines and bus work	NA3-11-003R	3/17/2011	X			Yes	New Information Available	
08.02-43-S1	54	Switchyard Component Ratings	NA3-11-003RA	5/12/2011	X			Yes	New Information Available	
08.02-44	54	High voltage circuit breakers and disconnect switches	NA3-11-003R	3/17/2011		X		No		
08.02-45	54	Design of the grounding system	NA3-11-003RA	5/12/2011		X		Yes		
08.02-46	54	Switchyard protection system monitoring, maintenance, and testing	NA3-11-003R	3/17/2011		X		Yes		

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08.02-47	54	Cable monitoring program for underground and inaccessible cables	NA3-11-003R	3/17/2011		X		Yes		
08.02-48	54	Fire barriers between all transformers	NA3-11-003R	3/17/2011	X			No	Not applicable to ESBWR technology	
08.02-49	54	AC/DC station service and grounding	NA3-11-003R	3/17/2011		X		Yes		
08.02-50	54	Stability of the grid	NA3-11-003RA	5/12/2011	X			No	Not applicable to ESBWR technology	
08.02-51	54	Relays associated with primary and backup protection scheme	NA3-11-003R	3/17/2011		X		Yes		
08.02-52	54	System impact study	NA3-11-003RA	5/12/2011	X			Yes	New Information Available	
08.02-53	54	Stability of the grid	NA3-11-003R	3/17/2011	X			No	Not applicable to ESBWR technology	
08.02-54	54	Maximum and minimum switchyard voltage limits	NA3-11-003RA	5/12/2011			X	No	Revised response to this RAI question is provided in Enclosure 14 of this letter.	

North Anna Unit 3 US-APWR S-COLA RAIs – Review Results										
RAI ID #	NRC RAI Letter #	RAI Subject	NA3 S-COLA RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Valid	RAI Response Requires Revision	COLA Change	Basis	Comments
08.02-55	54	Grid reliability and stability analysis	NA3-11-003RA	5/12/2011	X			No	Not applicable to ESBWR technology	
08.02-56	54	Transmission system reliability	NA3-11-003R	3/17/2011	X			No	Similar to a more appropriate RAI response; refer to NA3 RAI 8.2-23.	
08.02-57	54	FMEA of the switchyard components	NA3-11-003R	3/17/2011	X			No	Not applicable to ESBWR technology	
08.02-58	54	Maximum and minimum switchyard voltage limits	NA3-11-003R	3/17/2011	X			No	Similar to a more appropriate RAI response; refer to NA3 RAI 8.2-27.	
08.02-59	66	Grid stability analysis	NA3-11-021R	5/26/2011			X	No	Revised response to this RAI question is provided in Enclosure 15 of this letter.	
08.02-60	78	Over current relays for transformer 1 and 2	NA3-11-044R	9/16/2011		X		No		
08.02-61	78	Switchyard lightning protection system	NA3-11-044R	9/16/2011		X		Yes		
08.02-62	78	Condition monitoring of underground or inaccessible cables	NA3-11-044R	9/16/2011		X		No		
08.02-63	78	Switchyard batteries	NA3-11-044R	9/16/2011	X			No	COLA approach revised	

North Anna Unit 3 US-APWR S-COLA RAIs – Review Results										
RAI ID #	NRC RAI Letter #	RAI Subject	NA3 S-COLA RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Valid	RAI Response Requires Revision	COLA Change	Basis	Comments
08.02-64	78	Maximum and minimum voltage variation	NA3-11-044R	9/16/2011	X			Yes	New Information Available	
08.02-65	78	Switchyard dc power	NA3-11-044R	9/16/2011	X			No	Not applicable to ESBWR technology	
09.01.05-3	65	Program and schedule for heavy load handling	NA3-11-020R	5/6/2011	X			No	Not applicable to ESBWR technology	
09.02.01-14	65	Essential service water system (ESWS) pump(s) design details	NA3-11-020RA	6/9/2011	X			No	Not applicable to ESBWR technology	
09.02.01-14 (S1)	65	ESWP total dynamic head and net positive suction head (NPSH) available	NA3-11-020RB	9/27/2012	X			No	Not applicable to ESBWR technology	
09.02.02-1	65	NA3 CCWS - confirm DCD markup with RAI 571-4365 response is still valid and accurate.	NA3-11-020R	5/6/2011	X			No	Not applicable to ESBWR technology	
09.02.04-1	65	Potential radiological contamination of sanitary drains in the RCA.	NA3-11-020R	5/6/2011	X			No	Not applicable to ESBWR technology	

North Anna Unit 3 US-APWR S-COLA RAIs – Review Results										
RAI ID #	NRC RAI Letter #	RAI Subject	NA3 S-COLA RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Valid	RAI Response Requires Revision	COLA Change	Basis	Comments
09.02.05-2	96	WB temperature effects on the UHS	NA3-12-008R	4/13/2012	X			No	Not applicable to ESBWR technology	
09.02.05-2-S1	96	UHS Design Wet Bulb Temperature	NA3-12-008RA	8/13/2012	X			No	Not applicable to ESBWR technology	
09.02.05-3	99	Balance of Plant and Technical Specifications Branch (BPTS)	NA3-12-011RB	2/11/2013	X			No	Not applicable to ESBWR technology	
09.02.05-4	99	Balance of Plant and Technical Specifications Branch (BPTS)	NA3-12-011R	8/30/2012	X			No	Not applicable to ESBWR technology	
09.02.05-5	99	Balance of Plant and Technical Specifications Branch (BPTS)	NA3-12-011R	8/30/2012	X			No	Not applicable to ESBWR technology	
09.02.05-6	99	Balance of Plant and Technical Specifications Branch (BPTS)	NA3-12-011R	8/30/2012	X			No	Not applicable to ESBWR technology	
09.02.05-7	99	Balance of Plant and Technical Specifications Branch (BPTS)	NA3-12-011RA	12/13/2012	X			No	Not applicable to ESBWR technology	
09.02.05-8	99	Balance of Plant and Technical Specifications Branch (BPTS)	No Response Submitted		X			No	Not applicable to ESBWR technology	

North Anna Unit 3 US-APWR S-COLA RAIs – Review Results										
RAI ID #	**NRC RAI Letter #**	**RAI Subject**	**NA3 S-COLA RAI Response Letter #**	**RAI Response Letter Date**	**RAI or RAI Response Not Applicable**	**RAI Response Valid**	**RAI Response Requires Revision**	**COLA Change**	**Basis**	**Comments**
09.02.05-9	99	Balance of Plant and Technical Specifications Branch (BPTS)	NA3-12-011R	8/30/2012	X			No	Not applicable to ESBWR technology	
09.02.05-10	99	Balance of Plant and Technical Specifications Branch (BPTS)	No Response Submitted		X			No	Not applicable to ESBWR technology	
09.02.05-11	99	Balance of Plant and Technical Specifications Branch (BPTS)	NA3-12-011RA	12/13/2012	X			No	Not applicable to ESBWR technology	
09.02.05-12	99	Balance of Plant and Technical Specifications Branch (BPTS)	NA3-12-011R	8/30/2012	X			No	Not applicable to ESBWR technology	
09.02.05-13	99	Balance of Plant and Technical Specifications Branch (BPTS)	NA3-12-011R	8/30/2012	X			No	Not applicable to ESBWR technology	
09.02.05-14	99	Balance of Plant and Technical Specifications Branch (BPTS)	No Response Submitted		X			No	Not applicable to ESBWR technology	
09.03.04-1	65	Chemical and Volume Control System Flow Diagram	NA3-11-020RA	6/9/2011	X			No	Not applicable to ESBWR technology	
09.04.05-1	72	Labeling FSAR sections 9.4.5.2.3 and 9.4.5.2.5 as NAPS COL 9.4(4)	NA3-11-034R	7/7/2011	X			No	Not applicable to ESBWR technology	

North Anna Unit 3 US-APWR S-COLA RAIs – Review Results										
RAI ID #	NRC RAI Letter #	RAI Subject	NA3 S-COLA RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Valid	RAI Response Requires Revision	COLA Change	Basis	Comments
09.04.05-2	72	Basis and calculations used in the sizing of the heaters (i.e. 45 KW) for the MCR AHU	NA3-11-034R	7/7/2011	X			No	Not applicable to ESBWR technology	
09.04.05-3	72	Bases and calculations used in the sizing of the heaters for these ESF systems' air handling units	NA3-11-034R	7/7/2011	X			No	Not applicable to ESBWR technology	
09.04.05-4	72	Barrier between the ESW pump room and the UHS transfer pump room	NA3-11-034RA	8/22/2011	X			No	Not applicable to ESBWR technology	
09.04.05-5	72	UHS ESW Pump House and GDC 17	NA3-11-034RA	8/22/2011	X			No	Not applicable to ESBWR technology	
09.04.05-6	72	ESW Pump House dampers and temperature switches	NA3-11-034RA	8/22/2011	X			No	Not applicable to ESBWR technology	
09.04.05-7	72	Capacities of the heaters and exhaust fans for the UHS ESW Pump House Ventilation System	NA3-11-034RA	8/22/2011	X			No	Not applicable to ESBWR technology	

North Anna Unit 3 US-APWR S-COLA RAIs – Review Results										
RAI ID #	NRC RAI Letter #	RAI Subject	NA3 S-COLA RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Valid	RAI Response Requires Revision	COLA Change	Basis	Comments
09.04.05-8	100	Engineered Safety Feature Ventilation System	NA3-12-012R	1/7/2013	X			No	Not applicable to ESBWR technology	
09.05.01-19	58	Separation of redundant fire pumps and suctions	NA3-11-008R	3/7/2011	X			No	Not applicable to ESBWR technology	
09.05.01-20	58	Filtering of fire water	NA3-11-008R	3/7/2011	X			No	Not applicable to ESBWR technology	
09.05.01-21	58	NFPA 24, 2010 Edition, and/or AWWA C906	NA3-11-008R	3/7/2011	X			No	Not applicable to ESBWR technology	
09.05.01-22	58	Maintenance of records related to the fire protection program	NA3-11-008R	3/7/2011	X			No	Not applicable to ESBWR technology	
09.05.01-23	58	Reporting of events and conditions related to fire protection	NA3-11-008R	3/7/2011	X			No	Not applicable to ESBWR technology	
09.05.01-24	58	RG 1.189, Revision 2 / NFPA codes and standards in effect 180 days prior to submittal	NA3-11-008R	3/7/2011	X			No	Not applicable to ESBWR technology	
09.05.01-25	58	Modification of procedures related to the fire protection program	NA3-11-008R	3/7/2011	X			No	Not applicable to ESBWR technology	

North Anna Unit 3 US-APWR S-COLA RAIs – Review Results										
RAI ID #	NRC RAI Letter #	RAI Subject	NA3 S-COLA RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Valid	RAI Response Requires Revision	COLA Change	Basis	Comments
09.05.01-26	58	Availability of access keys for fire brigade leader.	NA3-11-008R	3/7/2011		X		Yes		
10.02.03-1	73	Turbine rotor integrity - MHI report	NA3-11-035R	7/25/2011	X			No	Not applicable to ESBWR technology	
10.02.03-2	73	Turbine rotor integrity	NA3-11-035R	7/25/2011	X			No	Not applicable to ESBWR technology	
10.02.03-3	73	Turbine rotor integrity	NA3-11-035R	7/25/2011	X			No	Not applicable to ESBWR technology	
10.02.03-4	73	Turbine rotor integrity	NA3-11-035R	7/25/2011	X			No	Not applicable to ESBWR technology	
10.02.03-5	73	Turbine rotor integrity	NA3-11-035R	7/25/2011	X			No	Not applicable to ESBWR technology	
10.02.03-6	73	Turbine rotor integrity	NA3-11-035R	7/25/2011	X			No	Not applicable to ESBWR technology	
10.02.03-7	73	Turbine rotor integrity	NA3-11-035R	7/25/2011	X			No	Not applicable to ESBWR technology	
10.02.03-8	73	Turbine rotor integrity - inspection program	NA3-11-035R	7/25/2011	X			No	Not applicable to ESBWR technology	

North Anna Unit 3 US-APWR S-COLA RAIs – Review Results

RAI ID #	NRC RAI Letter #	RAI Subject	NA3 S-COLA RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Valid	RAI Response Requires Revision	COLA Change	Basis	Comments
11.02-3	67	LWMS augment(s) listed in Table A-1 to RG 1.110	NA3-11-024R	6/9/2011		X		No		BWR values are used instead of PWR values.
11.02-4	67	Calculation of liquid effluent releases (expected and maximum)	NA3-11-024R	6/9/2011	X			No	Not applicable to ESBWR technology	
11.02-5	67	Liquid effluent doses - LADTAP II Code	NA3-11-024R	6/9/2011	X			No	Not applicable to ESBWR technology	The portions of the response related to US-APWR technology are superseded. For Part "1" of the response, refer to the corresponding FSAR Chapter 12 tables. The listed LADTAP inputs and their bases remain valid except that for Item "i, Source Terms," the liquid effluent isotopic activities are calculated using the BWR-GALE code and provided in FSAR Table 12.2-19bR. For Part "2," refer to the footnote for DCD Table 12.2-20a, which states that an ESBWR capacity factor of 0.92 would result in a negligible dose increase. The footnote from DCD Table 12.2-20a has been added to FSAR Table 12.2-20aR to reflect this conclusion. For Part "3," updated LADTAP II code input and output files are provided in Enclosure 23 of this letter.

North Anna Unit 3 US-APWR S-COLA RAIs – Review Results										
RAI ID #	NRC RAI Letter #	RAI Subject	NA3 S-COLA RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Valid	RAI Response Requires Revision	COLA Change	Basis	Comments
11.02-6	67	RATAF code	NA3-11-024RA	8/16/2011	X			No	Not applicable to ESBWR technology	
11.02-7	67	Evaluation of doses from loss of cooling tower makeup water.	NA3-11-024RA	8/16/2011	X			Yes	COLA approach revised	
11.03-3	67	Insufficient information on the site-specific cost-benefit analysis (CBA) for the GWMS.	NA3-11-024R	6/9/2011	X			No	Not applicable to ESBWR technology	
11.03-4	67	Annual gaseous effluent releases (expected and maximum) - GALE code	NA3-11-024RA	8/16/2011	X			No	Not applicable to ESBWR technology	

North Anna Unit 3 US-APWR S-COLA RAIs – Review Results										
RAI ID #	**NRC RAI Letter #**	**RAI Subject**	**NA3 S-COLA RAI Response Letter #**	**RAI Response Letter Date**	**RAI or RAI Response Not Applicable**	**RAI Response Valid**	**RAI Response Requires Revision**	**COLA Change**	**Basis**	**Comments**
11.03-5	67	Gaseous effluent doses - GASPAR II code	NA3-11-024R	6/9/2011	X			No	Not applicable to ESBWR technology	The portions of the response related to US-APWR technology are superseded. For Part "1" of the response, refer to the corresponding FSAR Chapter 12 tables. The listed GASPAR II inputs and their bases remain valid except that for Item "b, Atmospheric Dispersion and Ground Deposition Factors for 50-Mile Region," there are additional tables in FSAR Section 2.3.5. Also, for Item "p, Source Term," the gaseous effluent isotopic activities are calculated using the methodology of NUREG-0016, as described in DCD Appendix 12B. The resulting activities are provided in FSAR Table 12.2-17R. For Part "2" of the response, refer to DCD Appendix 12B, Section 12B.6, which identifies that an ESBWR capacity factor of 0.92 was used to determine gaseous activity releases. For Part "3," updated GASPAR II code input and output files are provided in Enclosure 24 of this letter.

North Anna Unit 3 US-APWR S-COLA RAIs – Review Results

RAI ID #	NRC RAI Letter #	RAI Subject	NA3 S-COLA RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Valid	RAI Response Requires Revision	COLA Change	Basis	Comments
11.04-5	67	Implementation milestones: epoxy coatings program - SWMS & paints/coatings - AB	NA3-11-024R	6/9/2011	X			No	Not applicable to ESBWR technology	
11.04-6	76	Lighting available in IRSF during loss of 480 VAC power.	NA3-11-039R	7/18/2011	X			No	Not applicable to ESBWR technology	
11.04-7	76	Periodic in-service testing and inspection of IRSF components.	NA3-11-039R	7/18/2011	X			No	Not applicable to ESBWR technology	
11.04-8	76	Loss of IRSF ventilation and standpipe heat tracing during loss of power.	NA3-11-039R	7/18/2011	X			No	Not applicable to ESBWR technology	
11.04-9	77	A plant specific layout showing the locations of the IRSF and other Seismic Cat I buildings in the control area is req'd	NA3-11-040R	7/18/2011	X			No	Not applicable to ESBWR technology	
11.04-10	77	Assure design of IRSF will follow guidelines in RG 1.143 or alternative design proposed to satisfy GDC 61 and 2	NA3-11-040R	7/18/2011	X			No	Not applicable to ESBWR technology	

North Anna Unit 3 US-APWR S-COLA RAIs – Review Results										
RAI ID #	NRC RAI Letter #	RAI Subject	NA3 S-COLA RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Valid	RAI Response Requires Revision	COLA Change	Basis	Comments
11.04-11	86	Detailed information regarding IRSF radiation monitors	NA3-11-056R	11/7/2011	X			No	Not applicable to ESBWR technology	
11.05-6	67	RE-035 process and effluent radiation monitor sensitivity	NA3-11-024R	6/9/2011	X			No	Not applicable to ESBWR technology	
12.02-14	90	Degasifier Impact on Radwaste Systems	NA3-11-063R	12/14/2011	X			No	Not applicable to ESBWR technology	
12.02-15	90	Degasifier Liquid Source Terms	NA3-11-063R	12/14/2011	X			No	Not applicable to ESBWR technology	
12.02-16	90	Degasifier Gaseous Source Terms	NA3-11-063R	12/14/2011	X			No	Not applicable to ESBWR technology	
12.02-17	110	Radiation Sources	No Response Submitted		X			Yes	COLA approach revised	
12.03-12.04-14	92	CVCS Holdup Tank Return Lines	NA3-11-065R	4/10/2012	X			No	Not applicable to ESBWR technology	
12.03-12.04-15	92	Degasifier Subsystem Design Features	NA3-11-065R	4/10/2012	X			No	Not applicable to ESBWR technology	

North Anna Unit 3 US-APWR S-COLA RAIs – Review Results

RAI ID #	NRC RAI Letter #	RAI Subject	NA3 S-COLA RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Valid	RAI Response Requires Revision	COLA Change	Basis	Comments
12.03-12.04-16	92	Reuse of RCS Fluid Via Charging Pumps	NA3-11-065R	4/10/2012	X			No	Not applicable to ESBWR technology	
12.03-12.04-17	92	Occupational Radiation Exposure for CVCS	NA3-11-065R	4/10/2012	X			No	Not applicable to ESBWR technology	
12.03-12.04-18	92	Resin Fines in RCS	NA3-11-065R	4/10/2012	X			No	Not applicable to ESBWR technology	
12.03-12.04-19	92	Damage to RCP Seals	NA3-11-065R	4/10/2012	X			No	Not applicable to ESBWR technology.	
12.03-12.04-20	92	Chemistry Analysis Parameters	NA3-11-065R	4/10/2012	X			No	Not applicable to ESBWR technology	
12.03-12.04-21	92	Chemical Drain Tank Sample Line Purge	NA3-11-065R	4/10/2012	X			No	Not applicable to ESBWR technology	
12.03-12.04-22	93	Construction Worker Dose Assessment	NA3-11-066R	1/23/2012	X			No	Superseded by another RAI response, refer to RAI 12.03-46 and 12.03-47	
12.03-12.04-23	93	Construction Worker Dose Review	NA3-11-066R	1/23/2012	X			No	Superseded by another RAI response; refer to NA3 US-APWR RAI 12.03-47	

North Anna Unit 3 US-APWR S-COLA RAIs – Review Results										
RAI ID #	**NRC RAI Letter #**	**RAI Subject**	**NA3 S-COLA RAI Response Letter #**	**RAI Response Letter Date**	**RAI or RAI Response Not Applicable**	**RAI Response Valid**	**RAI Response Requires Revision**	**COLA Change**	**Basis**	**Comments**
12.03-12.04-24	93	Interim Radwaste Storage Facility (IRSF) Physical Barriers	NA3-11-066R	1/23/2012	X			No	Not applicable to ESBWR technology	
12.03-12.04-25	93	IRSF Drainage Pipes	NA3-11-066R	1/23/2012	X			No	Not applicable to ESBWR technology	
12.03-12.04-26	93	High Integrity Container (HIC) Stacking	NA3-11-066R	1/23/2012	X			No	Not applicable to ESBWR technology	
12.03-12.04-27	93	Compliance with 10 CFR 20.2007	NA3-11-066R	1/23/2012	X			No	Not applicable to ESBWR technology	
12.03-12.04-28	93	APWR Interim Radwaste Storage Facility Compliance with 40 CFR 190 Limits.	NA3-11-066R	1/23/2012	X			No	Not applicable to ESBWR technology	
12.03-12.04-29	93	Temperature Impact on IRSF Components	NA3-11-066R	1/23/2012	X			No	Not applicable to ESBWR technology	
12.03-12.04-30	93	Combustible Gas Generation	NA3-11-066R	1/23/2012	X			No	Not applicable to ESBWR technology	

North Anna Unit 3 US-APWR S-COLA RAIs – Review Results										
RAI ID #	**NRC RAI Letter #**	**RAI Subject**	**NA3 S-COLA RAI Response Letter #**	**RAI Response Letter Date**	**RAI or RAI Response Not Applicable**	**RAI Response Valid**	**RAI Response Requires Revision**	**COLA Change**	**Basis**	**Comments**
12.03-12.04-31	93	Occupational Radiation Exposure Contribution from the APWR Interim Radwaste Storage Facility	NA3-11-066R	1/23/2012	X			No	Not applicable to ESBWR technology	
12.03-12.04-32	93	Blowdown (BD) Sump Source Term	NA3-11-066R	1/23/2012	X			Yes	COLA approach revised	
12.03-12.04-33	93	BD Sump Radiation Zone	NA3-11-066R	1/23/2012	X			Yes	COLA approach revised	
12.03-12.04-34	93	BD Sump Occupational Radiation Exposure	NA3-11-066R	1/23/2012	X			Yes	COLA approach revised	
12.03-12.04-35	93	BD Sump Design Features for RG 4.21	NA3-11-066R	1/23/2012	X			Yes	COLA approach revised	
12.03-12.04-36	93	Zinc Injection System	NA3-11-066R	1/23/2012	X			Yes	New Information Available	
12.03-37	105	Prevent Access to VHRA in IRSF	No Response Submitted		X			No	Not applicable to NA3	
12.03-38	105	VHRA access IRSF crane shield	No Response Submitted		X			No	Not applicable to NA3	

North Anna Unit 3 US-APWR S-COLA RAIs – Review Results

RAI ID #	NRC RAI Letter #	RAI Subject	NA3 S-COLA RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Valid	RAI Response Requires Revision	COLA Change	Basis	Comments
12.03-39	105	VHRA access w/ regard to truck bay shield wall	No Response Submitted		X			No	Not applicable to NA3	
12.03-40	105	VHRA Permanent markings	No Response Submitted		X			No	Not applicable to NA3	
12.03-41	105	LHRAs within IRSF	No Response Submitted		X			No	Not applicable to NA3	
12.03-42	105	Description of equipment in IRSF vaults	No Response Submitted		X			No	Not applicable to NA3	
12.03-43	105	IRSF Heating and Ventilation system	No Response Submitted		X			No	Not applicable to NA3	
12.03-44	105	Heating/ventilation Rad monitoring equipment in IRSF	No Response Submitted		X			No	Not applicable to NA3	
12.03-45	105	Methods for conservative G-Values	No Response Submitted		X			No	Not applicable to NA3	
12.03-46	106	Dose to construction workers	No Response Submitted		X			No	Similar to a more appropriate RAI response; refer to NA3 RAI 12.03-47	
12.03-47	106	TLD location with regard to ISFSI and SGSB	No Response Submitted		X			Yes	COLA Approach Revised	See COLA FSAR Section 12.4.7.1

North Anna Unit 3 US-APWR S-COLA RAIs – Review Results										
RAI ID #	**NRC RAI Letter #**	**RAI Subject**	**NA3 S-COLA RAI Response Letter #**	**RAI Response Letter Date**	**RAI or RAI Response Not Applicable**	**RAI Response Valid**	**RAI Response Requires Revision**	**COLA Change**	**Basis**	**Comments**
12.03-48	109	Radiation Protection Design Features	No Response Submitted		X			No	Not applicable to ESBWR technology	
12.03-49	109	Design Features of blowdown sump to meet 10 CFR 20, C, F, H	No Response Submitted		X			Yes	COLA approach revised	
12.03-50	109	Design features of site-specific piping between BD sump and discharge to meet 20.1406	No Response Submitted		X			Yes	COLA approach revised	
13.04-1	84	Milestones for the development of a ground water monitoring program	NA3-11-053R	10/12/2011		X		Yes		
19.03-28	80	LOLA - availability of GTG	NA3-11-046R	9/8/2011	X			No	Not applicable to ESBWR technology	
19-1	56	LOLA - site drawing labeling all areas	NA3-11-006R	3/14/2011		X		Yes		Reference to Dominion letter NA3-10-007 not applicable.
19-2	56	LOLA - shutdown conditions mitigative strategies	NA3-11-006R	3/14/2011		X		No		Response acceptable except for reference to the US-APWR DCD.

North Anna Unit 3 US-APWR S-COLA RAIs – Review Results										
RAI ID #	**NRC RAI Letter #**	**RAI Subject**	**NA3 S-COLA RAI Response Letter #**	**RAI Response Letter Date**	**RAI or RAI Response Not Applicable**	**RAI Response Valid**	**RAI Response Requires Revision**	**COLA Change**	**Basis**	**Comments**
19-3	56	LOLA - staging areas and important equipment in the mitigation procedures	NA3-11-006R	3/14/2011		X		Yes		
19-4	56	LOLA - labeling of equipment used to implement B.5.b strategies	NA3-11-006R	3/14/2011		X		No		Response acceptable except for reference to the US-APWR Mitigative Measures Evaluation and MST Phase 3 Item 3.
19-5(1)	56	LOLA - significant design features credited in the mitigation strategies to meet the requirements of 10 CFR 50.54(hh)(2)	NA3-11-006R	3/14/2011		X		No		
19-6	56	LOLA - credited normal and alternate water sources	NA3-11-006R	3/14/2011	X			No	Not applicable to ESBWR technology	
19-7	56	LOLA - credit for Fire Protection System (FPS) as meeting injection and/or spray during a LOLA event	NA3-11-006R	3/14/2011	X			Yes	COLA approach revised	
19-8	56	LOLA - available portable pumping capability on-site	NA3-11-006R	3/14/2011		X		Yes		Commitment relocated to MST Phase 2 Item 2.

North Anna Unit 3 US-APWR S-COLA RAIs – Review Results

RAI ID #	NRC RAI Letter #	RAI Subject	NA3 S-COLA RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Valid	RAI Response Requires Revision	COLA Change	Basis	Comments
19-9	56	LOLA - locations of the SFP penetrations relied on for SFP make-up and spray strategies	NA3-11-006R	3/14/2011	X			No	Not applicable to ESBWR technology	
19-10	56	LOLA - modifications, if any to the NA3 design	NA3-11-006R	3/14/2011		X		No		Response acceptable except for reference to the US-APWR design.
19-11	56	LOLA - walk through every written procedure identified as applicable to 10 CFR 50.54(hh)(2) prior to loading fuel for the first time	NA3-11-006R	3/14/2011		X		Yes		
19-12	56	LOLA - SSCs critical to recovery are assured to survive a LOLA event	NA3-11-006R	3/14/2011		X		No		References to the location of fire protection system pumps are not applicable.
19-13	56	LOLA - factors considered in the mitigative strategies analysis	NA3-11-006R	3/14/2011	X			No	Not applicable to ESBWR technology	
19-14	56	LOLA - impacts of the proposed mitigation strategies and procedures	NA3-11-006R	3/14/2011		X		No		

North Anna Unit 3 US-APWR S-COLA RAIs – Review Results

RAI ID #	NRC RAI Letter #	RAI Subject	NA3 S-COLA RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Valid	RAI Response Requires Revision	COLA Change	Basis	Comments
19-15	56	LOLA - adequacy of the monitor nozzles spray coverage	NA3-11-006R	3/14/2011	X			Yes	COLA approach revised	
19-16	56	LOLA - protection of on-site and offsite responders	NA3-11-006R	3/14/2011		X		Yes		
19-17	56	LOLA - deployment of fire fighting brigade and operations personnel	NA3-11-006R	3/14/2011		X		Yes		
19-18	56	LOLA - expected time for Class B fire extinguishing equipment/supplies to be provided	NA3-11-006R	3/14/2011		X		No		
19-19	56	LOLA - agreement that the offsite resource will be available if it is needed	NA3-11-006R	3/14/2011		X		No		
19-20	56	LOLA - necessary equipment/supplies for initial offsite responders to fight a large accelerant-fed fire	NA3-11-006R	3/14/2011		X		Yes		

North Anna Unit 3 US-APWR S-COLA RAIs – Review Results

RAI ID #	NRC RAI Letter #	RAI Subject	NA3 S-COLA RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Valid	RAI Response Requires Revision	COLA Change	Basis	Comments
19-21	56	LOLA - staging areas	NA3-11-006R	3/14/2011		X		Yes		
19-22	56	LOLA - selection of triage areas	NA3-11-006R	3/14/2011		X		Yes		
19-23	56	LOLA - availability of portable battery and the gas turbine generator	NA3-11-006R	3/14/2011	X			No	Not applicable to ESBWR technology	
19-24	56	LOLA - downcomer area in the SFP	NA3-11-006R	3/14/2011		X		Yes		
19-25	56	LOLA - procedures and training for evaluators, decision makers, implementers, and licensed operators	NA3-11-006R	3/14/2011		X		Yes		

North Anna Unit 3 US-APWR S-COLA RAIs – Review Results										
RAI ID #	**NRC RAI Letter #**	**RAI Subject**	**NA3 S-COLA RAI Response Letter #**	**RAI Response Letter Date**	**RAI or RAI Response Not Applicable**	**RAI Response Valid**	**RAI Response Requires Revision**	**COLA Change**	**Basis**	**Comments**
19-26	56	LOLA - communications after a LOLA event	NA3-11-006R	3/14/2011		X		Yes		
19-27	56	LOLA - reference to Section 7.8 for the discussion of portable sprays	NA3-11-006R	3/14/2011	X			Yes	COLA approach revised	
ACC-01	ACC-01 (RAI Letter Dated 23 May 2011)	LPZ doses in ER 7.1.4 for US-APWR	NA3-11-033R	8/10/2011	X			No	Not Applicable to ESBWR Technology	
ACC-02	ACC-02 (RAI Letter Dated 23 May 2011)	Use updated population and land use data in severe accident analysis	NA3-11-033R	8/10/2011	X			Yes	New information available	Analysis used DCD R9 ESBWR source term input

North Anna Unit 3 US-APWR S-COLA RAIs – Review Results										
RAI ID #	**NRC RAI Letter #**	**RAI Subject**	**NA3 S-COLA RAI Response Letter #**	**RAI Response Letter Date**	**RAI or RAI Response Not Applicable**	**RAI Response Valid**	**RAI Response Requires Revision**	**COLA Change**	**Basis**	**Comments**
ACC-03	ACC-03 (RAI Letter Dated 23 May 2011)	Provide severe accident consequence assessments for all descriptors shown in Table 5-19 of NUREG-1811 for each type of initiating event and ensure average individual early and latent fatality risks are estimated in a manner consistent with the definitions on the NRC Safety Goal Policy Statement (51 FR 30028). Update to be made using recent meteorological and population data	NA3-11-033R	8/10/2011	X			No	Not applicable to ESBWR technology	NRC addressed in NUREG-1811
ACC-04	ACC-04 (RAI Letter Dated 23 May 2011)	Provide a revised SAMDA analysis for a US-APWR at the NAPS site	NA3-11-033RA	12/14/2011	X			Yes	New information available	Analysis used DCD R9 ESBWR source term input

North Anna Unit 3 US-APWR S-COLA RAIs – Review Results

RAI ID #	NRC RAI Letter #	RAI Subject	NA3 S-COLA RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Valid	RAI Response Requires Revision	COLA Change	Basis	Comments
HYD-01	HYD-01 (RAI Letter Dated 23 May 2011	Additional information required regarding Radiological Impact of Normal Operation calculation	NA3-11-033R	8/10/2011	X			No	RAI is not applicable to ESBWR technology	
MET-01	MET-01 (RAI Letter Dated 23 May 2011)	Describe changes to EAB distances that resulted from changing the method used to determine distances and the effects of the changes on X/Q values and consequences of design basis accidents	NA3-11-033R	8/10/2011		X		No		RAI narrative regarding EAB distances remains valid; cross-sectional area specified in COLA markup does not apply to ESBWR technology.
MET-02	MET-02 (RAI Letter Dated 23 May 2011)	Review and determine the representativeness of meteorological data used in the evaluation of the consequences of severe accidents	NA3-11-033R	8/10/2011		X		No		

North Anna Unit 3 US-APWR S-COLA RAIs – Review Results										
RAI ID #	**NRC RAI Letter #**	**RAI Subject**	**NA3 S-COLA RAI Response Letter #**	**RAI Response Letter Date**	**RAI or RAI Response Not Applicable**	**RAI Response Valid**	**RAI Response Requires Revision**	**COLA Change**	**Basis**	**Comments**
MET-03	MET-03 (RAI Letter Dated 23 May 2011)	Provide estimates of the annual emissions of criteria pollutants associated with operation of an US-APWR at the NAPS site	NA3-11-033RB	1/3/2012	X			No	Not applicable to ESBWR technology	

ENCLOSURE 4

Endorsed Comanche Peak Units 3 and 4 US-APWR RAIs

Review Results

Endorsed Comanche Peak Units 3 and 4 US-APWR RAIs – Review Results											
RAI ID #	**NRC RAI Letter #**	**RAI Subject**	**RAI Response Letter #**	**RAI Response Letter Date**	**DOM Endorse Letter #**	**RAI or RAI Response Not Applicable**	**RAI Response Valid**	**RAI Topic to be Addressed Outside COLA**	**COLA Change**	**Basis**	**Comments**
02.04.14-1	96	Controls for makeup water flow to UHS from ESWS	TXNB-09064	11/11/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
03.07.02-19	192	Demonstrate that the 50% reduction in gross section stiffness for all roof slabs and elevated slabs	TXNB-11004	1/27/2011	NA3-11-030	X			No	Not applicable to NA3	
03.07.04-1	53	Seismic instrumentation	TXNB-09057	10/21/2009	NA3-10-019	X			No	Not applicable to NA3	
03.08.01-1	106	Prestress friction losses of the tendons due to wobble and curvature coefficients used in the analysis	TXNB-09067	11/13/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
03.08.01-2	106	Describe the prestressing techniques and procedures to be used in construction of the PCCV	TXNB-09067	11/13/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
03.08.01-3	106	Applicable codes and standards for concrete mix ingredients	TXNB-09067	11/13/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
03.08.01-4	106	PCCV superstructure construction	TXNB-09067	11/13/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	

Endorsed Comanche Peak Units 3 and 4 US-APWR RAIs – Review Results

RAI ID #	NRC RAI Letter #	RAI Subject	RAI Response Letter #	RAI Response Letter Date	DOM Endorse Letter #	RAI or RAI Response Not Applicable	RAI Response Valid	RAI Topic to be Addressed Outside COLA	COLA Change	Basis	Comments
03.08.01-5	106	Examination of below-grade concrete and the monitoring of changes in the soil aggressivity	TXNB-09067	11/13/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
03.08.01-6	106	Preservice inspection (PSI) for the PCCV	TXNB-09067	11/13/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
03.08.01-7	106	Testing and inservice inspection requirements of areas at tendon end anchors	TXNB-09067	11/13/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
03.08.01-8	106	Tendons and the removal of a wire or strand for inspection for corrosion and testing	TXNB-09067	11/13/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
03.08.01-9	106	Inspection of accessible concrete surface areas to assess the general structural condition of the containment	TXNB-09067	11/13/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	

Endorsed Comanche Peak Units 3 and 4 US-APWR RAIs – Review Results											
RAI ID #	NRC RAI Letter #	RAI Subject	RAI Response Letter #	RAI Response Letter Date	DOM Endorse Letter #	RAI or RAI Response Not Applicable	RAI Response Valid	RAI Topic to be Addressed Outside COLA	COLA Change	Basis	Comments
03.08.01-10	148	Describe any special measures or precautions that may be necessary to avoid any delamination of the concrete in the dome of the PCCV.	TXNB-10026	4/1/2010	NA3-10-019	X			No	Not applicable to ESBWR technology	
03.08.04-2	108	Ultimate heat sink related structures (UHSRS) expansion joint	TXNB-09078	12/10/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
03.08.04-3	108	Site-specific structures protected from tornado missiles	TXNB-09078	12/10/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
03.08.04-17	108	Strength of concrete fill.	TXNB-09078	12/10/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
03.08.04-26	122	Equations used to modify the slab elements	TXNB-09085	12/14/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
03.08.04-33	122	Effects of out-of-plane wall flexibility	TXNB-09085	12/14/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
03.08.04-37	122	Explain how shell elements are connected to the brick elements	TXNB-09085	12/14/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	

Endorsed Comanche Peak Units 3 and 4 US-APWR RAIs – Review Results

RAI ID #	NRC RAI Letter #	RAI Subject	RAI Response Letter #	RAI Response Letter Date	DOM Endorse Letter #	RAI or RAI Response Not Applicable	RAI Response Valid	RAI Topic to be Addressed Outside COLA	COLA Change	Basis	Comments
03.08.04-39	122	Exact section number(s) of ASCE 4 that were used in the ESWPT analysis	TXNB-09085	12/14/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
03.08.04-41	122	Model properties and seismic analysis results for ESWPT	TXNB-09085	12/14/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
03.08.04-42	122	Model properties and seismic analysis results for ESWPT	TXNB-09085	12/14/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
03.08.04-45	122	Allowable soil bearing pressure	TXNB-09085	12/14/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
03.08.04-50	122	Design of seismic category I and II subsystems and components housed within or mounted to the PSFSV	TXNB-09085	12/14/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
03.08.04-60	122	Table of Contents for the Appendix 3NN	TXNB-09085	12/14/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
03.08.04-61	167	Application of ETHAFOAM 220 for use as expansion/separation joints for the UHSRS	TXNB-10057	8/9/2010	NA3-11-014	X			No	Not applicable to ESBWR technology	

Endorsed Comanche Peak Units 3 and 4 US-APWR RAIs – Review Results											
RAI ID #	**NRC RAI Letter #**	**RAI Subject**	**RAI Response Letter #**	**RAI Response Letter Date**	**DOM Endorse Letter #**	**RAI or RAI Response Not Applicable**	**RAI Response Valid**	**RAI Topic to be Addressed Outside COLA**	**COLA Change**	**Basis**	**Comments**
03.08.05-3	115	Factor of safety for overturning, sliding, and flotation	TXNB-09067	11/13/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
03.08.05-4	115	"Minor" seismic Category I buildings or structures	TXNB-09067	11/13/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
03.10-1	25	Implementation plan for the seismic qualification program	TXNB-09047	9/22/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
06.01.02-1	13	Protective coatings program	TXNB-09033	8/24/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
06.01.02-2	76	Containment sump performance	TXNB-09066	9/30/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
06.02.02-1	76	Containment sump performance	TXNB-09066	11/12/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
06.02.02-2	76	Containment cleanliness criteria	TXNB-09066	11/12/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
06.02.02-3	76	Containment cleanliness program	TXNB-09066	11/12/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	

Endorsed Comanche Peak Units 3 and 4 US-APWR RAIs – Review Results

RAI ID #	NRC RAI Letter #	RAI Subject	RAI Response Letter #	RAI Response Letter Date	DOM Endorse Letter #	RAI or RAI Response Not Applicable	RAI Response Valid	RAI Topic to be Addressed Outside COLA	COLA Change	Basis	Comments
06.02.02-4	229	Specify criteria used for containment cleanliness	TXNB-11063	10/10/2011	NA3-12-007	X			No	Not applicable to ESBWR technology	
06.04-2	77	Acceptance criteria for charcoal adsorber within the ESF filtration units of Main Control Room HVAC system	TXNB-09066	11/12/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
06.04-3	77	ESF filter system construction materials	TXNB-09066	11/12/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
06.04-11	172	Hazards analysis of refrigerants	TXNB-10069	10/6/2010	NA3-11-014	X			No	Not applicable to ESBWR technology	
06.04-12	202	Compliance with ASHRAE STD 15	TXNB-11018	3/18/2011	NA3-11-030	X			No	Not applicable for ESBWR technology	
06.06-1	43	ASME Code XI Edition/Addenda for Class	TXNB-09055	10/19/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
06.06-2	44	Augmented ISI program detail	TXNB-09055	10/19/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	

Endorsed Comanche Peak Units 3 and 4 US-APWR RAIs – Review Results											
RAI ID #	NRC RAI Letter #	RAI Subject	RAI Response Letter #	RAI Response Letter Date	DOM Endorse Letter #	RAI or RAI Response Not Applicable	RAI Response Valid	RAI Topic to be Addressed Outside COLA	COLA Change	Basis	Comments
08.01-02	9	GDC 5 applicability	TXNB-09030	8/11/2009	NA3-10-019	X			No	Similar to a more appropriate RAI response; refer to NA3 RAI 8.2-42.	
08.02-8	24	Isolated phase bus duct	TXNB-09040	9/8/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
08.02-27	152	Isolated phase bus duct	TXNB-10037	5/18/2010	NA3-10-019	X			No	Not applicable to ESBWR technology	
08.03.01-1	23	Site-specific electrical loads	TXNB-09040	9/8/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
09.01.05-1	52	Program and schedule for heavy load handling	TXNB-09057	10/21/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
09.01.05-1 (S1)	52	Program and schedule for heavy load handling	TXNB-12021	6/13/2012	NA3-12-031	X			No	Not applicable to ESBWR technology	
09.02.01-2	109	ESWS heat removal capability	TXNB-09071	11/20/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
09.02.01-3	109	ESWS water hammer	TXNB-09071	11/20/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	

Endorsed Comanche Peak Units 3 and 4 US-APWR RAIs – Review Results											
RAI ID #	NRC RAI Letter #	RAI Subject	RAI Response Letter #	RAI Response Letter Date	DOM Endorse Letter #	RAI or RAI Response Not Applicable	RAI Response Valid	RAI Topic to be Addressed Outside COLA	COLA Change	Basis	Comments
09.02.01-4	109	ESWS departures	TXNB-09071	11/20/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
09.02.01-5	109	Fire protection service system (FSS) features in the ESWP house	TXNB-09071	11/20/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
09.02.01-5 (S1)	109	Fire protection service system (FSS) features in the ESWP house	TXNB-10011	2/22/2010	NA3-10-019	X			No	Not applicable to ESBWR technology	
09.02.01-6	251	ESWS NPSH and testing for vortex	TXNB-12-016	5/31/2012	NA3-12-020	X			No	Not applicable to ESBWR technology	
09.02.01-7	251	ESWS side back flush	TXNB-12016	5/31/2012	NA3-12-020	X			No	Not applicable to ESBWR technology	
09.02.01-8	251	Periodic inspections for portions of piping in the essential service water pipe tunnel	TXNB-12016	5/31/2012	NA3-12-020	X			No	Not applicable to ESBWR technology	
09.02.01-10	251	System layout of the ESWS/UHS and water hammer testing	TXNB-12016	5/31/2012	NA3-12-020	X			No	Not applicable to ESBWR technology	
09.02.01-11	251	CDI information related to ESWS	TXNB-12016	5/31/2012	NA3-12-020	X			No	Not applicable to ESBWR technology	

Endorsed Comanche Peak Units 3 and 4 US-APWR RAIs – Review Results

RAI ID #	NRC RAI Letter #	RAI Subject	RAI Response Letter #	RAI Response Letter Date	DOM Endorse Letter #	RAI or RAI Response Not Applicable	RAI Response Valid	RAI Topic to be Addressed Outside COLA	COLA Change	Basis	Comments
09.02.01-11 (S1)	251	CDI information related to ESWS	TXNB-12031	9/10/2012	NA3-12-031	X			No	Not applicable to ESBWR technology	
09.02.04-1	126	Site-specific ITAAC for the PSWS	TXNB-10008	2/18/2010	NA3-10-019	X			No	Not applicable to ESBWR technology	
09.02.05-1	121	UHS design information	TXNB-09081	12/16/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
09.02.05-2	121	Non-safety-related parts of the UHS	TXNB-09081	12/16/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
09.02.05-3	121	Natural phenomena effects on ultimate heat sink (UHS)	TXNB-09081	12/16/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
09.02.05-9	121	Waterhammer vulnerabilities that apply to the UHS	TXNB-09081	12/16/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
09.02.05-12	121	Programmatic requirements and procedural controls for performing ESWS inspections	TXNB-09081	12/16/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
09.02.05-13	121	Programmatic requirements and procedural controls for performing UHS tests	TXNB-09081	12/16/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	

Endorsed Comanche Peak Units 3 and 4 US-APWR RAIs – Review Results

RAI ID #	NRC RAI Letter #	RAI Subject	RAI Response Letter #	RAI Response Letter Date	DOM Endorse Letter #	RAI or RAI Response Not Applicable	RAI Response Valid	RAI Topic to be Addressed Outside COLA	COLA Change	Basis	Comments
09.02.05-15	121	ITAAC for UHS and ESWS	TXNB-09081	12/16/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
09.02.05-19	252	UHS piping materials	TXNB-12018	6/7/2012	NA3-12-031	X			No	Not applicable to ESBWR technology	
09.02.05-21	252	Site-specific ITAAC for UHS transfer pumps and associated MOVs	TXNB-12018	6/7/2012	NA3-12-031	X			No	Not applicable to ESBWR technology	
09.02.05-23	252	UHS makeup	TXNB-12018	6/7/2012	NA3-12-031	X			No	Not applicable to ESBWR technology	
09.02.05-25	252	Postulated pipe failures in UHS	TXNB-12018	6/7/2012	NA3-12-031	X			No	Not applicable to ESBWR technology	
09.02.05-25 (S1)	252	Postulated pipe failures in UHS	TXNB-12031	9/10/2012	NA3-12-031	X			No	Not applicable to ESBWR technology	
09.04.01-2	63	MCR AHU heater capacity	TXNB-09060	10/30/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
09.04.03-1	48	Capacity of cooling and heating coils	TXNB-09055	10/19/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	

Endorsed Comanche Peak Units 3 and 4 US-APWR RAIs – Review Results											
RAI ID #	**NRC RAI Letter #**	**RAI Subject**	**RAI Response Letter #**	**RAI Response Letter Date**	**DOM Endorse Letter #**	**RAI or RAI Response Not Applicable**	**RAI Response Valid**	**RAI Topic to be Addressed Outside COLA**	**COLA Change**	**Basis**	**Comments**
09.04.05-2	110	ITAAC or startup testing for heater capacity	TXNB-09067	11/13/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
09.04.05-3	123	P&IDs of UHS ESW Pump House Ventilation System	TXNB-09081	12/16/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
09.04.05-4	123	Protection of UHS ESW pump house air intakes and air outlets from tornado generated missiles	TXNB-09081	12/16/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
09.04.05-6	123	Protection of UHS ESW pump house ventilation system components from tornado generated missiles	TXNB-09081	12/16/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
09.04.05-8	123	Integrity of the pump houses' equipment during the most severe design basis winter conditions	TXNB-09.04.05-8	12/16/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
09.04.05-10	123	FMEA for the UHS ESW Pump House Ventilation	TXNB-09081	12/16/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	

Endorsed Comanche Peak Units 3 and 4 US-APWR RAIs – Review Results											
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09.04.05-11	123	Size of MCCs for the UHS ESW Pump House Ventilation System	TXNB-09081	12/16/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
09.04.05-12	123	Location of the fresh air intakes of the four UHS ESW Pump Houses	TXNB-09081	12/16/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
09.04.05-16	213	Missile protection for the ESW and transfer pump room ventilation openings	TXNB-11032	5/6/2011	NA3-12-007	X			No	Not applicable to ESBWR technology	
09.04.05-18	213	ESW Pump House dampers and temperature switches	TXNB-11032	5/6/2011	NA3-12-007	X			No	Not applicable to ESBWR technology	
09.04.05-19	243	ITAAC for safety related backdraft dampers	TXNB-12006	2/27/2012	NA3-12-020	X			No	Not applicable to ESBWR technology	
09.04.05-22	243	Seismic category of UHS ESW Pump House Ventilation System's instrumentation	TXNB-12006	2/27/2012	NA3-12-020	X			No	Not applicable to ESBWR technology	
09.04.05-24	243	ITAAC for the UHS ESW pump house ventilation system	TXNB-12006	2/27/2012	NA3-12-020	X			No	Not applicable to ESBWR technology	

Endorsed Comanche Peak Units 3 and 4 US-APWR RAIs – Review Results

RAI ID #	NRC RAI Letter #	RAI Subject	RAI Response Letter #	RAI Response Letter Date	DOM Endorse Letter #	RAI or RAI Response Not Applicable	RAI Response Valid	RAI Topic to be Addressed Outside COLA	COLA Change	Basis	Comments
09.05.01-1	10	Fire protection training records	TXNB-09030	8/11/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
09.05.01-7	10	RG 1.189, Regulatory Position 1.8.6	TXNB-09030	8/11/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
09.05.01-8	10	Storage of unused ion exchange resins and hazardous chemicals	TXNB-09030	8/11/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
09.05.01-10	10	NFPA 30 standards for the use, handling, and storage of flammable and combustible liquids	TXNB-09030	8/11/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
09.05.01-16	10	Standard for portable fire extinguishers	TXNB-09030	8/11/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
09.05.01-18	10	Fire Brigade Equipment	TXNB-09030	8/11/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
09.05.01-20	10	Fire protection features in new fuel areas	TXNB-09030	8/11/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
09.05.02-1	34	Back-up power supplies for communication systems to the NRC Operations Center	TXNB-09054	10/15/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	

Endorsed Comanche Peak Units 3 and 4 US-APWR RAIs – Review Results

RAI ID #	NRC RAI Letter #	RAI Subject	RAI Response Letter #	RAI Response Letter Date	DOM Endorse Letter #	RAI or RAI Response Not Applicable	RAI Response Valid	RAI Topic to be Addressed Outside COLA	COLA Change	Basis	Comments
09.05.02-2	178	Offsite communication capabilities for the onsite operations support center	TXNB-10072	10/11/2010	NA3-11-014	X			No	Not applicable to ESBWR technology	
09.05.02-4 S01	196	Emergency offsite communication	TXNB-11053	8/4/2011	NA3-12-007	X			No	Not applicable to ESBWR technology	
10.02.03-1	6	Turbine inspection program description	TXNB-09023	6/17/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
10.02.03-2	169	Turbine inspection program	TXNB-10056	8/9/2010	NA3-11-014	X			No	Not applicable to ESBWR technology	
10.03.06-1	7	FAC Monitoring: Description for construction and schedule for constr. & operations	TXNB-09028	8/7/2009	NA3-10-019	X			No	Similar to a more appropriate RAI response; refer to NA3 ESBWR R-COLA RAI 10.03.06-1 response.	
10.03.06-2	7	FAC Monitoring: Specifications	TXNB-09028	8/7/2009	NA3-10-019	X			No	Similar to a more appropriate RAI response; refer to NA3 ESBWR R-COLA RAI 10.03.06-2 response.	

Endorsed Comanche Peak Units 3 and 4 US-APWR RAIs – Review Results											
RAI ID #	NRC RAI Letter #	RAI Subject	RAI Response Letter #	RAI Response Letter Date	DOM Endorse Letter #	RAI or RAI Response Not Applicable	RAI Response Valid	RAI Topic to be Addressed Outside COLA	COLA Change	Basis	Comments
10.03.06-3	7	FAC concerns related to the minimum allowable wall thickness at which the component must be repaired or replaced.	TXNB-09028	8/7/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
10.03-1	16	Design details of MSSVs, including the valve throat area and design basis functional analysis.	TXNB-09033	8/7/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
10.04.08-1	17	SGBDS and Table 3.2-201 classification	TXNB-09034	8/24/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
10.04.08-2	17	SGBDS and duplicative statements describing system.	TXNB-09034	8/24/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
11.02-1	29	Mobile processing systems cross-contamination	TXNB-09048	9/24/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
11.02-4	29	Precautions to prevent unmonitored release	TXNB-09048	9/24/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
11.02-6	49	Leakage from mobile or temporary equipment	TXNB-09055	10/19/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	

Endorsed Comanche Peak Units 3 and 4 US-APWR RAIs – Review Results

RAI ID #	NRC RAI Letter #	RAI Subject	RAI Response Letter #	RAI Response Letter Date	DOM Endorse Letter #	RAI or RAI Response Not Applicable	RAI Response Valid	RAI Topic to be Addressed Outside COLA	COLA Change	Basis	Comments
11.04-1	38	Contracted mobile de-watering system	TXNB-09055	10/19/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
11.04-2	38	Contracted mobile de-watering system	TXNB-09055	10/19/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
11.05-2	50	Site specific design of process and effluent radiation monitoring equipment	TXNB-09055	10/19/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
12.01-1	118	Use of Approved NEI 07-03	TXNB-09068	11/16/2009	NA3-10-019		X		Yes		Except for reference to S-COLA 12.1 and 12.5. NE COLA Appendix 12BB references NEI 07-03.
12.01-2	118	NEI Template 07-08	TXNB-09068	11/16/2009	NA3-10-019		X		Yes		Except for reference to S-COLA 12.1 and 12.5. NE COLA Appendix 12AA references NEI 07-08.
12.01-3	118	Regulatory Guides 8.20, 8.32, 1.206 and 4.21	TXNB-09068	11/16/2009	NA3-10-019	X			No	Similar to a more appropriate RAI response; refer to RAI 12.03-12.04-9, Item e	

Endorsed Comanche Peak Units 3 and 4 US-APWR RAIs – Review Results

RAI ID #	NRC RAI Letter #	RAI Subject	RAI Response Letter #	RAI Response Letter Date	DOM Endorse Letter #	RAI or RAI Response Not Applicable	RAI Response Valid	RAI Topic to be Addressed Outside COLA	COLA Change	Basis	Comments
12.01-4	118	NEI Template 08-08 and Regulatory Guide 4.21	TXNB-09068	11/16/2009	NA3-10-019	X			No	Similar to more appropriate RAI response; refer to NA3 RAI 12.03-12.04-8	
12.02-1	85	Radiation sources	TXNB-09062	11/5/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
12.03-12.04-1	99	Compliance with 10CFR 20.1406 minimization of contamination	TXNB-09064	11/11/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
12.03-12.04-2	119	Compliance with 10 CFR 20.1602 (very high rad areas)	TXNB-09068	11/16/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
12.03-12.04-3	119	Compliance with 10 CFR 20.1501, SRP 12.3-12.4, and RG 1.206 in selection and calibration of portable rad protection instrumentation	TXNB-09068	11/16/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
12.05-1	100	Compliance with respiratory protection requirements of 10 CFR 20 Subpart H in accordance with RG 8.15	TXNB-09064	11/11/2009	NA3-10-019	X			No	Other- NE COLA FSAR 12BB already adopts NEI 07-03, which is cited in CP RAI response	

Endorsed Comanche Peak Units 3 and 4 US-APWR RAIs – Review Results											
RAI ID #	**NRC RAI Letter #**	**RAI Subject**	**RAI Response Letter #**	**RAI Response Letter Date**	**DOM Endorse Letter #**	**RAI or RAI Response Not Applicable**	**RAI Response Valid**	**RAI Topic to be Addressed Outside COLA**	**COLA Change**	**Basis**	**Comments**
12.05-2	100	Cobalt Reduction Strategy	TXNB-09064	11/11/2009	NA3-10-019	X			No	Not applicable to ESBWR technology	
12.05-3	117	Deviations from NEI 07-03 (radiation protection) and 07-08 (ALARA)	TXNB-09068	11/16/2009	NA3-10-019	X			No	Not applicable to NA3	
12.05-4	117	Calibration of portable and laboratory radiation protection instrumentation	TXNB-09068	11/16/2009	NA3-10-019	X			No	Not applicable to NA3	
12.05-5	136	Non-radiological respiratory protection program	TXNB-10020	3/9/2010	NA3-10-019	X			No	Not applicable to NA3	
12.05-6	136	Source term reduction strategy	TXNB-10020	3/9/2010	NA3-10-019	X			No	Not applicable to ESBWR technology	
12.05-6, Sup	136	Source term reduction strategy	TXNB-11015	3/18/2011	NA3-11-030	X			No	Not applicable to NA3	

ENCLOSURE 5

Enrico Fermi Unit 3 ESBWR RAIs

Review Results

Enrico Fermi Unit 3 ESBWR RAIs – Review Results

RAI ID #	NRC RAI Letter #	RAI Subject	RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Addressed in COLA	RAI Topic to be Addressed Outside COLA	COLA Change	Basis	Comments
1-4	61	Part 30, 40 and 70 Licenses	NRC3-11-0021	7/15/2011			X	Yes	The results of Dominion's review are provided in Enclosure 25 of this letter.	Chapter 13 changes (ex. 13.4) incorporated in July submission. COLA FSAR Section 13.4, Part 7, and Part 8 changes provided in December submission.
1-7	69	Types and amounts of sources, byproducts, and SNM	NRC3-11-0044	12/7/2011		X		Yes		
1-8	81	Conformance with SRPs and BTPs	NRC3-13-0006	2/8/2013	X			No	Not applicable to NA3	
1-9	81	Conformance with RGs	NRC3-13-0006	2/8/2013	X			No	Not applicable to NA3	
1-10	81	Addition of GSIs 201, 202, 203	NRC3-13-0006	2/8/2013		X		Yes		
01.05-1	77	Fukushima Seismic - CEUS SSC Model	NRC3-12-0025	8/24/2012	X			No	Not applicable to NA3	
01.05-1 Sup 1	77	Fukushima Seismic - CEUS SSC Model	NRC3-13-0004	1/25/2013	X			No	Not applicable to NA3	
01.05-1 Sup 2	77	Fukushima Seismic - CEUS SSC Model	NRC3-13-0010	2/22/2013	X			No	Not applicable to NA3	
01.05-1 Sup 3	77	Fukushima Seismic -- CEUS SSC Model	NRC3-13-0011	3/15/2013	X			No	Not applicable to NA3	

Enrico Fermi Unit 3 ESBWR RAIs – Review Results										
RAI ID #	NRC RAI Letter #	RAI Subject	RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Addressed in COLA	RAI Topic to be Addressed Outside COLA	COLA Change	Basis	Comments
01.05-2	77	Fukushima NTTF - Communications Systems and Equipment Used During Emergency Event	NRC3-12-0023	7/13/2012		X		Yes		
01.05-2 Sup 1	77	Fukushima NTTF - Communications Systems and Equipment Used During Emergency Event	NRC3-13-0013	4/18/2013		X		Yes		
01.05-3	78	Core Cooling, Containment, and SFP Cooling Capabilities	NRC3-12-0024	8/24/2012	X			No	Superseded by another RAI response; refer to RAI 01.05-3 Sup 1	
01.05-3 Sup 1	78	Core Cooling, Containment, and SFP Cooling Capabilities	NRC3-13-0002	1/25/2013	X			No	Superseded by another RAI response; refer to RAI 01.05-3 Sup 2	
01.05-3 Sup 2	78	Core Cooling, Containment, and SFP Cooling Capabilities	NRC3-13-0008	2/19/2013		X		Yes		
01.05-4	78	Spent Fuel Pool/Buffer Pool Level Instrumentation	NRC3-12-0024	8/24/2012	X			No	Superseded by another RAI response; refer to RAI 01.05-4 Sup 1	
01.05-4 Sup 1	78	Spent Fuel Pool/Buffer Pool Level Instrumentation	NRC3-13-0002	1/25/2013	X			No	Superseded by another RAI response; refer to RAI 01.05-4 Sup 2	
01.05-4 Sup 2	78	Spent Fuel Pool/Buffer Pool Level Instrumentation	NRC3-13-0008	2/19/2013		X		Yes		
01.05-5	84	FLEX – Mitigating External Events	NRC3-13-0013	4/18/2013		X		No		

Enrico Fermi Unit 3 ESBWR RAIs – Review Results

RAI ID #	NRC RAI Letter #	RAI Subject	RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Addressed in COLA	RAI Topic to be Addressed Outside COLA	COLA Change	Basis	Comments
01.05-5 Sup 1	84	FLEX – Mitigating External Events	NRC3-13-0022	7/9/2013		X		Yes		
01.05-6	84	Reliable Spent Fuel Pool Instrumentation	NRC3-13-0013	4/18/2013		X		No		
01.05-6 Sup 1	84	Reliable Spent Fuel Pool Instrumentation	NRC3-13-0022	7/9/2013		X		Yes		
01.05-7	86	Fire protection program elements to support SNM onsite	NRC3-13-0025	7/24/2013		X		Yes		
01.05-8	88	Physical Security Plan requirements for new fuel receipt.	NRC3-13-0029	8/14/2013	X			Yes	Not applicable to NA3	The SNM Physical Protection Program for new fuel is included in Part 8
01.05-9	88	Site physical protection requirements for fresh fuel.	NRC3-13-0029	8/14/2013	X			Yes	Not applicable to NA3	The SNM Physical Protection Program for new fuel is included in Part 8
01.05-9 Sup 1	88	Mitigative strategies description	NRC3-13-0030	8/30/2013		X		Yes		
01-7 Sup 1	69	Licensing of byproduct, source, and special nuclear material under 10 CFR Parts 30, 40, and 70	NRC3-12-0004	2/1/2012			X	No	The results of Dominion's review are provided in Enclosure 26 of this letter.	
01-7 Sup 2	69	Licensing of byproduct, source, and special nuclear material under 10 CFR Parts 30, 40, and 70	NRC3-13-0020	6/28/2013		X		Yes		

Enrico Fermi Unit 3 ESBWR RAIs – Review Results

RAI ID #	NRC RAI Letter #	RAI Subject	RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Addressed in COLA	RAI Topic to be Addressed Outside COLA	COLA Change	Basis	Comments
01-8 Sup	81	Conformance with SRPs and BTPs	NRC3-13-0009	2/22/2013		X		Yes		Changes addressing SRP 2.0, BTP-5.4, and 10.3 not adopted.
01-9 Sup	81	Conformance with RGs	NRC3-13-0009	2/22/2013		X		Yes		Changes addressing RG 1.135, RG 4.15 and Division 5 RGs not adopted.
2-1	39	EF3 long term dispersion values do not fall within DCD site parameter values	NRC3-10-0036	9/2/2010	X			No	Not applicable to NA3	
02.03.01-15	39	Number of tornadoes in five-county area near EF3	NRC3-10-0036	9/2/2010	X			No	Not applicable to NA3	
02.03.01-16	39	Historical maximum snowpack for EF3 site	NRC3-10-0036	9/2/2010	X			No	Not applicable to NA3	
02.03.01-17	39	Impact on design and operation resulting from EF3 being located in a PM2.5 nonattainment area	NRC3-10-0036	9/2/2010	X			No	Not applicable to NA3	
02.03.01-18	49	EF3 extreme winter precipitation event maximum roof load	NRC3-11-0003	1/10/2011	X			No	Not applicable to NA3	
02.03.01-19	49	Request for use of different term and more precise methodology discussion in determining the	NRC3-11-0003	1/10/2011	X			No	Not applicable to NA3	

Enrico Fermi Unit 3 ESBWR RAIs – Review Results										
RAI ID #	**NRC RAI Letter #**	**RAI Subject**	**RAI Response Letter #**	**RAI Response Letter Date**	**RAI or RAI Response Not Applicable**	**RAI Response Addressed in COLA**	**RAI Topic to be Addressed Outside COLA**	**COLA Change**	**Basis**	**Comments**
02.03.01-20	73	Update site characteristic values to include "hurricane wind speed" and "hurricane missile spectra" or provide justification for excluding	NRC3-12-0010	4/3/2012	X			No	Not applicable to NA3	
02.03.02-2	21	Mistake in EF3 FSAR Figure	NRC3-10-0003	2/8/2010	X			No	Not applicable to NA3	
02.03.02-7	39	EF3 Meteorological Data	NRC3-10-0036	9/2/2010	X			No	Not applicable to NA3	
02.03.02-8	39	Detroit Metropolitan Airport extreme values in EF3 FSAR	NRC3-10-0036	9/2/2010	X			No	Not applicable to NA3	
02.03.02-9	39	Wind direction persistence summaries for EF3	NRC3-10-0036	9/2/2010	X			No	Not applicable to NA3	
02.03.03-8	39	EF3 meteorological monitoring instrumentation	NRC3-10-0036	9/2/2010	X			No	Not applicable to NA3	
02.03.03-9	49	Difference in meteorological monitoring instruments planned for met tower at EF3	NRC3-11-0003	1/10/2011	X			No	Not applicable to NA3	
02.03.04-5	39	Data from EF3 met tower	NRC3-10-0036	9/2/2010	X			No	Not applicable to NA3	
02.03.04-6	39	EF3 inleakage and air intake X/Q site characteristic values compared to ESBWR DCD site parameter values	NRC3-10-0036	9/2/2010	X			No	Not applicable to NA3	

Enrico Fermi Unit 3 ESBWR RAIs – Review Results										
RAI ID #	**NRC RAI Letter #**	**RAI Subject**	**RAI Response Letter #**	**RAI Response Letter Date**	**RAI or RAI Response Not Applicable**	**RAI Response Addressed in COLA**	**RAI Topic to be Addressed Outside COLA**	**COLA Change**	**Basis**	**Comments**
02.03.05-3	35	Fermi Meteorological Data	NRC3-10-0033	6/26/2010	X			No	Not applicable to NA3	
02.03.05-4	35	Impact of differences in temperature and surface roughness in over water dispersion pathways	NRC3-10-0033	6/26/2010	X			No	Not applicable to NA3	
02.03.05-5	49	EF3 long-term dispersion site characteristic values	NRC3-11-0003	1/10/2011	X			No	Not applicable to NA3	
02.04.02-5	28	Erosion protection measures	NRC3-10-0018	5/7/2010	X			No	Not applicable to NA3	
02.04.05-9	28	Lake-level data	NRC3-10-0018	5/7/2010	X			No	Not applicable to NA3	
02.04.05-10	28	Wave run-up figure	NRC3-10-0018	5/7/2010	X			No	Not applicable to NA3	
02.04.13-10	28	Ground water release conceptual model	NRC3-10-0018	5/7/2010	X			No	Not applicable to NA3	
02.04.13-11	40	Use maximum leach rate in analysis	NRC3-10-0046	10/19/2010	X			No	Not applicable to NA3	
02.04.13-12	42	Simulate an instantaneous release	NRC3-10-0046	10/19/2010	X			No	Not applicable to NA3	
02.05.01-31	37	Markup to revise FSAR Table 2.5.1-201.	NRC3-10-0034	8/13/2010	X			No	Not applicable to NA3	
02.05.01-32	37	FSAR Figure 2.5.1-207 including the approximate limits of the Cottonwood Grove fault.	NRC3-10-0034	8/13/2010	X			No	Not applicable to NA3	

Enrico Fermi Unit 3 ESBWR RAIs – Review Results

RAI ID #	NRC RAI Letter #	RAI Subject	RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Addressed in COLA	RAI Topic to be Addressed Outside COLA	COLA Change	Basis	Comments
02.05.02-11	36	Process followed for updating EPRI/SOG seismic sources.	NRC3-10-0035	8/6/2010	X			No	Not applicable to NA3	
02.05.02-12	36	FSAR Figures needing correction.	NRC3-10-0035	8/6/2010	X			No	Not applicable to NA3	
02.05.02-13	36	Parameters of attenuation models for CEUS hard rock.	NRC3-10-0035	8/6/2010	X			No	Not applicable to NA3	
02.05.02-14	36	Update relevant FSAR figures that compare the shear modulus reduction and damping curves used in the site response analysis to compare the shear modulus reduction and damping curves used in the site response analysis to the dynamic laboratory test results, similar to the figures provided in response to RAI 02.05.02-5.	NRC3-10-0035	8/6/2010	X			No	Not applicable to NA3	
02.05.02-15	36	Hazard contribution from the source zone DAM08.	NRC3-10-0039	8/13/2010	X			No	Not applicable to NA3	
02.05.02-16	66	Information needed by the NRC to review site response calculations.	NRC3-11-0036	9/23/2011	X			No	Not applicable to NA3	
02.05.02-17	70	Appropriateness of correlation model.	NRC3-12-0007	2/16/2012	X			No	Not applicable to NA3	
02.05.02-18	70	Target DE spectrum using a limited number of iterations of the program RASCALS.	NRC3-12-0003	2/16/2012	X			No	Not applicable to NA3	

Enrico Fermi Unit 3 ESBWR RAIs – Review Results										
RAI ID #	**NRC RAI Letter #**	**RAI Subject**	**RAI Response Letter #**	**RAI Response Letter Date**	**RAI or RAI Response Not Applicable**	**RAI Response Addressed in COLA**	**RAI Topic to be Addressed Outside COLA**	**COLA Change**	**Basis**	**Comments**
02.05.02-19	72	Clarification on SAFs	NRC3-12-0009	3/29/2012	X			No	Not applicable to NA3	
02.05.02-20	82	Range of parameters for shear-wave velocity for the granular backfill and use of the EPRI (1993) generic sand curves instead of more recently published ones.	NRC3-13-0007	2/8/2013	X			No	New information available	
02.05.02-21	87	Shear wave velocity profiles	NRC3-13-0027	8/9/2013	X			Yes	Not applicable to NA3	
02.05.02-21 Sup 1	87	Shear wave velocity profiles	NRC3-13-0031	8/30/2013	X			No	Not applicable to NA3	
02.05.04-29	36	Observed orientation of discontinuities in the Bass Islands Group	NRC3-10-0035	8/6/2010	X			No	Not applicable to NA3	
02.05.04-30	36	Establishing slopes for shallow and deep tunnels	NRC3-10-0035	8/6/2010	X			No	Not applicable to NA3	
02.05.04-31	36	Groundwater sulfate exposure to concrete effects	NRC3-10-0035	8/6/2010	X			No	Not applicable to NA3	
02.05.04-32	36	Use of Hoek-Brown friction angle and cohesion of the Bass Island Group	NRC3-10-0035	8/6/2010	X			No	Not applicable to NA3	
02.05.04-33	36	Sup to 2.5.4-23: Terzaghi approach effect of weaker zone below the Bass Island Group	NRC3-10-0035	8/6/2010	X			No	Not applicable to NA3	

Enrico Fermi Unit 3 ESBWR RAIs – Review Results										
RAI ID #	NRC RAI Letter #	RAI Subject	RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Addressed in COLA	RAI Topic to be Addressed Outside COLA	COLA Change	Basis	Comments
02.05.04-34	36	Sup to 2.5.4-20: Capture the liquefaction evaluation in the FSAR and provide assumed N_60 and compaction.	NRC3-10-0035	8/6/2010	X			No	Not applicable to NA3	
02.05.04-35	40	Localized liquefaction potential beneath other than SC I structures (COL Item 2.0-29-A)	NRC3-10-0042	9/21/2010	X			No	Not applicable to NA3	
02.05.04-36	52	Soil property requirements and ITAAC - SC I side backfill, ITAAC, SWV near surface, and quantity of backfill	NRC3-11-0010	3/29/2011	X			No	Not applicable to NA3	
02.05.04-37	55	Proposed licensing condition to disallow placement of fill material (not concrete) beneath SC I structure to a thickness of >5 ft.	NRC3-11-0020	6/17/2011	X			No	Not applicable to NA3.	
02.05.04-40	71	Provide the ITAAC used to ensure concrete fill beneath SC I structures of >5ft thick, meet the design, construction, and testing applicable to ACI standards.	NRC3-12-0006	2/16/2012	X			No	Not applicable to NA3.	
02.05.04-41	72	Justify Poisson's ratio for Bass Island and Salina Group	NRC3-12-0009	3/29/2012	X			No	Not applicable to NA3	
03.07.01-1 and 03.07.01-2 (Supplement)	7	Sup to 3.7.1-1 and -2 (pre-May2010 RAIs): Response was to explain that RAI 2.5.4-38 replaces the responses to the original 3.7.1-1 and -2.	NRC3-11-0035	8/26/2011	X			No	Not applicable to NA3	

Enrico Fermi Unit 3 ESBWR RAIs – Review Results										
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03.07.01-3	70	Explain why it is appropriate to define the FIRS for this facility on the basis of a ID column of concrete material if the lateral extension of this material is limited to its footprint.	NRC3-12-0008	3/23/2012	X			No	Not applicable to NA3	
03.07.01-4	70	Explain impact of increased SWV on FWSC FIRS and how data from Hasek, 2002 is applicable to the aforementioned Fermi 3 site conditions.	NRC3-12-0008	3/23/2012	X			No	Not applicable to NA3.	
03.07.01-5	70	Since backfill material is limited in lateral extent explain why it is appropriate to define the PBSRS and FIRS for the RB/FB and CB on the basis of a 1D column of backfill material.	NRC3-12-0008	3/23/2012	X			No	Not applicable to NA3	
03.07.01-6	70	EF3 FSAR (modified by Q2.5.4-38), indicates two horizontal components of spectrum-compatible ground motion used in SSI have correlation coefficients slightly under 0.30. This deviates from the guidance in SRP 3.7.1 (less than 0.16). Staff needs additional technical basis for the use of 0.30.	NRC3-12-0003	2/16/2012	X			No	Not applicable to NA3	

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03.07.01-6 (Supplement)	70	Provide plots of cumulative power and power spectra for the in-column input motions.	NRC3-12-0016	5/22/2012	X			No	Not applicable to NA3	
03.07.01-7	70	Provide justification of acceptability of PGV/PGA values for artificial THs being higher than the selected controlling earthquake and also provide a comparison of the response spectra of the artificial THs and the est. target spectra (SSI FIRS) at 2% and 10% damping for RB/FB and CB.	NRC3-12-0003	2/16/2012	X			No	Not applicable to NA3	
03.07.01-8	70	Provide in the FSAR comparison plots of RB/FB and CB FIRS with RG 1.60 spectrum anchored at 0.1 g.	NRC3-12-0003	2/16/2012	X			No	Not applicable to NA3	
03.07.01-8 (Supplement)	70	Provide an FSAR markup that indicates that the minimum horizontal input requirements are met by the NUREG/CR-0098 spectra shape for rock sites.	NRC3-12-0016	5/22/2012	X			No	Not applicable to NA3	
03.07.02-5	70	Site-specific analysis for the Seismic Category II structures	NRC3-12-003	2/16/2012	X			No	Not applicable to NA3	
03.07.02-6	70	Ignoring embedment effects on SSI response	NRC3-12-019	6/16/2012	X			No	Not applicable to NA3	

Enrico Fermi Unit 3 ESBWR RAIs – Review Results

RAI ID #	NRC RAI Letter #	RAI Subject	RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Addressed in COLA	RAI Topic to be Addressed Outside COLA	COLA Change	Basis	Comments
03.07.02-6 Sup 1	70	Ignoring embedment effects on SSI response	NRC3-13-0032	9/12/2013			X	No		For NA3, the impact of the engineered backfill on SSI response will be addressed in sensitivity studies in 2014 to demonstrate that the effects of the structural fill are enveloped by the design basis site-specific SSI analysis.
03.07.02-7	70	SASSI2000 code and the geometry and properties of the excavated volume modeled in both SASSI analyses	NRC3-12-0007	3/1/2012	X			No	Not applicable to NA3	

Enrico Fermi Unit 3 ESBWR RAIs – Review Results

RAI ID #	NRC RAI Letter #	RAI Subject	RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Addressed in COLA	RAI Topic to be Addressed Outside COLA	COLA Change	Basis	Comments
03.07.02-7 Sup 1	70	SASSI2000 code and the geometry and properties of the excavated volume modeled in both SASSI analyses	NRC3-13-0032	9/12/2013		X		Yes		For NA3, the licensing basis SSI analyses are being performed utilizing the Direct Method of SASSI2010 and not the Subtraction method, as described in the FSAR. The excavated volume FE models are also described and presented in the FSAR figures. In 2014, the Modified Subtraction Method of SASSI2010, as benchmarked to the Direct Method as required, will be utilized for sensitivity studies for the impact of the engineered backfill on SSI response.
03.07.02-8	70	how SSSI effects are evaluated between structures	NRC3-12-0019	6/15/2012	X			No	Not applicable to NA3	

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RAI ID #	NRC RAI Letter #	RAI Subject	RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Addressed in COLA	RAI Topic to be Addressed Outside COLA	COLA Change	Basis	Comments
03.07.02-8 Sup 1	70	How SSSI effects are evaluated between structures	NRC3-13-0032	9/12/2013			X	No		RAI 03.07.02-8 (DTE letter NRC3-13-0032, dated 09-12-2013): This EF3 RAI deals with structure-soil-structure-interaction (SSSI) effects between the RB/FB on the CB and CB on the FWSC. For NA3, the SSSI effects on these structures will be addressed in sensitivity studies in 2014.
03.07.02-9	79	SSI effects and the Fukushima Near-Term Task Force recommendations contained in SECY-12-0025 as it pertains to the seismic hazard evaluation	NRC3-12-0030	10/12/2012	X			No	Not applicable to NA3	

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03.07.02-9 Sup 1	79	SSI effects and the Fukushima Near-Term Task Force recommendations contained in SECY-12-0025 as it pertains to the seismic hazard evaluation	NRC3-13-0032	9/12/2013		X		Yes		For NA3, the SSI methodology and modeling approach, including FE mesh size, use of subtraction method and effect of assumed structural damping ratios is addressed for the licensing basis cases in the NA3 FSAR. Sensitivity studies for the impact of engineered backfill on SSI response will be completed in 2014. The SSSI effects including relative lateral wall deflections will also be addressed in the 2014 SSSI sensitivity studies.
03.07.02-10	82	Deterministic strain-iterated lower-bound (LB), best-estimate (BE), and upper-bound (UB) shear wave velocity profiles	NRC3-13-0007	2/8/2013	X			No	Not applicable to NA3	

Enrico Fermi Unit 3 ESBWR RAIs – Review Results

RAI ID #	NRC RAI Letter #	RAI Subject	RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Addressed in COLA	RAI Topic to be Addressed Outside COLA	COLA Change	Basis	Comments
03.08.05-1	70	Justification for using 2006 code edition of AC-349	NRC3-12-0003	2/16/2012	X			No	Not applicable to NA3	
03.08.05-2	70	Site-specific seismic stability evaluations	NRC3-12-0003	2/16/2012	X			No	Not applicable to NA3	
03.08.05-2 Sup 1	70	Site-specific seismic stability evaluations	NRC3-13-0032	9/12/2013		X		Yes		For NA3, the additional details, including the coefficient of friction used and the considered resistance from shear keys that the NRC requested in this RAI are included in the 2013 FSAR and its supporting technical report. The numerical values for each of the terms in the stability equations used to evaluate the factors of safety against sliding and how they were obtained are also included in the supporting technical report.

Enrico Fermi Unit 3 ESBWR RAIs – Review Results										
RAI ID #	NRC RAI Letter #	RAI Subject	RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Addressed in COLA	RAI Topic to be Addressed Outside COLA	COLA Change	Basis	Comments
03.08.05-3	70	How the seismic load (in the E-W direction) imposed by the CB bearing against the concrete fill is transferred to the underlying rock	NRC3-12-0003	2/16/2012	X			No	Not applicable to NA3	
03.08.05-3 Sup 1	70	How the seismic load (in the E-W direction) imposed by the CB bearing against the concrete fill is transferred to the underlying rock	NRC3-13-0032	9/12/2013		X		Yes		For NA3, it has been determined that base friction alone for the RB/FB and CB is not sufficient to prevent sliding to meet the 1.1 SRP factor of safety. These structures are required to utilize the passive resistance to contribute to the resistance to sliding to meet the 1.1 factor of safety. This is described in the FSAR.
03.08.05-4	70	Whether lateral pressures for the RB/FB and CB below-grade walls at the Fermi site are bounded by those considered in the ESBWR DCD	NRC3-12-0003	2/16/2012	X			No	Not applicable to NA3	

Enrico Fermi Unit 3 ESBWR RAIs – Review Results										
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03.08.05-4 Sup 1	70	Whether lateral pressures for the RB/FB and CB below-grade walls at the Fermi site are bounded by those considered in the ESBWR DCD	NRC3-13-0032	9/12/2013	X			No	Not applicable to NA3	
03.08.05-5	70	Whether the fill concrete below the FSWC is reinforced or not; and shear resistance.	NRC3-12-0003	2/16/2012	X			No	Not applicable to NA3	
08.02-18	80	NRC Bulletin 2012-01	NRC3-12-0031	12/10/2012		X		No		
09.01.05-1	32	Non-metallic slings	NRC3-10-0028	6/25/2010		X		Yes		
09.02.04-1	64	Potable and sanitary water system tank storage locations and flooding	NRC3-11-0031	8/12/2011	X			No	Not applicable to NA3	
10.02.03-1	31	GE turbine type for missile analysis GE Report ST-56834/P, R1	NRC3-10-0045	10/5/2010		X		Yes		The response to the RAI resulted in change(s) to GE Steam Turbine Group report ST-56834/P, which is referenced in the COLA FSAR Section 10.2. The associated COLA change is to provide reference to this report in the COLA.

Enrico Fermi Unit 3 ESBWR RAIs – Review Results

RAI ID #	NRC RAI Letter #	RAI Subject	RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Addressed in COLA	RAI Topic to be Addressed Outside COLA	COLA Change	Basis	Comments
10.02.03-2	31	Turbine control system as described in GE Report ST-56834/P, R1	NRC3-10-0045	10/5/2010		X		Yes		The response to the RAI resulted in change(s) to GE Steam Turbine Group report ST-56834/P, which is referenced in the COLA FSAR Section 10.2. The associated COLA change is to provide reference to this report in the COLA.

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RAI ID #	NRC RAI Letter #	RAI Subject	RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Addressed in COLA	RAI Topic to be Addressed Outside COLA	COLA Change	Basis	Comments
10.02.03-3	31	120% rated speed in GE Report ST-56834/P, R1	NRC3-10-0045	10/5/2010			X	No	Response to the RAI topic will be submitted in separate correspondence.	Dominion concurs with the clarifications and justifications of information or methods provided in the RAI response regarding GE report ST-56834/P. The updated GE report, ST-56834/P, is referenced in the COLA FSAR Section 10.2. As the RAI response did not directly affect the report or the COLA, no COLA change is indicated. The subject report for NA3 was submitted to NRC in letter Serial No. NA3-13-020, dated December 6, 2013.

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RAI ID #	NRC RAI Letter #	RAI Subject	RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Addressed in COLA	RAI Topic to be Addressed Outside COLA	COLA Change	Basis	Comments
10.02.03-4	31	GE material specification B50A373B8	NRC3-10-0045	10/5/2010		X		Yes		The response to the RAI resulted in change(s) to GE Steam Turbine Group report ST-56834/P, which is referenced in the COLA FSAR Section 10.2. The associated COLA change is to provide reference to this report in the COLA.
10.02.03-5	31	GE Report ST-56834/P, R1 - rotor forging testing	NRC3-10-0045	10/5/2010		X		Yes		The response to the RAI resulted in change(s) to GE Steam Turbine Group report ST-56834/P, which is referenced in the COLA FSAR Section 10.2. The associated COLA change is to provide reference to this report in the COLA.

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RAI ID #	**NRC RAI Letter #**	**RAI Subject**	**RAI Response Letter #**	**RAI Response Letter Date**	**RAI or RAI Response Not Applicable**	**RAI Response Addressed in COLA**	**RAI Topic to be Addressed Outside COLA**	**COLA Change**	**Basis**	**Comments**
10.02.03-6	31	GE Report ST-56834/P, R1 - FATT testing temperature effect on missile analysis	NRC3-10-0045	10/5/2010		X		Yes		The response to the RAI resulted in change(s) to GE Steam Turbine Group report ST-56834/P, which is referenced in the COLA FSAR Section 10.2. The associated COLA change is to provide reference to this report in the COLA.

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10.02.03-7	31	GE Report ST-56834/P, R1 - Figure 3.1 basis	NRC3-10-0045	10/5/2010			X	No	Response to the RAI topic will be submitted in separate correspondence.	Dominion concurs with the clarifications and justifications of information or methods provided in the RAI response regarding GE report ST-56834/P. The updated GE report, ST-56834/P, is referenced in the COLA FSAR Section 10.2. As the RAI response did not directly affect the report or the COLA, no COLA change is indicated. The subject report for NA3 was submitted to NRC in letter Serial No. NA3-13-020, dated December 6, 2013.

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RAI ID #	NRC RAI Letter #	RAI Subject	RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Addressed in COLA	RAI Topic to be Addressed Outside COLA	COLA Change	Basis	Comments
10.02.03-8	31	GE Report ST-56834/P, R1 - solid rotor experience/testing	NRC3-10-0045	10/5/2010			X	No	Response to the RAI topic will be submitted in separate correspondence.	Dominion concurs with the clarifications and justifications of information or methods provided in the RAI response regarding GE report ST-56834/P. The updated GE report, ST-56834/P, is referenced in the COLA FSAR Section 10.2. As the RAI response did not directly affect the report or the COLA, no COLA change is indicated. The subject report for NA3 was submitted to NRC in letter Serial No. NA3-13-020, dated December 6, 2013.

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RAI ID #	NRC RAI Letter #	RAI Subject	RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Addressed in COLA	RAI Topic to be Addressed Outside COLA	COLA Change	Basis	Comments
10.02.03-9	31	GE Report ST-56834/P, R1 - solid rotor stress analysis	NRC3-10-0045	10/5/2010			X	No	Response to the RAI topic will be submitted in separate correspondence.	Dominion concurs with the clarifications and justifications of information or methods provided in the RAI response regarding GE report ST-56834/P. The updated GE report, ST-56834/P, is referenced in the COLA FSAR Section 10.2. As the RAI response did not directly affect the report or the COLA, no COLA change is indicated. The subject report for NA3 was submitted to NRC in letter Serial No. NA3-13-020, dated December 6, 2013.

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RAI ID #	NRC RAI Letter #	RAI Subject	RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Addressed in COLA	RAI Topic to be Addressed Outside COLA	COLA Change	Basis	Comments
10.02.03-10	31	GE Report ST-56834/P, R1 - stresses in dovetails and keyways	NRC3-10-0045	10/5/2010			X	No	Response to the RAI topic will be submitted in separate correspondence.	Dominion concurs with the clarifications and justifications of information or methods provided in the RAI response regarding GE report ST-56834/P. The updated GE report, ST-56834/P, is referenced in the COLA FSAR Section 10.2. As the RAI response did not directly affect the report or the COLA, no COLA change is indicated. The subject report for NA3 was submitted to NRC in letter Serial No. NA3-13-020, dated December 6, 2013.

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RAI ID #	NRC RAI Letter #	RAI Subject	RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Addressed In COLA	RAI Topic to be Addressed Outside COLA	COLA Change	Basis	Comments
10.02.03-11	31	Section 5 of GE Report ST-56834/P, Revision 1, overspeed probability	NRC3-10-0045	10/5/2010		X		Yes		The response to the RAI resulted in change(s) to GE Steam Turbine Group report ST-56834/P, which is referenced in the COLA FSAR Section 10.2. The associated COLA change is to provide reference to this report in the COLA.
10.02.03-12	53	Followup to question 10.02.03-4. OE for integral rotors and restrictions on materials chemistry.	NRC3-11-0028	9/30/2011		X		Yes		The response to the RAI resulted in change(s) to GE Steam Turbine Group report ST-56834/P, which is referenced in the COLA FSAR Section 10.2. The associated COLA change is to provide reference to this report in the COLA.

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10.02.03-13	53	Followup to question 10.02.03-6. Use of bounding FATT in analysis, per the DCD.	NRC3-11-0028	9/30/2011		X		Yes		The response to the RAI resulted in change(s) to GE Steam Turbine Group report ST-56834/P, which is referenced in the COLA FSAR Section 10.2. The associated COLA change is to provide reference to this report in the COLA.
10.02.03-14	53	Followup to question 10.02.03-8. Rotor volumetric inspections and flaw propagation.	NRC3-11-0028	9/30/2011		X		Yes		The response to the RAI resulted in change(s) to GE Steam Turbine Group report ST-56834/P, which is referenced in the COLA FSAR Section 10.2. The associated COLA change is to provide reference to this report in the COLA.

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10.02.03-15	53	Followup to question 10.02.03-10. Tangential stresses at the slot bottoms of axial entry dovetails; location of axial entry dovetails; and OE with rotor shot-peening.	NRC3-11-0028	9/30/2011		X		Yes		The response to the RAI resulted in change(s) to GE Steam Turbine Group report ST-56834/P, which is referenced in the COLA FSAR Section 10.2. The associated COLA change is to provide reference to this report in the COLA.
10.02.03-16	53	Followup to question 10.02.03-11. Valve failure data and hydraulic system reliability.	NRC3-11-0028	9/30/2011		X		Yes		The response to the RAI resulted in change(s) to GE Steam Turbine Group report ST-56834/P, which is referenced in the COLA FSAR Section 10.2. The associated COLA change is to provide reference to this report in the COLA.
10.02.03-17	67	Material properties; GE material specification B50A373B12, GE-ST report ST-56834 turbine missile analysis revision 4	NRC3-11-0042	10/28/2011		X		Yes		

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10.02.03-18	67	Turbine missile analysis report GE-ST-56834 flaw propagation	NRC3-11-0042	10/28/2011		X		Yes		
10.02.03-19	67	Turbine inservice inspection scope and frequency	NRC3-11-0042	10/28/2011		X		Yes		
10.04.07-1	68	Departure due to changes incorporated by RAI 12.02-7?	NRC3-11-0043	12/14/2011	X			No	Not applicable to NA3	
11.04-2 (Supplement)	4	Temporary low-level radioactive waste storage facilities	NRC3-11-0034	8/24/2011		X		Yes		
11.04-4	57	SWMS DEP 11.4-1 Figure 11.4-1R incomplete for 2 pumps in series	NRC3-11-0018	6/17/2011		X		Yes		
11.04-4 (Supplement)	57	SWMS revised system process diagram	NRC3-11-0034	8/1/2011		X		Yes		
12.02-5 (Supplement)	18	Annual Airborne Releases for Offsite Doses and Annual Liquid Effluent Releases	NRC3-11-0029	8/1/2011	X			Yes	DCD revised	
12.02-7	58	Departure for iodine activity concentrations in RCS	NRC3-11-0018	6/17/2011	X			No	Not applicable to NA3	
12.02-7 (Supplement)	58	Operation of Cond Purification at 100% system flow	NRC3-11-0032	8/5/2011	X			Yes	Not applicable to NA3	
12.03-12.04-5	27	Construction Worker Dose and Assumptions	NRC3-10-0022	5/21/2010	X			No	Similar to more appropriate RAIs; refer to NA3 RAI 12.03-12.04-46 and 12.03-12.04-47	

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12.03-12.04-6	42	Address objectives of RG 4.21	NRC3-10-0046	10/19/2010		X		Yes		
12.03-12.04-6 Sup 1	42	EF3 liquid effluent discharge line is underground piping to Lake Erie. EF3 SUP 11.2-2 addresses monitoring of this line	NRC3-11-029	8/1/2011		X		Yes		
12.03-12.04-6 Sup 2	42	Address objectives of RG 4.21	NRC3-11-0034	8/24/2011		X		Yes		
12.03-12.04-7	42	Radwaste Storage Departure	NRC3-10-0046	10/19/2010		X		Yes		
12.03-12.04-8	42	Description of Condensate Storage Tank	NRC3-10-0046	10/19/2010		X		Yes		
12.03-12.04-9	52	Design and Shielding Considerations for Radwaste Storage	NRC3-11-0010	3/29/2011	X			No	Not applicable to NA3	
13.03-55	41	EP ITAAC	NRC3-10-0043	10/6/2010	X			No	Not applicable to NA3	
13.03-56	41	EP ITAAC	NRC3-10-0043	10/6/2010	X			No	Not applicable to NA3	
13.03-57	41	EP ITAAC	NRC3-10-0043	10/6/2010		X		Yes		
13.03-58	41	EP ITAAC	NRC3-10-0043	10/6/2010	X			No	Not applicable to NA3	
13.03-59	41	EP ITAAC	NRC3-10-0043	10/6/2010	X			No	Not applicable to NA3	

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13.03-60	41	EP ITAAC	NRC3-10-0043	10/6/2010		X		Yes		
13.03-61	41	EP ITAAC	NRC3-10-0043	10/6/2010	X			No	Not applicable to NA3	
13.03-62	41	EP ITAAC	NRC3-10-0043	10/6/2010	X			No	Not applicable to NA3	
13.03-63	41	EP ITAAC	NRC3-10-0043	10/6/2010	X			No	Not applicable to NA3	
13.03-64	41	EP ITAAC	NRC3-10-0043	10/6/2010	X			No	Not applicable to NA3	
13.03-65 Sup	79	EP License Condition	NRC3-13-0016	4/30/2013		X		Yes		
13.03-88	52	Part 30 License	NRC3-11-0010	3/29/2011	X			No	Superseded by another RAI response; refer to RAI 01-7	
13.03-89	52	Part 40 License	NRC2-11-0010	3/29/2011	X			No	Superseded by another RAI response; refer to RAI 01-7	
13.03-90	52	Part 70 License	NRC3-11-0010	3/29/2011	X			No	Superseded by another RAI response; refer to RAI 01-7	
13.03-91	79	Fukushima - Emergency Preparedness	NRC3-12-0026	9/7/2012		X		Yes		
13.03-92	83	Revision of NEI 10-05 used for on-shift staffing analysis	NRC3-13-0012	4/12/2013		X		Yes		

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13.03-93	83	EAL proposed license condition	NRC3-13-0012	4/12/2013		X		Yes		
14.02-4	33	License conditions required for ITP post-COL activities	NRC3-10-0026	7/9/2010		X		Yes		
19.03-1	43	Revise MST table to ID commitments	NRC3-10-0053	11/8/2010		X		Yes		
19.03-2	43	Makeup to SFP and spray of spent fuel, internal & external	NRC3-10-0053	11/8/2010		X		Yes		
19.03-3	43	Reactor water level monitoring without power	NRC3-10-0053	11/8/2010		X		Yes		
19.03-4	43	Use of CRD system for RPV makeup	NRC3-10-0053	11/8/2010		X		Yes		
19.03-5	43	ADS valves available for depressurization	NRC3-10-0053	11/8/2010		X		Yes		
19.03-6	43	Portable generator use for reactor makeup	NRC3-10-0053	11/8/2010		X		Yes		
19.03-7	43	License condition/program for implementation of 50.54(hh)(2) in Ch. 13	NRC3-10-0053	11/8/2010		X		Yes		
19.03-8	43	Management of commitments per NEI 99-04	NRC3-10-0053	11/8/2010		X		Yes		
19.03-9	43	ID staging areas and equipment therein	NRC3-10-0053	11/8/2010	X			Yes	COLA approach revised	
19.03-10	43	Provide details of airlift support agreements	NRC3-10-0053	11/8/2010	X			No	Not applicable to NA3	

Enrico Fermi Unit 3 ESBWR RAIs – Review Results

RAI ID #	NRC RAI Letter #	RAI Subject	RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Addressed in COLA	RAI Topic to be Addressed Outside COLA	COLA Change	Basis	Comments
19.03-11	43	ID off-site support firefighting equipment	NRC3-10-0053	11/8/2010	X			No	Not applicable to NA3	
19.03-12	43	Staging area location and size	NRC3-10-0053	11/8/2010	X			Yes	COLA approach revised	
19.03-13	43	Define "damage footprint"	NRC3-10-0053	11/8/2010		X		Yes		
19.03-14	43	Sharing equipment and personnel with existing unit(s)	NRC3-10-0053	11/8/2010	X			Yes	COLA approach revised	
19.03-15	43	SAMG-like procedures vs. EDMGs	NRC3-10-0053	11/8/2010		X		Yes		
19.03-16	43	ESBWR design features to mitigate effects of aircraft impact	NRC3-10-0053	11/8/2010		X		Yes		
19.03-17	43	Describe the supplemental methods for adding water to the core and SFP	NRC3-10-0053	11/8/2010		X		Yes		
19.03-18	43	Describe models for dose assessment to event responders	NRC3-10-0053	11/8/2010	X			No	Not applicable to NA3	The NA3 Emergency Plan, Appendix 2, discusses the radiation dose model used - MIDAS.
19.03-19	43	Use of NEI 06-12, R3 for development of EDMGs	NRC3-10-0053	11/8/2010		X		Yes		
19.03-20	43	Radiation protection provisions for firefighter on ladder using sprays	NRC3-10-0053	11/8/2010	X			No	Not applicable to NA3	

Enrico Fermi Unit 3 ESBWR RAIs – Review Results										
RAI ID #	NRC RAI Letter #	RAI Subject	RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Addressed in COLA	RAI Topic to be Addressed Outside COLA	COLA Change	Basis	Comments
19.03-21	43	Labeling or tagging LOLA event response equipment	NRC3-10-0053	11/8/2010		X		No		
19.03-22	43	Procedure walk-through prior to fuel load commitment.	NRC3-10-0053	11/8/2010		X		Yes		
19.03-23	43	Provide a commitment to train evaluators, decision makers, and implementers	NRC3-10-0053	11/8/2010		X		Yes		
19.03-24	43	Timing of airlifted support to fight accelerant-driven fires	NRC3-10-0053	11/8/2010	X			No	Not applicable to NA3	
19.03-25	43	Commitment to re-evaluate off-site support organizations and agreements.	NRC3-10-0053	11/8/2010		X		Yes		
19.03-26	43	Commitment to update procedures for coordination of off-site & local support organizations	NRC3-10-0053	11/8/2010		X		Yes		
19.03-27	43	Table-top exercise use to support training; and schedule for same	NRC3-10-0053	11/8/2010		X		Yes		
19.03-28	43	Clarify roles of fire dept. "connections" vs. fire "hydrants" for ring header supply	NRC3-10-0053	11/8/2010	X			No	Not applicable to NA3	
19.03-29	43	Protective measures for responders where rad. barriers are damages or structural damage occurs	NRC3-10-0053	11/8/2010		X		Yes		
19.03-30	43	Communication restoration plan after LOLA	NRC3-10-0053	11/8/2010		X		Yes		

Enrico Fermi Unit 3 ESBWR RAIs – Review Results

RAI ID #	NRC RAI Letter #	RAI Subject	RAI Response Letter #	RAI Response Letter Date	RAI or RAI Response Not Applicable	RAI Response Addressed in COLA	RAI Topic to be Addressed Outside COLA	COLA Change	Basis	Comments
19.03-31	43	Command/control structure if MCR staff substantially affected	NRC3-10-0053	11/8/2010		X		Yes		
19.03-32	43	Off-site notifications and ERO callout if MCR lost	NRC3-10-0053	11/8/2010		X		Yes		
19.03-33	43	Initial damage assessment to ERO	NRC3-10-0053	11/8/2010		X		Yes		
19.03-34	43	Basis for boundary conditions for EDMGs for LOLA event	NRC3-10-0053	11/8/2010		X		Yes		
19.03-35	43	Portable sprays - equipment locations; limitations; performance parameters	NRC3-10-0053	11/8/2010		X		Yes		
19.03-36	43	Basis for CST to hotwell makeup flow	NRC3-11-0022	6/29/2011	X			Yes	COLA approach revised	
19.03-37	43	Arrangement of spent fuel in the SFP	NRC3-11-0024	7/12/2011		X		Yes		
19.03-38	63	Standard license conditions in COLA related to 10 CFR 50.54(hh)(2)	NRC3-11-0030	8/16/2011		X		Yes		

ENCLOSURE 6

Revised Response to NRC RAI Letter No. 50

Question 02.02.03-8

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

North Anna Unit 3

Dominion

Docket No. 52-017

RAI NO.: 5210 (RAI Letter 50)

SRP SECTION: 02.02.03 – EVALUATION OF POTENTIAL ACCIDENTS

QUESTIONS for Siting and Accident Conseq Branch (RSAC)

DATE OF RAI ISSUE: 12/02/2010

QUESTION NO.: 02.02.03-8

RG 1.206 provides guidance regarding the information that NRC needs to ensure potential hazards in the site vicinity are identified and evaluated to meet the siting criteria in 10 CFR 100.20 and 10 CFR 100.21. The staff has performed confirmatory calculations which show that carbon dioxide concentrations at the control room air intake could exceed the National Institute for Occupational Safety and Health (NIOSH) immediately dangerous to life or health (IDLH) concentration limit of 40,000 ppm. However, the applicant's calculated concentration is lower than the IDLH concentration (COL FSAR Table 6.4-201). Therefore, the staff requests that the applicant provide the input data it used in ALOHA modeling of this chemical. Please also provide the rationale for using an urban or forest roughness factor selected in ALOHA modeling compared to the open country option used for on-site chemicals stored at Units 1 and 2.

As shown in COL FSAR Table 6.4-201, the applicant showed that calculated distances up to which IDLH concentrations could be exceeded would exceed the distances to the nearest control room air intake for each of the following chemicals: Ammonium Hydroxide (19%), Dimethylamine (40%), Hydrazine (20%), Hydrochloric Acid (30%) for Unit 3, and Ammonium Hydroxide (30%) and Carbon Dioxide for Units 1 and 2. This implies that the concentration of the above chemicals exceed respective IDLH concentrations at the control room air intake. However, the applicant calculated maximum concentrations of these chemicals using ALOHA in Table 6.4-201 are lower than the respective IDLH concentrations inside the control room. Please provide rationale and justification for using ALOHA model instead of HABIT model identified in the guidance provided in RG 1.78. Provide the concentrations of chemicals at the control room air intake along with the concentration in the control room for comparison.

Dominion Response

Dominion responded to this RAI question in a letter dated January 10, 2011 (ML110110613). That response was specific to the US-APWR technology and requires revision to reflect Dominion's change in its nuclear technology selection from the US-APWR to the ESBWR design. As such, the chemicals discussed in the original question are no longer valid. This RAI response supersedes the January 10, 2011 response in its entirety and is only for chemicals applicable to the ESBWR design (i.e., this response proceeds as if the question were asked of chemicals associated with the ESBWR design).

RAI Question 02.02.03-8 includes two parts:

1. The NRC staff requests that the applicant provide the input data it used in ALOHA modeling of carbon dioxide concentrations at the control room air intake and provide the rationale for using an urban or forest roughness factor selected in ALOHA modeling compared to the open country option used for on-site chemicals stored at Units 1 and 2.
2. The NRC staff requests that the applicant provide rationale and justification for using the ALOHA model instead of the HABIT model identified in the guidance provided in RG 1.78, and provide the concentrations of chemicals at the control room air intake along with the concentration in the control room for comparison.

The response to each part follows. Tables 1 through 4 and Figure 1, which are referenced in the response, are provided in Attachments 1 and 2, respectively.

1. Carbon Dioxide was analyzed for the ESBWR design, and it was found that the concentrations at the control room intake and inside the control room do not exceed the IDLH concentrations (see Table 4). Table 1 below presents a summary of the Areal Locations of Hazardous Atmospheres (ALOHA) model input values and the basis used for each input in the modeling of carbon dioxide. As specified by Regulatory Guide 1.206, *Combined License Applications for Nuclear Power Plants,* for each postulated event, the evaluation should determine a range of concentrations at the site for a spectrum of meteorological conditions. The evaluation conducted used a spectrum of standard meteorological conditions as depicted in Table 2, below, for selected stability class, wind speed, time of day, and cloud cover conditions.

   Additionally, because the carbon dioxide is stored as a cryogenic liquid and the specific gravity of carbon dioxide is 1.53 (i.e., heavier than air), it was modeled as a heavy gas. Because ALOHA's chemical library does not contain enough chemical data for carbon dioxide to be run as a heavy gas, a new chemical – carbon dioxide (heavy) – was created. Table 3 shows the properties for carbon dioxide (heavy) that were used in the cryogenic carbon dioxide analysis.

The degree of atmospheric turbulence influences how quickly a chemical cloud moving downwind will mix with the air around it and be diluted. Friction between the ground and air passing over it is one cause of atmospheric turbulence. Because the air nearest the ground is slowed the most, eddies can develop. The rougher the ground surface, the greater the ground roughness (Z_0), and the greater the turbulence that develops. "Urban or Forest" ground roughness was selected for the determined worst case meteorological class for the following Unit 3 chemicals stored on-site: hydrogen and nitrogen. The selection of "Urban or Forest" is appropriate because the release at the indicated chemicals' storage locations would require a resultant vapor cloud to travel between or around the Unit 3 structures in order to reach the control room air intakes. Figure 1 below shows the storage locations in relation to the Unit 3 Control Room (CR) HVAC intake. In the case of hydrogen and nitrogen, which are both heavy gases, it should be noted that ALOHA assumes a ground roughness of 10 cm when "Urban or Forest" is selected. This value is equivalent to tall grass as it falls between "grass with bushes and some trees" (at 4 cm) and "1-2 m high vegetation" (at 20 cm).

The analysis for carbon dioxide (heavy) has been updated and conservatively uses the "Open Country" ground roughness.

It should be noted that "Open Country" roughness was conservatively selected for the remaining chemicals listed in FSAR Table 2.2-205, including the Units 1 and 2 chemicals, because either the concentration inside the CR remains below the toxic limit of each chemical using the conservative "Open Country" ground roughness value or there are no obstructions or roughness elements between these storage locations and the Unit 3 CR HVAC intake.

2. As stated in the first paragraph of this response, the chemicals discussed in the original question are no longer valid due to the change from the US-APWR design to the ESBWR design. For the ESBWR design, the Unit 3 chemicals for which the distance to the toxic limit exceeds the distance to the control room are: Liquid Hydrogen (Transportation Tanker), Nitrogen, and Oxygen. The Units 1 & 2 chemicals for which the distance to the toxic limit exceeds the distance to the control room are Ammonium Hydroxide (30%), Carbon Dioxide (heavy), and Novec 1230. However, due to the CR air exchange rate, none of the chemicals in this response have concentrations that exceed the toxic limit inside the CR (see Table 4 below).

   Regulatory Guide 1.78, *Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release*, does not specify that the HABIT model be used for control room habitability analysis, only that the dispersion model permits temporal as well as spatial variations in release terms and concentrations. This is indicated in Regulatory Position 3.3 of Regulatory Guide 1. 78, which states:

> *"The atmospheric transport of a released hazardous chemical should be calculated using a dispersion or diffusion model that permits temporal as well as spatial variations in release terms and concentrations. The NRC uses a computer code, HABIT, for control room habitability evaluation. The HABIT code is described in NUREG/CR-6210, "Computer Codes for Evaluation of Control Room Habitability (HABIT)" (Ref. 8). ... Other atmospheric dispersion models (e.g., ARCON96) with similar capabilities may be used for dispersion calculations."*

ALOHA is part of the Computer-Aided Management of Emergency Operations (CAMEO) software package developed by the U.S. Environmental Protection Agency and National Oceanic and Atmospheric Administration to provide planning for chemical release emergencies. ALOHA, like HABIT, permits temporal as well as spatial variations in release terms and concentrations. However, unlike HABIT, ALOHA uses a time dependent Gaussian plume model for neutrally buoyant gases and a heavy gas dispersion model for gases with specific gravities greater than 1.0, and generates output in a concentration versus time format for specified receptors. This results in a more realistic prediction of a wider range of gaseous dispersion scenarios and ensuing chemical concentrations.

Furthermore, in a February 17, 2011 letter to the NRC, "Report on the Safety Aspects of the South Carolina Electric and Gas Company Combined License Application for V.C. Summer Nuclear Station, Units 2 and 3", the ACRS suggested restricting the use of HABIT to only neutral density gas dispersion modeling because the code does not consider heavy gas effects. SRP Section 2.3.4 makes a similar restriction for the use of the HABIT computer code.

Finally, ALOHA was used and approved in the Combined Licenses issued for Vogtle Units 3 and 4 and V.C. Summer Units 2 and 3, along with numerous COL Applications now before the NRC Staff, including previous revisions of the North Anna Unit 3 COL Application.

Table 4 presents a summary of the ALOHA modeling results, including the constituent concentrations both at the CR HVAC intake and inside the CR.

FSAR Section 2.2 reflects the chemicals addressed in this response.

Proposed COLA Revision

None.

Table 1: ALOHA Input Values with Bases

Menu	Parameter	Input	Basis
Site Atmospheric Data			
Site Data	Location	38° 04' N 77° 48' W Elevation: 300 feet State: Virginia	ALOHA uses the latitude, longitude, and elevation of a chemical release in some of its computations, including sun angle or solar radiation (latitude, longitude, and time of day of calculation) and atmospheric pressure (elevation of location) (ALOHA).
Site Data	Number of Air Changes	0.36 air exchanges per hour	The number of air exchanges per hour (of outside air) for the control room is used to estimate indoor concentrations of carbon dioxide.
Site Data	Date and Time	See Table 2	The date was selected because it coincides with the summer solstice. The time 12:00 pm was selected for those meteorological classes likely to occur during the daytime because solar radiation is highest during midday and higher solar radiation leads to a higher evaporation rate and thus a larger vapor cloud. The time 5:00 am on June 21, 2008 was selected to provide a realistic meteorological condition for those meteorological classes likely to occur during the evening or early morning.
Setup/ Chemical	Chemical Information	Carbon Dioxide (Heavy)	As noted in Part 1 of the response, due to the storage conditions of the carbon dioxide, it is appropriate to model it as a heavy gas. Since ALOHA does not have enough properties for cryogenic carbon dioxide to do this, it was necessary to enter a new chemical using the properties in Table 3 of this response.
Setup/ Atmospheric	Wind Speed	A meteorological sensitivity analysis was performed at varying wind speeds and meteorological stability classes to determine the worst case scenario (See Table 2)	RG 1.206 requires that for each postulated event, the evaluation should determine a range of concentrations at the site for a spectrum of meteorological conditions. The ALOHA model was run over a spectrum of meteorological conditions to determine the worst case CR concentration for cryogenic carbon dioxide. The chosen wind speed inputs were based on the meteorological stability classes defined by Pasquill.

Table 1: ALOHA Input Values with Bases

Menu	Parameter	Input	Basis
Setup/Atmospheric	Wind Direction	W	In the ALOHA modeling runs conducted, the threat at point function was chosen which allows the user to set the receptor location directly downwind from the source for a worst-case determination, effectively negating the input for this menu item (i.e., the model will not take into account an inputted value for wind direction).
Setup/ Atmospheric	Wind Measurement Height	10 meters	ALOHA calculates a wind profile based on where the meteorological data is taken (ALOHA). Wind rose data from the onsite meteorological tower, described in ESP Application SSAR Section 2.3.3.1.2, were collected at a height of 10 meters. Additionally, the surface wind speeds for determining the Pasquill stability class are defined at 10 meters.
Setup/ Atmospheric	Ground Roughness	"Open Country"	See Part 1 of this response.
Setup/ Atmospheric	Cloud Cover	The appropriate selection is chosen to agree with the meteorological stability class (See Table 2)	ALOHA uses this value to estimate the amount of incoming solar radiation at the time of a chemical release. There are defined cloud cover percentages for some of the Pasquill meteorological classes (ALOHA).
Setup/ Atmospheric	Air Temperature	91.5 °F (mid-day) 71.5 °F (night-time)	The highest mean daily maximum temperature for three years of available National Weather Service (NWS) data (2007, 2008, 2009) was used for mid-day calculations and the highest mean daily minimum temperature for the same three years of available data was used for night-time calculations.

Table 1: ALOHA Input Values with Bases

Menu	Parameter	Input	Basis
Setup/ Atmospheric	Stability Class	A meteorological sensitivity analysis was performed at varying wind speeds and stability classes (See Table 2)	The atmosphere may be more or less turbulent depending on the amount of incoming solar radiation as well as other factors. Meteorologists have defined atmospheric stability classes, each representing a different degree of turbulence in the atmosphere. When moderate to strong incoming radiation heats air near the ground, causing it to rise and generate large eddies, the atmosphere is considered unstable (relatively turbulent). When solar radiation is weak or absent, air near the surface has a reduced tendency to rise, and less turbulence develops (stable atmosphere). As required in RG 1.206, a meteorological sensitivity analysis was performed.
Setup/ Atmospheric	Inversion Height	None	Inversion height has no effect on the heavy gas model. Furthermore, most inversions are at heights much greater than ground level. Inversions at lower heights generally only occur during the early morning hours under very stable conditions. These conditions are accounted for by modeling F stability class at very low wind speeds, which allows very little lateral dispersion.
Setup/ Atmospheric	Humidity	63%	A relative humidity of 63% was selected because it is the average relative humidity over three years of available NWS data (2007, 2008, 2009).
Setup/Source	Direct	Direct	In ALOHA, the direct source is the option chosen for modeling a direct release of a gas over a given period of time.
Setup/Source	Direct/source strength units of mass or volume	Pounds	Releasing the quantity in pounds is an accurate representation of the amount of a chemical in a container for a gas.
Setup/Source	Direct/Instantaneous or Continuous	Continuous	Continuous was selected because this allows for modeling a time duration release within ALOHA.

Table 1: ALOHA Input Values with Bases

Menu	Parameter	Input	Basis
Setup/Source	Direct/Amount of Pollutant Entering the Atmosphere	1041.1 lbs/min	For substances that are normally gases at ambient temperature and handled as a gas, if the released substance is not contained by passive mitigation systems or if the contained pool would have a depth of 1 cm or less, the entire quantity shall be released over 10 minutes and the release rate shall be assumed to be the total quantity divided by 10. (40 CFR 68.25) In the case of cryogenic carbon dioxide, the total mass in the container (10,411 pounds) was assumed to be released over a period of 10 minutes.
Setup/Source	Direct/Source Height	0 feet	The source height is the height of a chemical release above the ground. Source height is zero if the chemical is released at ground-level. 40 CFR 68.22 defines the worst-case release as occurring at ground-level (40 CFR 68.22).

Table 1 References:

(40 CFR 68.22) Code of Federal Regulations – Title 40: Protection of Environment, *Chapter 1 – Environmental Protection Agency; Subchapter C – Air Programs; Part 68 – Chemical Accident Prevention Provisions; Subpart B – Hazard Assessment; Subsection 68.22 - Offsite consequence analysis parameters,* June 1996.

(40 CFR 68.25) 40 CFR 68.25: Code of Federal Regulations – Title 40: Protection of Environment, *Chapter 1 – Environmental Protection Agency; Subchapter C – Air Programs; Part 68 – Chemical Accident Prevention Provisions; Subpart B – Hazard Assessment; Subsection 68.25 - Worst-case release scenario analysis,* May 1999.

(ALOHA) U.S. Environmental Protection Agency and National Oceanic and Atmospheric Administration, *ALOHA User's Manual,* February 2007.

Table 2: Meteorological Sensitivity Analysis

Stability Class	Surface Wind Speed (m/s)	Cloud Cover	Date/ Time
A	1.5	0%	June 21, 2008 / 12:00 pm
B	1.5	50%	June 21, 2008 / 12:00 pm
C	3	50%	June 21, 2008 / 12:00 pm
C	5.5	0%	June 21, 2008 / 12:00 pm
D	3	50%	June 21, 2008 / 5:00 am
D	5.5	50%	June 21, 2008 / 12:00 pm
E	1	50%	June 21, 2008 / 5:00 am
E	2	50%	June 21, 2008 / 5:00 am
F	1	0%	June 21, 2008 / 5:00 am
F	2	0%	June 21, 2008 / 5:00 am
F	3	0%	June 21, 2008 / 5:00 am

Table 3: Carbon Dioxide (Heavy) Properties

Carbon Dioxide (Heavy) Property	Property Value[1]	Reference
Molecular Weight	44.01 g/mol	ALOHA
Normal Boiling Point	194.7 K	Yaws 2008
Critical Temperature	304.21 K	ALOHA
Gas Density	713 kg/m^3 @ 298.15 K and 101,325 Pa	Yaws 2008
Gas Heat Capacity (Constant Pressure)	925.02 J/kg-K @ 373.15K and 101,325 Pa	Yaws 2003
Liquid Heat Capacity	1984.6 J/kg-K @ 246.58K and 101,325 Pa	ALOHA
Vapor Pressure	56.5 atm (42,490 mm Hg) @ 68 °F	NIOSH
Critical Pressure	1.070 psia	CHRIS

Table 3 References:

(ALOHA) U.S. Environmental Protection Agency and National Oceanic and Atmospheric Administration, *ALOHA User's Manual*, February 2007.

(CHRIS) United States Coast Guard, *Chemical Hazards Response Information System*, June 1999.

(NIOSH) National Institute for Occupational Safety and Health (NIOSH), *Pocket Guide to Chemical Hazards*, http://www.cdc.gov/niosh/npg/, Accessed June 2013.

(Yaws 2003) Yaws, Carl L., *Yaws' Handbook of Thermodynamic and Physical Properties of Chemical Compounds*, 2003.

(Yaws 2008) Yaws, Carl L., *Yaws' Handbook of Physical Properties for Hydrocarbons and Chemicals*, Knovel, 2008.

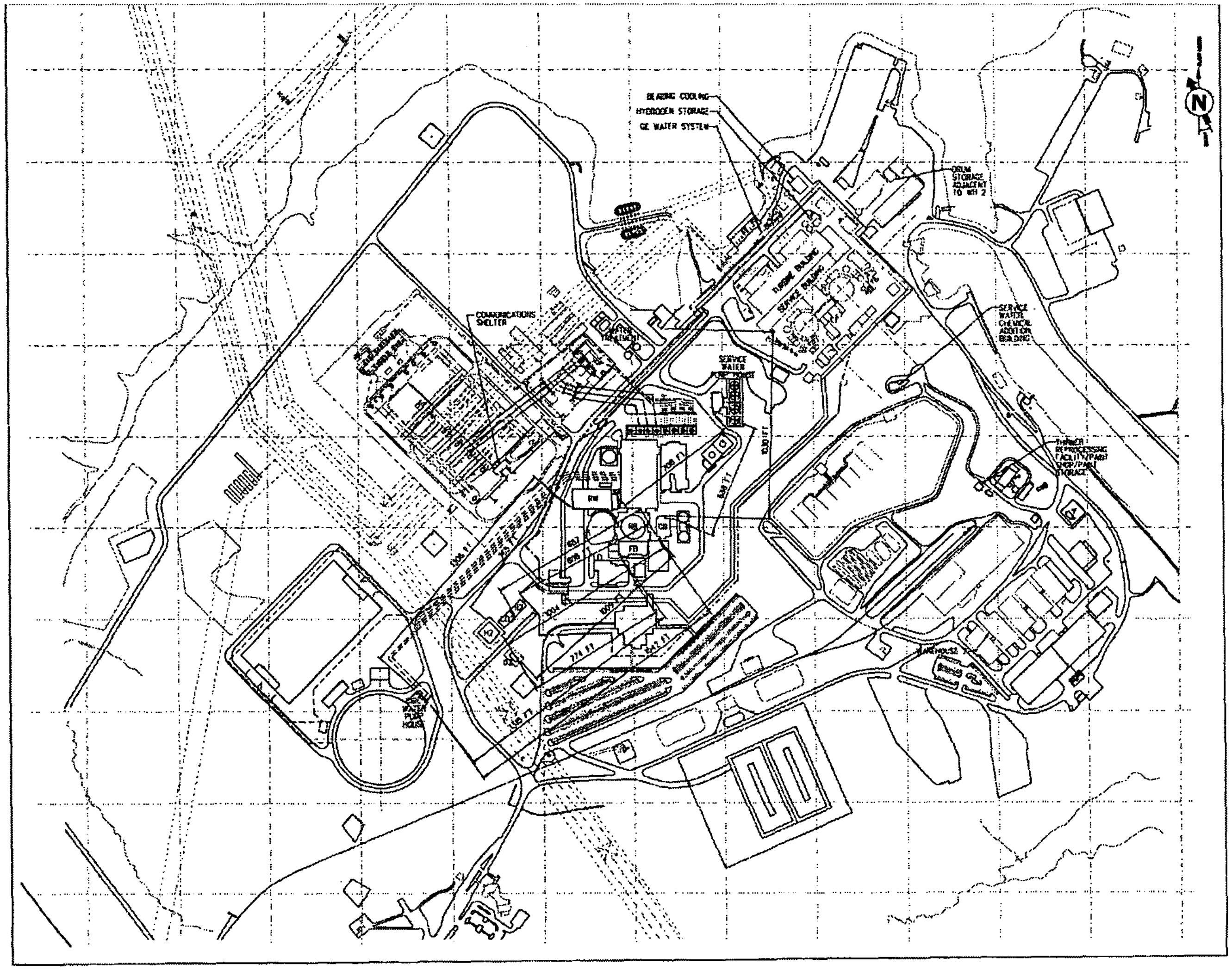
Table 4: CR Toxic Gas Concentrations

Chemical/Material	Distance to Unit 3 CR Intake (ft)	Toxic Limit (ppm)(1)	Distance to Toxic Limit (ft)(10)	Maximum Concentration at the CR HVAC Intake (ppm)	Maximum CR Concentration (ppm)
Unit 3					
Carbon Dioxide(6)	887	40,000	798	29,200	1,790
Liquid Hydrogen – On-Site Storage(5),(6)	1,004	71,400	906	54,800	3,360
Liquid Hydrogen – Transportation Tanker(5),(6)	1,004	71,400	1,311	148,000	9,570
Nitrogen(5)	806	71,400(7)	2,130	468,000	26,800
Oxygen	1,009	235,000(8)	1,446	464,000	26,600
Sodium Hypochlorite – Circulating Water Pump House(2),(6)	1,542	10(4)	444	1.28	0.326
Sodium Hypochlorite – Service Water Pump House(2),(6)	638	10(4)	276	2.49	0.698
Sodium Hypochlorite – Station Water Intake(2),(6)	1,030	10(4)	354	1.64	0.442
Nalco H-130 – Circulating Water Pump House(6)	1,542	3,300(3)	219	165	39.9
Nalco H-130 – Service Water Pump House(6)	638	3,300(3)	189	392	99.4
Units 1 & 2					
Acetone(6)	2,214	2,500	102	10.6	2.16
Ammonium Hydroxide (30%)	1,228	300	1,278	329	26.7
Carbon Dioxide(6)	1,146	40,000	1,446	85,000	5,330
Nalco H-130(6)	1,406	3,300(3)	177	141	34.1
Halon 1301(6)	1,228	40,000	72	79.3	4.57
Hydrazine (35%)	1,228	50	849	26.0	6.89
Hydrochloric Acid (31%)	1,628	50	438	4.26	0.830
Nitrogen	1,146	71,400	618	21,900	1,250
NOVEC 1230	858	150(9)	1,065	227	13.1
Carboline #2 - Toluene	1,683	500	99	4.30	1.10
Carboline #2 – Methyl Ethyl Ketone	1,683	3,000	60	15.1	3.39
Sodium Hypochlorite (15%)(2),(6)	1,769	10(4)	54	0.0189	0.00473

Notes:

(1) The toxic limit is the IDLH limit unless otherwise noted
(2) As chlorine gas based on a decomposition analysis of sodium hypochlorite
(3) As ethanol
(4) As chlorine
(5) An Urban or Forest roughness factor was selected in ALOHA when evaluating hydrogen and nitrogen to account for the wakes/eddies that would be generated as the formed cloud traveled between/around the Unit 3 structures
(6) Modeled as a heavy gas due to the chemical properties and/or storage conditions
(7) Toxic limit is when an oxygen-deficient environment occurs (71,400 ppm)
(8) Toxic limit is the concentration at which an oxygen-enriched environment occurs (235,000 ppm)
(9) Time-Weighted Average (TWA)
(10) The "Distance to the Toxic Limit" is the distance at which the concentration goes below the toxic limit

Figure 1: Onsite Chemical Storage Locations in Relation to the Unit 3 Control Room HVAC Intake



ENCLOSURE 7

Revised Response to NRC RAI Letter No. 24, Question 02.04.12-1

and NRC RAI Letter No. 34, Question 02.04.12-2

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

North Anna Unit 3

Dominion

Docket No. 52-017

RAI LETTER NO.: 024, 034

SRP SECTION: 02.04.12 – GROUNDWATER

DATE OF RAI ISSUE: 08/08/2008, 03/26/2009

QUESTION NO.: 02.04.12-1

Staff has reviewed the groundwater analysis results described in FSAR Section 2.4.12. In accordance with 10 CFR 100.20(c)(3) and 10 CFR 52.79(a)(1)(iii) NRC staff requests that the applicant: (a) provide the technical bases for the assumptions, parameter values, and boundary conditions of the MODFLOW model(s) used to evaluate post-construction groundwater heads, (b) provide a discussion of the alternative explanations considered to explain the head at well OW-901 and the discrepancy between the observed head at this well and the model results, and (c) provide the technical basis for the confidence in model predictions of post-construction groundwater heads given this discrepancy.

QUESTION NO.: 02.04.12-2

The purpose of this RAI is to address the requirements of 10 CFR 50.55a, GDC 2, GDC 4, and 10 CFR 100.20(c)(3). These regulations require (1) a complete description of the effects of groundwater levels on the design bases of plant foundations, and (2) a complete description of the site dewatering system, including its reliability in maintaining groundwater conditions within the design bases of structures, systems, and components important to safety.

The applicant conducted groundwater modeling to estimate maximum post-construction groundwater elevations. A narrative description of the groundwater modeling was provided to Staff in the applicant's Letter No. 024 dated September 19, 2008 (in response to RAI 2.4.12-1). Based on the results of the modeling, the applicant concluded that the maximum post-construction groundwater elevation in the power block area will be 86.26 m (283 ft) NAVD88, 2.134 m (7 ft) below the design plant grade elevation. Since the maximum groundwater elevation is less than the DCD site parameter value of 0.61 m (2 ft) below plant grade (87.79 m, or 288 ft msl), the applicant concluded that a permanent dewatering system is not needed for safe operation of Unit 3.

Staff has concluded that the groundwater elevations predicted by the model are strongly dependent on the characteristics of the model drain cells that represent the site surface water drainage system (i.e. the drainage ditches) surrounding the power block. Staff request additional information supporting the applicant's conclusion that the groundwater elevations in the power block area will meet the maximum groundwater level requirement of the DCD over the life of the facility. Such information may include the following elements.

- Model sensitivity studies demonstrating the impact on groundwater elevations of the drain cell characteristics (elevations, conductance, and recharge rates).
- Additional evidence that the surface water drainage system will behave as a groundwater drain (as predicted by the groundwater model) over the life of the facility. This may include, for example, additional details of the surface water drainage system design and maintenance.
- Discussion of whether high water levels in the drainage ditches (such as during storms) can cause high groundwater levels in the power block area as a result of infiltration from the drains.
- A discussion of how groundwater monitoring data obtained during plant operation will be used to evaluate groundwater elevations in the power block area.

Dominion Response

Dominion responded to RAI question 02.04.12-1 in a letter dated September 19, 2008 (ML082700252). The NRC issued related RAI question 02.04.12-2 in RAI Letter No. 034, dated March 26, 2009. Dominion responded to RAI question 02.04.12-2 in a letter dated June 17, 2009 (ML091700117). Those responses were submitted when North Anna Unit 3 was the reference COLA (R-COLA) for the ESBWR design. This RAI response supersedes both the September 19, 2008 response to RAI question 02.04.12-1 and the June 17, 2009 response to RAI question 02.04-12-2 in their entirety.

The development of the groundwater flow model for the Unit 3 site is described in the attached report, *North Anna Groundwater Model*, which addresses parts (a), (b) and (c) of RAI question 02.04.12-1.

In response to RAI 02.04.12-2, the groundwater levels predicted by the groundwater flow model will be compared with data subsequently obtained from the groundwater monitoring program described in FSAR Section 2.4.12.3. The calibration will be updated, if needed, and the groundwater model will be run again to evaluate groundwater levels in the power block area.

Proposed COLA Revision

None.

ATTACHMENT TO ENCLOSURE 7

Dominion North Anna 3 Combined License Application

North Anna Groundwater Model

DOMINION

NORTH ANNA 3 COMBINED LICENSE APPLICATION

NORTH ANNA

GROUNDWATER MODEL

Bechtel Power

November 2013

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1 OBJECTIVE

1.1 Purpose

The purpose of this report is to provide a summary of the simulated post construction groundwater levels (predicted elevations) for the power block area of the proposed North Anna Unit 3 (Unit 3) Nuclear Power Station near Richmond in Louisa County, Virginia. The proposed Unit 3 is described in Dominion (2006). This report describes the development of a groundwater numerical model to support the Combined Operating License (COL) Application for Unit 3, Final Safety Analysis Report (FSAR) Section 2.4.12. The groundwater model was also developed to support the Postulated Accidental Release of Radioactive Effluents to Ground and Surface Waters analysis in FSAR Section 2.4.13.

This report includes seven sections: Objective (Section 1), Site Overview (Section 2), Groundwater Model (Section 3), Model Calibration (Section 4), Post-Construction Simulations (Section 5), Conclusions (Section 6), and References (Section 7).

1.2 Unit 3 Groundwater Design Criteria

In December 2010, General Electric (GE) Hitachi Nuclear Energy revised the Design Control Document (DCD), Tier 2, for the Economic Simplified Boiling Water Reactor (ESBWR) (GE 2010). Chapter 2 (Table 2.0-1) indicates that maximum groundwater levels beneath safety-related structures, systems, and components (SSCs) must be a minimum of 0.61 m (2 ft) below design plant grade (GE 2010). Therefore, as the design plant grade is at an elevation of 290 ft relative to the North American Vertical Datum of 1988 (NAVD 88), groundwater levels must not exceed an elevation of 288 ft NAVD 88 at these structures.

Chapter 2 of the DCD (GE 2010) indicates that the 0.61-m site parameter is applicable to Seismic Category I, II, and Radwaste Building structures. Therefore, post-construction simulated groundwater elevations were analyzed for the following buildings (GE 2010, Table 3.2-1):

- Reactor Building (RB) – Seismic Category I
- Fuel Building (FB) – Seismic Category I
- Control Building (CB) – Seismic Category I
- Fire Water Service Complex (FWSC) – Seismic Category I
- Turbine Building (TB) – Seismic Category II
- Service Building (SB) – Seismic Category II
- Ancillary Diesel Building (ADB) – Seismic Category II
- Radwaste Building (RWB) – Non-Seismic

1.3 Horizontal Projection and Vertical Datum

The horizontal projection used in this report is Virginia South State Plane 4502, U.S. Feet. This projection is based on the North American Datum 1983 (NAD83). Plant north is rotated 23.54 degrees to the east of north.

The vertical datum used in this report is NAVD 88. As Lake Anna pool elevations (and other historical data) are recorded relative to the National Geodetic Vertical Datum of 1929 (NGVD 29), the corresponding elevations relative to the NAVD 88 datum will be reported using an orthometric height conversion. For example, at the location of the Reactor Building (RB), the design plant grade elevation of 290 ft NAVD 88 is estimated to be 0.86 ft higher in NGVD 29, or 290.86 ft. However, note that the conversion from NGVD 29 to NAVD 88 of -0.860 ft is valid only for the power station site as it is based on latitude and longitude of the proposed centerline location of future Unit 3. The conversion is location dependent and will be different for locations removed from the site. For example, at the North Anna dam spillway, the conversion would be 0.863 ft.

Because the difference in datum conversions at the power station and the spillway is only 0.003 ft, and because the results in this report are reported to the nearest tenth or hundredth of a foot, these differences have no effect on the groundwater modeling results.

2 SITE OVERVIEW

2.1 Site Overview

The site description focuses on the groundwater model domain, which extends about one-half mile to the north, south, and west of Unit 3, and slightly less than one-half mile to the east of Unit 3 (Figure 1).

Unit 3 is located approximately forty miles to the north-northwest of Richmond, Virginia. The topography at Unit 3 is gently rolling (Dominion 2006, Section 2.1.1.2). Local elevation within the model domain ranges from approximately 225 ft NAVD 88 up to an elevation of approximately 350 ft NAVD 88. The site is bounded on the north and west sides by Lake Anna and to the east and southeast by the Waste Heat Treatment Facility (WHTF). To the west and the south, the area within the model domain is drained by short, intermittent streams that flow into Lake Anna.

Figure 1 shows the location of existing Units 1 and 2 and the proposed Unit 3. The finished ground level grade of Unit 3 will be approximately 289.5 ft NAVD 88. Design plant grade is at DCD elevation 4650 mm (GE 2010), which corresponds to site elevation 290 ft NAVD 88.

2.2 Hydrostratigraphic Units

The geologic setting of Unit 3 is discussed in Dominion (2006), Pavlides (1980) and in the Units 1 & 2 and abandoned Units 3 & 4 site investigations reports. Groundwater in the surficial aquifer system at Unit 3 occurs in the fractured bedrock and in the overlying unconsolidated materials that are largely weathering products (i.e., residual soil or saprolite) of the underlying bedrock. The unconsolidated material and underlying bedrock at the site have been given the following classifications (Dominion 2006, Section 2.5.4.2.2):

- Zone I: Residual clays and clay silts – all structures of parent rock are lost
- Zone IIA: Saprolite – core stone less than 10 percent of volume of overall mass
- Zone IIB: Saprolite – core stone 10 to 50 percent of volume of the overall mass
- Zone III: Weathered rock: core stone more than 50 percent of volume of the overall mass
- Zone IV: Parent rock – slightly weathered to fresh rock below zone of isolated core stones

Groundwater at the site occurs in unconfined conditions in both the saprolite and underlying bedrock (Dominion 2008), as conceptually illustrated in Figure 2. Therefore, two hydrostratigraphic units are relevant for the development of the groundwater model: the saprolite and the shallow bedrock. The elevation, thickness, and geologic description of these units were determined from the Unit 3 geotechnical and hydrogeological borings.

2.2.1 Saprolite

Saprolite at the site is generally exposed at the ground surface or underlies a thin layer of residual soil or fill. The saprolite extends to the top of the rock from which it was derived; however, the contact between the saprolite and sound rock may be gradational and not well defined (Dominion 2006). The saprolite is reported to range in thickness from about 2 to 125 feet and is of variable

lithology, depending on the type of parent material from which it was derived (Dominion 2006). Borings drilled as part of the Early Site Permit (ESP) subsurface investigation program penetrated saprolite to depths ranging from about 6 to 35 feet (Dominion 2006, Appendix 2.5.4B). The saprolite penetrated by these borings is classified as a micaceous, silty-clayey, fine to coarse sand or sandy silt, with occasional (i.e., less than 10 percent) to some (i.e., between 10 and 50 percent rock fragments.

2.2.2 Fractured Bedrock

The bedrock beneath the saprolite is described as quartz gneiss with some biotite quartz gneiss and interbedded quartz gneiss, biotite quartz gneiss, and hornblende gneiss. The bedrock exhibits a variable weathering profile and variable joints and fractures. Groundwater flows through these joints and fractures. Investigations at the site have indicated that there is a hydrologic connection between the saprolite and the bedrock (Dominion 2006). As stated in Dominion (2006, p. 2-2-140):

> *Groundwater in the crystalline rocks is stored and transmitted through joints and fractures in the rocks, while the main body of the rock between the joints and fractures is essentially impermeable. The number and extent of the joints/fractures, and the width of the openings between their surfaces, generally decrease with depth, thus limiting the significance of the water-transmitting capability of the bedrock to its upper few hundred feet.*

For the groundwater model, it is assumed that most of the fractures in the bedrock are closed after the first one hundred feet below ground surface due to the stresses exerted by the material above. This assumption implies that groundwater flow is limited to the upper one hundred feet below the ground surface.

2.3 Groundwater Flow Conditions

2.3.1 Historical Conditions (Pre-Construction of Units 1 & 2)

Historical groundwater conditions (i.e., prior to Units 1 & 2 construction) are described as follows: Groundwater was found in both the saprolite and the underlying metamorphic bedrock. The configuration of the piezometric surface generally follows the surface topography. The static piezometric head was found to be equal for the groundwater contained in both the saprolite and underlying rock, indicating a hydrologic connection between the two. The observed horizontal hydraulic gradient averaged about eight feet per hundred, or eight percent, sloping toward the North Anna River or its tributaries.

Following the construction and filling of Lake Anna, the proposed reservoir was expected to have a relatively minor effect on the groundwater condition in the site area. Filling the reservoir was expected to raise the base level of the groundwater discharge from the present elevation of 200 ft NGVD 29 to about 250 ft NGVD 29. The higher discharge level would result in a lower hydraulic gradient across the plant site. The resulting gradient was expected to be on the order of 6 percent as compared to the existing gradient of 8 percent. The rate of groundwater movement under these conditions was estimated to be about 0.015 feet per day.

2.3.2 Current Conditions

Groundwater flow at the Unit 3 site is generally to the north and east, toward Lake Anna. Three intermittent streams, all of which flow into Lake Anna, are located to the west and south of Unit 3. The average hydraulic gradient from the southwest corner of the model domain toward Lake Anna is about 0.04 ft/ft.

Groundwater levels at the site have been monitored from December 2002 through November 2007 using a network of 26 observation wells. The OW-800 and OW-900 series wells were installed during the ESP and COL investigations, respectively. The other wells, P-series wells and WP wells were installed for monitoring purposes around the Service Water Reservoir (SWR) and the Independent Spent Fuel Storage Installation, respectively. The observed groundwater elevations from December 2002 through November 2007 are presented in Figure 3. In general, the measured water levels show little seasonal variability, as compared to Figure 4, and little interannual variability (Figure 3). Figure 4 presents the relation between precipitation and groundwater elevations in Louisa County over the year 1978, which illustrates some seasonal groundwater variability. Note that periods of quarterly data at the site (e.g., December 2002 through September 2003 and November 2006 through November 2007) show a lesser degree of variability than that presented in Figure 4. These data (i.e., observed groundwater levels from December 2002 through November 2007) were used to develop piezometric surface contour maps for the water table aquifer. The spatial trend is similar in each of these maps: higher groundwater levels located to the south and west of Unit 3. The piezometric surface map for May 2007 is shown in Figure 5.

There are four well pairs at the site. These wells have been installed adjacent to each other, with one well completed in bedrock and the other completed in the saprolite. Nearly equal water level elevations have been recorded in the well pairs, indicating a hydrologic connection between the saprolite and the bedrock.

2.4 Net Infiltration

2.4.1 Piedmont Province Recharge

As discussed in Trapp and Horn (1997):

> *Recharge to aquifers in the Piedmont Physiographic Province site occurs largely as infiltration of local precipitation in interstream areas. ...Most of the recharge in the Piedmont and Blue Ridge Provinces takes place in interstream areas. Almost all recharge is from precipitation that enters the aquifers through the porous regolith. Much of the recharge water moves laterally through the regolith and discharges to a nearby stream or depression during or shortly after a storm or precipitation event. Some of the water, however, moves downward through the regolith until it reaches the bedrock where it enters fractures in crystalline rocks and sandstones or solution openings in carbonate rocks.*

The Piedmont Province receives an average annual precipitation of "44 inches" (Powell and Abe 1985, p. 4). Recharge to aquifers from precipitation in the province is estimated at approximately

"8.5 to 11.3 inches per year and range[s] from 20 to 27 percent of precipitation" (Powell and Abe 1985, p. 11).

2.4.2 Local Recharge

Recharge to the water table occurs primarily from local precipitation. With respect to recharge percolation through the saprolite, as described in the abandoned Units 3 and 4 site investigation report, because the permeability of the saprolite is moderately low, any liquid discharged at the surface would most likely run off in the form of surface discharge towards the North Anna River. It is estimated that a small amount (less than 5 percent) would enter the ground and percolate vertically downward at the rate of about 1 foot per day. When the percolation intersects the water table, it would flow with the groundwater to the north and east with the hydraulic gradient toward the North Anna River.

Average precipitation from 1942 to 2012 at the Louisa observation station, approximately 12 miles to the west of the site, as presented in Table 1 (NCDC 2013a), is approximately 44 inches/year. The wettest year on record is 2003, with total annual precipitation of 71.6 inches. Groundwater elevations measured in 2003, however, are no higher than during other years (Figure 3), indicating that the groundwater levels are not significantly affected by the variability of annual rainfall.

In addition to precipitation, the Service Water Reservoir (SWR) for Units 1 and 2 contributes recharge to the aquifer system (Figure 1). The SWR was constructed by a combination of earth dike and cut. The side slopes and bottom are provided with 2-foot-thick compacted impervious earth liner, which is estimated to have a permeability of about 1×10^{-6} cm/sec. Seepage through the liner contributes locally to recharge of the groundwater system (Section 4.1.3). The rate of recharge from the SWR is assumed to be slightly higher than recharge from precipitation. This value is adjusted during calibration (Section 4).

2.5 Hydraulic Conductivity

Hydraulic conductivity for the Unit 3 site was assessed using slug tests for 13 observation wells, slug tests for wells P-10, P-23, and P-24, and two borehole packer tests in the bedrock for OW-949. These tests are summarized in Table 2. Relative to the location of the reactor building, observation wells were spread relatively randomly throughout the Unit 3 site (Figure 5). The P-wells are located approximately 1700 to 2000 ft to the east of the Reactor Building (RB). OW-949 is located about 1000 ft to the southwest of the reactor building (Figure 5). The geometric mean of the slug tests at each observation well are shown in Figure 6.

Hydraulic conductivity was assessed as a function of the geologic unit (i.e., saprolite and shallow bedrock) and as a function of the observation location relative to an unnamed fault that traverses through the Unit 3 site.

2.5.1 Hydraulic Conductivity by Geologic Unit

For the eleven observation wells (OW wells) screened in the saprolite, hydraulic conductivity values range from 0.25 ft/day to 9.9 ft/day (Table 2). The minimum hydraulic conductivity for the saprolite based on all slug test data, including the data from the observation wells near the SWR,

is about 0.02 ft/day; the geometric mean of these data is 1.3 ft/day. The hydraulic conductivity of the underlying shallow bedrock as determined from the observation well slug tests screened in the quartz gneiss (i.e., OW-845 and OW-949) and the borehole packer tests from OW-949 ranges from 0.48 ft/day to 6.3 ft/day, with a geometric mean value of about 2.1 ft/day.

2.5.2 Hydraulic Conductivity Relative to Unnamed Fault at Unit 3 site

An unnamed fault (Fault "a") that traverses through the Unit 3 site was identified in earlier site investigations for Units 1 and 2 (Figure 7). The length of this fault has been estimated to be about 3000 feet based on geologic mapping of excavations and trenches (Dominion 2006). Figure 7 identifies two different geologic units to the north and south of a transition line that generally coincides with this fault: gn (granite gneiss, massive with some biotite granite gneiss) to the north of the fault and hgn (interbedded hornblende gneiss, biotite granite gneiss, and granite gneiss) to the south of the fault.

Therefore, hydraulic conductivity was assessed for observation wells to the north of the fault and for observation wells to the south of the fault. Observation wells to the north of the fault included OW-841, OW-843, OW-845, OW-846, OW-848, OW-849, OW-945, and OW-946. Observations to the south of the fault included OW-842, OW-844, OW-847, OW-947, OW-949, P-10, P-23, and P-24. Hydraulic conductivity values from the slug tests to the north of the fault range from 1.3 ft/day to 9.9 ft/day, with a geometric mean of 3.2 ft/day. Hydraulic conductivity values to the south of the fault range from 0.02 ft/day to 2.4 ft/day, with a geometric mean of 0.55 ft/day. Excluding the P-well data, hydraulic conductivity values to the south of the fault range from 0.25 ft/day to 2.4 ft/day. With the P-well data, the minimum hydraulic conductivity is about 0.02 ft/day. This hydraulic conductivity is an order of magnitude lower than the hydraulic conductivities estimated from the slug tests. The slug test data suggest a zone of higher hydraulic conductivity to the north of the fault and a zone of lower hydraulic conductivity to the south of the fault.

2.6 Groundwater Use from the Deep Aquifer

Three wells in the vicinity of the Unit 3 site are used to supply water for use by Units 1 and 2 (Dominion 2008, Section 2.4.12.1.3). These wells include Well No. 4 (new), Well No. 6, and Well No. 7. However, these wells are installed to depths of 305 ft, 375 ft, and 730 ft, respectively. These wells are open in the deeper competent bedrock, which is not expected to communicate with the unconfined surficial aquifer. Therefore, they are not included in the present analysis. An additional well, Well No. 8, has been drilled and is scheduled to be in use to supply water to Units 1 and 2. It is assumed that this well is also completed in the deeper bedrock and does not communicate with the unconfined surficial aquifer.

2.7 Lake Anna Water Levels

As discussed in Section 2.3, groundwater flow is toward Lake Anna. Consequently, the surficial aquifer discharges into Lake Anna. Groundwater levels in the immediate vicinity of the lake are influenced by the water level in Lake Anna. Figure 8 shows daily measurements of the water level in the lake from October 1978 through October 2007. The water level remains quite close to elevation 250 ft (NGVD 29), with the exception of a few months at the end of the summer and

early fall in many years where the lake drops one to two feet below 250 ft (NGVD 29). Regional droughts can cause dry periods (e.g., 2001 to 2002) during which the Lake Anna water level may also drop (i.e., the lowest Lake Anna water levels of approximately 245.1 ft NGVD29 occurred in October 2002; see Figure 8). Based on the duration curve presented in Figure 9, 85 percent of the time the Lake Anna water level is higher than 249 ft (NGVD 29).

3 GROUNDWATER MODEL

Section 3 describes the conceptualization and setup of the numerical groundwater flow model.

3.1 Conceptual Hydrogeologic Model

Based on the aquifer description presented in Section 2, the surficial aquifer at Unit 3 was conceptualized as a two-layer system. The upper layer represents the saprolite and the lower layer represents the shallow bedrock. The lower boundary of the model is at a depth of approximately 125 ft from the ground surface. This depth was chosen as most fractures were assumed to be closed below 100 ft due to the stresses exerted by the material above. An additional 25 ft was necessary to account for post-construction conditions (see Section 3.2.2)

The model domain was selected in such a manner so as to minimize the impact of assumptions regarding boundary conditions on predictions in the area of Unit 3 and its vicinity. The boundaries of the model domain were placed where reasonable assumptions regarding local conditions could be made. Because the physical system represented by a numerical groundwater model is heterogeneous and complex, numerous assumptions and simplifications must be made to efficiently model the subsurface conditions. Therefore, a simpler model that appropriately represents the conditions at the site is preferable over a more complex model.

3.2 Numerical Model

3.2.1 Numerical Code

The conceptual hydrogeologic model was implemented in a two-dimensional, two-layer numerical groundwater model using the code MODFLOW 2000 (Harbaugh et al. 2000). MODFLOW solves the three-dimensional groundwater flow equation using a finite-difference method. It has been widely used in the industry since its development and release by the U.S. Geological Survey in 1984.

From its inception, MODFLOW has had a modular structure that allows the incorporation of additional modules and packages to solve other equations that are often needed to handle specific groundwater problems (McDonald & Harbaugh 1988). Over the years, several such modules and packages have been added to the original code. MODFLOW 2000 is a major revision of the code that expanded upon the modularization approach that was originally included in MODFLOW.

To facilitate the development of the present model, the user interface Groundwater Vistas (GWV) was used. GWV was developed by Environmental Simulations, Inc. (ESI) (ESI 2011).

3.2.2 Numerical Grid

Figure 10 shows the numerical grid, the extents of the model and the active cells of the model that represent the model domain described in Section 3.1. Grid cells outside this area are inactive. The grid spacing varies between the outer and inner domain. The horizontal grid cell spacing for the outer domain is equal to 50 ft by 50 ft. The grid cell spacing for the inner domain (i.e., in the power block area) is equal to 10 ft by 10 ft. The active area of the model covers an area of about one square mile.

3.2.2.1 Definition of Model Layers

<u>Top of Model Layer 1</u>: The top of the two-layer model is based on a recent site-specific LiDAR aerial survey. The elevation values were assigned to model grid cells and the resulting ground surface elevation is presented in Figure 11.

<u>Bottom of Model Layer 1</u>: The bottom of model layer 1 (top of model layer 2) was initially defined using data from site borings. The B-, M-, and W-series borings were drilled during the ESP and COL site investigations. Borings 1-55 and 101-106 were drilled during the investigation and construction of Units 1 & 2 and 600-series borings were drilled during the site investigation of abandoned Units 3 & 4. Table 3 lists the elevations and corresponding zone (III-IV or IV) used in the initial development of the bottom of model layer 1. The general criteria for selecting a top of bedrock elevation for each boring was based on identifying the top elevation for zone III-IV or zone IV. If both zones were present in a boring, the top elevation for the uppermost zone was used. If zone III-IV units were not identified, but zone IV units were identified, zone IV top elevations were used as the top of bedrock. If multiple units of either zone occurred, the uppermost top elevation was used. If a boring contained only zones I, IIA, or IIB, the boring was not used. The top of bedrock was defined as the top of zone III-IV or zone IV. If a zone appeared more than once in the boring, the top-most elevation was used.

The point values tabulated in Table 3 were interpolated using Inverse Distance Weighting in ArcGIS to create a top of bedrock surface, which was then imported to GWV. The model layer 1 bottom elevations were then adjusted to ensure a minimum layer thickness of 5 ft. This procedure resulted in cells of varying thicknesses throughout the domain. Because initial modeling results with the default interpolation produced small zones of dry cells, the layer 1 bottom elevations were locally adjusted to correspond more strongly with the existing ground surface topography (Figure 11). These adjustments also minimize any stability or convergence issues often associated with dry cells. Figure 12 shows the bottom elevations of model layer 1.

<u>Bottom of Model Layer 2</u>: The bottom of the second layer initially replicated the ground surface topography, but at a depth of 125 ft from the surface. This value was chosen as most fractures should be closed at this depth due to the stresses exerted by the material above (see Section 2.2). An additional 25 ft to the 100 ft, which is the depth at which most fractures are assumed to be closed (see Section 3.1), was necessary to ensure the bottom of model layer 2 extends beneath the deepest Unit 3 foundation (i.e., the shear key around the Reactor and Fuel Buildings). The model layer 2 bottom values were consistent in both calibration and post-construction models to minimize the differences between the calibration and post-construction models. Figure 13 shows the elevations for the bottom of the lower model layer.

3.2.3 <u>Types of Boundary Conditions Used in the Model</u>

The boundaries of the model domain were selected to coincide with key physical features that allow the definition of boundary conditions. Five different types of flow boundary conditions and properties were used for the model: drain, constant head, general head boundary, recharge (recharge is classified as a property in GWV because it is applied to every model cell), and no flow boundaries. Different types of boundary conditions in GWV are discussed in ESI (2011). Drain boundaries, constant head boundaries, the general head boundary, and recharge were

applied to model layer 1. A brief description of these boundary conditions is provided below, with details of their specific implementation in Sections 4 and 5.

Drain Boundary: The drain boundary condition is designed to simulate features that remove water from the aquifer at a rate equal to the product of the conductance of the drain and the difference between the head in the aquifer and a given level associated with the drain. Drain boundaries are used to simulate the effect of agricultural drains or seepage faces where groundwater discharges to the surface. Seepage faces can exist along steep slopes or escarpments. In such cases, the drain elevation corresponds to the ground surface elevation. When the water level reaches the ground surface elevation, it is removed by the drain boundary. The drain has no effect if the head in the aquifer falls below the fixed elevation of the drain (SWS 2008, p. 256). The conductance of drains used to represent a seepage face is proportional to the area of the drain cells, and depends on the materials near the seepage face that may affect discharge conditions. As described in SWS 2008 (p. 257):

> *There is no general formulation for calculating drain conductance. In most situations, the detailed information required to calculate drain conductance is not available to the groundwater modeler. These details include the detailed head distribution around the drain, aquifer hydraulic conductivity near the drain, distribution of fill material, number and size of the drain pipe openings, the amount of clogging materials, and the hydraulic conductivity of clogging materials. It is common to calculate drain conductance from measured values of flow rate and head difference. Drain Conductance value is usually adjusted during model calibration.*

Constant Head Boundary: The constant head boundary condition is used to fix the head value in selected grid cells. The effect of the constant head condition is to provide a source of water entering the system, or a sink for water leaving the system, depending on the head conditions in the surrounding grid cells. In some cases, however, constant head conditions can act as infinite sources of water.

General Head Boundary: The general head boundary condition allows flow into or out of a cell from an external source in proportion to the difference between the head in the cell and the reference head assigned to the external source. This boundary makes it possible to avoid unnecessarily extending the model domain outward to meet the element influencing the head in the model. Differences between the general-head boundary and the constant head boundary are that for the general head boundary condition, the model solves for the head values, while with the constant head boundary condition the head values are specified. Also, the general head boundary conditions do not act as infinite sources of water as can constant head boundary conditions.

Recharge: Recharge is applied at the ground surface and is used to simulate the effect of applied groundwater recharge. Such recharge represents the net gain of the groundwater system as a result of deep infiltration resulting from precipitation, after the effect of evapotranspiration losses have taken into account. The recharge boundary condition can also be used to describe artificial recharge or seepage from a pond.

No Flow Boundary: The no flow boundary describes boundaries in which no flow occurs, such as a groundwater divide, or those resulting from impermeable neighboring materials.

3.2.4 Numerical Solver and Settings

GVW includes several different solvers for the numerical solution of the groundwater flow equation. The Pre-conditioned Conjugate Gradient (PCG2) solver was selected for use. The PCG2 solver is recommended by ESI (2011) for most models.

The PCG2 solver uses two convergence criteria: the head change criterion and the residual criterion. The head change criterion is based on the change between successive outer iterations and the residual criterion is based on the change between successive inner iterations. The same settings and convergence criteria were used for pre-construction models and post-construction models (see Sections 4 and 5).

4 MODEL CALIBRATION

Model calibration was performed using a two-phased approach. The first approach was based on automated optimization using a calibration tool included with GWV known as Model-Independent Parameter Estimation (PEST), which is an optimization tool that adjusts model parameters until the fit between model outputs is optimized (PEST 2005; ESI 2011). The second approach was based on incremental adjustments of the model parameters to satisfy the calibration criteria described in Section 4.4. The resulting calibrated model is described in Section 4.5. Subsequent calibration sensitivity simulations were developed; these are presented in Section 4.6.

Calibration assumptions, targets, measures and statistics, and criteria as well as the phased calibration approach and results, are discussed in the following sections.

4.1 Calibration Assumptions and Design Input

The model calibration is based on several site-specific assumptions, as described below.

4.1.1 Aquifer Extent

Assumption #1: The surficial aquifer is limited to the top 125 ft below the ground surface.

Rationale: As discussed in Section 2.2, the number and extent of the joints and fractures decrease with depth. Most fractures in the bedrock are expected to be closed below a depth of 100 ft due to the stresses exerted by the material above. The model was extended an additional 25 ft to account for post-construction conditions (see Section 3.2).

Assumption #2: The bottom of layer 2 can be treated as a no flow boundary.

Rationale: As discussed in Section 2.2, all joints and fractures are assumed to be closed 100 ft below the ground surface (note that the bottom of model layer 2 is 125 ft below ground surface). Therefore, the materials at greater depths can be considered relatively impermeable, providing a no flow boundary at the bottom of the model.

4.1.2 Flow Boundary Conditions

Assumption #3: Intermittent streams along and near the model boundaries can be treated as drains.

Rationale: The groundwater elevation contours for May 2007 (Figure 5) infers that in the vicinity of the streams near the west and south-southwest boundary of the model domain, the groundwater contours are approximately perpendicular to the streams. Therefore, groundwater flow through the western and southern boundaries of the model is assumed to be negligible. These streams can be modeled by designating drain cells in their streambed, with the drain elevation at the approximate invert elevation of each stream.. When the water table reaches the top of the drain cells, water is removed from the model as it would be in an intermittent stream. When the water table is below the top of the drain cells, the streams have no influence on groundwater flow. The value of conductance of the drain cells in the streams was set to a fixed value of 1000 ft^2/day. Figure 14 shows the location of these creeks.

Assumption #4: The eastern boundary of the model is the Waste Heat Treatment Facility (WHTF), which can be described as constant head boundaries with a constant head of 250.6 ft NAVD 88 (251.5 ft NGVD 29) (Figure 14) for pre-construction simulations.

Rationale: As discussed in Section 2.4.8 of Dominion (2006), three dikes and two canals form and interconnect three ponds of the WHTF. Hydraulic losses of circulating water as it flows through the canals and the Dike 3 skimmer wall structure cause the water level in the WHTF to be about 1.5 ft higher than the normal North Anna Reservoir pool level (Dominion 2006).

Assumption #5: The northern model boundary, Lake Anna, can be described as a constant head boundary, with a specified head elevation of 249.1 ft NAVD 88 (250.0 ft NGVD 29) (Figure 14).

Rationale: As discussed in Section 2.7, historic water level data for Lake Anna suggest that its water surface remains relatively constant at approximately 249.1 ft NAVD 88 (250.0 ft NGVD 29) (Figure 8 and Figure 9) about 50 percent of the time.

Assumption #6: The abandoned Units 3 & 4 intake near the north-central portion of the site that is filled with water can be described in the simulations of existing site conditions by constant head cells at elevation 225 ft NAVD 88 (Figure 14).

Rationale: This area is currently being pumped down to a level lower than Lake Anna. The water level can be as low as 225 ft NAVD 88. Also, the LiDAR data produced elevations in these areas at approximately 225 ft NAVD 88.

Assumption #7: A third semi-dry depression located just south of the forebay for the Unit 3 water intake can be described by drain cells (Figure 14).

Rationale: This depression is allowed to drain freely out through a tunnel to the other two pumped depressions. Consequently, the groundwater level in this area never rises above the ground surface elevation. Therefore, based on the existing ground surface data the drain

elevation at the cells within this depression is set equal to the ground surface at elevation 250 ft NAVD 88.

4.1.3 Groundwater Recharge

Assumption #8: Groundwater recharge in areas occupied by buildings or paved surfaces is zero (Figure 15).

Rationale: Precipitation falling on these areas cannot infiltrate into the subsurface. Instead, precipitation runs off and is collected by the existing drainage system at the site. Major existing buildings were included as areas of zero recharge.

Assumption #9: Recharge from the Service Water Reservoir (SWR) for Units 1 and 2 is higher than recharge in surrounding areas (Figure 15).

Rationale: Local recharge from seepage through the clay liner of the SWR was included in the model. As described in Section 2.4, the SWR was constructed using a 2-ft-thick compacted impervious liner. Recharge from the SWR was initially assigned a value of 12 in/yr (higher than a value of 11 in/yr for the majority of the model domain; see Assumption #10) and adjusted during calibration to determine the recharge that gives the best agreement with observed water levels. Although the amount of recharge to groundwater from the SWR is not known and is adjusted during calibration, the amount of recharge is expected to be higher than the domain recharge value because the SWR is a water body that continually seeps through its compacted liner, constantly contributing recharge throughout the year.

Assumption #10: Recharge over the rest of the model domain is uniform (Figure 15).

Rationale: The assumption of a uniform recharge rate was tested by considering variable recharge rates over different areas, based on vegetation cover and ground surface slope. These alternative assumptions did not seem to affect substantively the calibration of the model. Therefore, it was decided to use a single value for recharge.

4.1.4 Hydraulic Conductivity

Assumption #11: The hydraulic conductivity varies across the model domain. For the calibration, the hydraulic conductivity distribution was described by two zones: a higher conductivity zone in the northern half of the model domain and a lower conductivity zone in the lower half of the model domain (see Section 2.5). The dividing line of the two hydraulic conductivity zones coincides with a transition between granite gneiss and hornblende gneiss and an unnamed fault "a" (Figure 7). Following an initial calibration using PEST, the hydraulic conductivity values were adjusted to match the calibration criteria discussed in Section 4.4.

Rationale: As discussed in Section 2.5, the dominant bedrock material north of the fault is a geologic unit composed of granite gneiss, massive with some biotite granite gneiss (gn), while south of the fault the predominant bedrock material is a geologic unit interbedded hornblende gneiss, biotite granite gneiss and granite gneiss (hgn). The two materials are expected to have different hydraulic conductivity as a result of different weathering rates because of different mineral assemblage. Granite gneiss has more quartz and less biotite than

hornblende gneiss. Quartz is expected to be more resistant to weathering and biotite is expected to be least resistant to weathering compared to other minerals found in the gneisses such as feldspar and hornblende. The different weathering rates could lead to different fracture coatings and fracture apertures, both of which could affect rock mass permeability.

The assumption of the two different hydraulic conductivity zones is also supported by the distribution of the slug tests (Section 2.5). During the calibration phase, the northern conductivity zone was initially assigned a value of 3.2 ft/day and the southern zone is assigned a value of 0.55 ft/day. These values correspond to the geometric means of the slug tests to the north and south of the transition line, respectively (Table 2).

Assumption #12: The hydraulic conductivity of model layer 2 is assumed to be the same as model layer 1, utilizing two zones of hydraulic conductivity instead of four.

Rationale: During model development, different combinations of parameter zones were tested. Utilizing four zones in calibration did not substantively improve the model calibration. Therefore, the simpler representation (i.e., two zones) was used.

Assumption #13: All natural materials are assumed to be horizontally and vertically isotropic.

Rationale: The validity of this assumption was evaluated by performing model runs with the vertical hydraulic conductivity, K_v, equal to the horizontal hydraulic conductivity, K_h, and comparing the results with model runs using $K_v=0.1*K_h$. The simulations using $K_v=K_h$ gave better agreement with the data. It is also noted that data from well pairs do not exhibit large vertical gradients.

4.1.5 Steady-State Conditions

Assumption #14: Groundwater conditions at the Unit 3 site can be described by a steady-state model.

Rationale: Groundwater levels are not significantly affected by seasonal variability or annual variability in precipitation. Historical groundwater levels (Figure 3) and annual precipitation measurements support this assumption (see Figures 3 and 4).

4.2 Calibration Targets

The model was calibrated for existing conditions at Unit 3 by comparing the model simulated groundwater head values with observed groundwater elevations. Groundwater elevations near Unit 3 were monitored December 2002 to November 2007 (Figure 3). During the monitoring period, observed groundwater elevations have exhibited little variability. Reliable data for the greatest number of wells (26) during a "wet" period are available for May 2007. These observations were used to calibrate the model. Table 4 gives the locations of the wells used in the calibration, as well as the May 2007 water level elevations. Figure 5 shows piezometric surface contours based on these data..

4.3 Calibration Measures and Statistics

Several parameters providing different measures of the agreement between simulated and observed groundwater levels were used for the calibration of the model. These parameters are defined in terms of the calibration residuals (the difference between observed and calculated results. Calibration statistics are discussed in Anderson & Woessner (1992) and SWS (2008, pp. 498-500).

The calibration residual, R_i, at a point i is defined as:

$$R_i = {}^{obs}X_i - {}^{calc}X_i \qquad (1)$$

where

${}^{calc}X_i$ is the calculated or simulated water level at point i; and

${}^{obs}X_i$ is the observed water level at point i.

The residual mean, $\bar{R}$, is a measure of the average residual value and is defined by the equation (Anderson & Woessner, p. 8):

$$\bar{R} = \frac{1}{n}\sum_{i=1}^{n} R_i \qquad (2)$$

where n is the number of points where calculated and observed values are compared.

The absolute residual mean, $|\bar{R}|$, is a measure of the average absolute residual value and is defined as (Anderson & Woessner 1992; SWS 2008, p. 499):

$$|\bar{R}| = \frac{1}{n}\sum_{i=1}^{n} |R_i| \qquad (3)$$

The Root Mean Squared (RMS) error is defined as (Anderson & Woessner 1992; SWS 2008, p. 499):

$$RMS = \left[\frac{1}{n}\sum_{i=1}^{n} R_i^2\right]^{1/2} \qquad (4)$$

The standard deviation of the water levels calculated with the model is calculated as (SWS 2008, p. 500):

$${}^{model}\sigma = \left[\frac{1}{n}\sum_{i=1}^{n}\left({}^{model}X_i - {}^{model}\bar{X}\right)^2\right]^{1/2} \qquad (5)$$

where

${}^{model}\sigma$ is the standard deviation of the calculated values with the model.

The standard deviation of the residuals is similar to the above equation, but uses residuals at each point and the average residual.

The normalized root mean squared (NRMS) or (scaled RMS in GWV) is the RMS divided by the maximum difference in the observed head values. It is given by the following equation (SWS 2008, p. 499):

$$NRMS = \frac{RMS}{{}^{obs}X_{max} - {}^{obs}X_{min}} \quad (6)$$

Finally, an additional measure of the adequacy of each run is the discrepancy between inflows and outflows from the model domain. To satisfy the overall mass balance, this discrepancy should be zero. In practice, however, a mass balance of zero may not be possible. The aim in calibrating and developing the groundwater model for Unit 3 was to achieve a mass balance discrepancy as small as possible. The mass balance discrepancy, M_d, is calculated using the following equation:

$$M_d = \frac{V_{in} - V_{out}}{\frac{1}{2}(V_{in} + V_{out})} \quad (7)$$

where

V_{in} is total flow into the model domain; and

V_{out} is total flow out of the model domain.

4.4 Calibration Criteria

The following criteria for calibration measures and statistics were used for model calibration:

1. Root mean squared residual (RMS) < 6 ft;
2. Normalized root mean squared residual (NRMS) < 10 percent;
3. Absolute value of maximum residual < 10 ft; and
4. Mass balance discrepancy (M_d) < 1 percent; and

With respect to the mass balance, SWS (2008, p. 488) states that "the mass balance is one of the key indicators of a successful simulation. If the mass balance error for a simulation is less than 2%, the results of the simulation may generally be considered acceptable, provided the model is also calibrated. If the mass balance error is more than 2%, there may be some instabilities in the solution, and some inconsistencies in the results."

4.5 Calibration Base Case

Multiple calibration methods were utilized to match simulated groundwater elevations with observed groundwater elevations. These calibration methods include: 1) automated calibration using PEST and 2) manual calibration by trial and error. The development of the calibration base case is presented in this section. Additional calibration sensitivity cases are discussed in Section 4.6.

Initial parameter estimates were based on site-specific knowledge; the hydraulic conductivity of the northern and southern conductivity zones were assumed initially to be equal to the geometric mean values of the slug test results in each zone: 3.2 ft/day in the northern zone and 0.55 ft/day in the southern zone. Recharge is assigned as described in Section 4.1.3.

4.5.1 Automated Calibration Using PEST

The automated calibration using PEST includes two separate calibrations: an optimization of hydraulic conductivity in two zones (north and south of the unnamed fault), and an optimization of hydraulic conductivity in two zones as well as recharge values for two zones (the model domain zone and the SWR zone).

As stated previously, PEST is an optimization tool that reduces the discrepancies between model outputs and field observations to a minimum by adjusting model parameters. The differences between field measurements and model outputs are captured in an "objective function", which is defined as the weighted sum of squared deviations between field observations and corresponding model outputs. As PEST executes, it progressively reduces this objective function until it cannot be reduced further.

For Unit 3 PEST optimizations, hydraulic conductivity values were based on factor-based change limits and recharge values were based on relative change limits (see PEST [2005], p. 2-21 for details on change limits). Based on the default values in GWV, factor-based changes were set to a maximum value of ten. This assumption changes initial estimates by up to a maximum of ten times the parameter value. Maximum relative changes were to set a value of 0.5.

PEST also supports logarithmic transformation of some or all parameters. Often the parameter estimation process is much faster and more stable when PEST is asked to estimate the log of a parameter, rather than the parameter itself. For example, hydraulic conductivity values were log transformed as part of the optimization process. Details of the advantages and disadvantages of each of these approaches are discussed in PEST (2005). Note that log-transformed parameters must be factor-limited.

In addition, PEST allows the use of "tied" parameters. Tied parameters vary according to the parameter with which they are tied. For example, in an isotropic system, the vertical hydraulic conductivity would be tied to and vary the same as horizontal hydraulic conductivity. Thus, the vertical hydraulic conductivity is the same as horizontal hydraulic conductivity.

4.5.1.1 Estimating Hydraulic Conductivity

This approach to calibration attempted to determine the hydraulic conductivities north and south of the unnamed fault using PEST by fitting the simulated heads with the observed heads. The horizontal hydraulic conductivity (Kx) is assumed to be equal to the vertical hydraulic conductivity (Kv) in the PEST simulation (see Section 4.1). Hydraulic conductivity zones 1 and 2 are assigned as PEST parameters Kx1 (north of the fault) and Kx2 (south of the fault). Vertical hydraulic conductivity for zones 1 and 2, assigned as Kv1 and Kv2, are tied to Kx1 and Kx2, respectively. Initial values for hydraulic conductivity zones 1 and 2 are assigned 3.2 ft/day and 0.55 ft/day, respectively. Table 5 presents a summary of the upper and lower bounds and other PEST options for each parameter. Recharge zones are described in Section 4.1 and presented in Figure 15. Table 6 presents the PCG2 solver settings used.

Results from this PEST simulation present optimized values of Kx1 and Kx2 as 1.14 ft/day and 0.43 ft/day, respectively. As presented in the *.rec file, the correlation coefficient matrix provides a measure of how well the parameters are correlated. A smaller absolute value in the off-diagonal matrix elements indicates a better confidence of estimated parameters, as it indicates the parameters are not correlated to each other. In this run the off-diagonal correlation value between Kx1 and Kx2 is -0.44, indicating a low correlation between the two parameters.

With respect to simulated residuals, all of the residuals (observed groundwater elevation minus simulated groundwater elevation) in the observation wells were less than 10 ft, except for two wells (OW-947 and OW-945). Because the residuals in these two wells did not meet the calibration criteria in Section 4.4, the next step in the calibration process was to include additional parameters (recharge values under SWR and the domain) along with the Kx1 and Kx2 in a subsequent PEST calibration.

4.5.1.2 Estimating Hydraulic Conductivity and Recharge

Based on preliminary calibration simulations, simulated groundwater heads were most sensitive to the recharge from the model domain and from the SWR. Initial values for hydraulic conductivity zones 1 and 2 are the same as in the previous PEST run (3.2 ft/day and 0.55 ft/day, respectively, Table 5) and initial recharge values for SWR and model domain were assigned based on Section 4.1 (11 in/yr and 12 in/yr, respectively).

Results from this PEST run indicated optimized values for Kx1 and Kx2 of 1.22 ft/day and 0.60 ft/day, respectively, and 0.0027397 ft/day and 0.006849 ft/day for recharge zones 1 and 2, respectively. Simulated residuals at the observation wells indicate residuals of less than 10 ft for every well except OW-947 and OW-945. However, the off-diagonal elements of the correlation coefficient matrix show that all the parameters are highly correlated to each other (i.e., correlation values of approximately 0.99). This high correlation of the hydraulic conductivity values with the recharge values indicates that the values obtained from the PEST calibration are not unique and thus the parameters obtained should not be used in any subsequent simulations. Such results indicate that satisfying the calibration criteria with PEST may not be possible; thus, the next step in the calibration process is a manual trial-and-error approach.

4.5.2 Calibration Method 2: Manual Trial-and-Error

The manual trial-and-error approach was based on a user iteratively changing model parameters and reviewing the model output with respect to the calibration measures and statistics described in Section 4.3 and calibration criteria described in Section 4.4.

Because the correlation coefficient matrix elements indicate low correlation for the first PEST run (Section 4.5.1.1), the manual approach was based on the first PEST run. Results from the first PEST run indicate hydraulic conductivity values of 1.14 ft/day for zone 1 and 0.43 ft/day for zone 2. Initial values for recharge zones 1 (model domain) and 2 (SWR) are assigned 11 in/yr and 12 in/yr, respectively. These recharge values were iteratively adjusted until all the calibration criteria in Section 4.4 were met. Hydraulic conductivities were not adjusted in the manual calibration step.

The final parameters are presented in Table 7 and the residuals are presented in Table 8. All calibration criteria from Section 4.4 were met in the manual trial-and-error approach. The calibrated values for hydraulic conductivity fall within the range of values determined from the slug tests (Section 2.5) and the calibrated recharge value for the majority of the model domain is consistent with regional recharge values (Section 2.4) and is approximately 25 percent of annual average precipitation.

Figures 16 and 17 present calibrated groundwater elevations and the calibration residuals, respectively. In addition, a comparison between the calculated vs. observed heads is presented in Figure 18. A review of the calibration base case results presented in these tables and figures indicates that the calibration criteria (Section 4.4) are met. Therefore, the calibrated base case (manual trial-and-error) is considered to be an acceptable match to the observed groundwater elevations and will be used as the basis for all further simulations.

The resulting calibrated model produced some small zones of flooded cells (Figure 16). These flooded cells generally occur in areas near hydrological model boundaries (i.e., the WHTF, drain cells representing intermittent streams or depressions) and areas where there is a localized decrease in ground surface elevation (e.g., road cuts, detention basins). In these localized areas, the grid resolution is too coarse to accurately reflect the depressed surface elevation. Thus, because the flooded cells are primarily associated with existing hydrological boundaries, coupled with the fact that the grid resolution limits the accuracy of the depressed ground surface elevations, these flooded cells are not expected to adversely impact the overall model calibration and subsequent post-construction simulations.

4.5.2.1 Discussion Related to OW-901

ESBWR R-COLA RAI 02.04.12-1 requested additional discussion regarding the discrepancy between the observed groundwater elevation and the simulated groundwater elevation (i.e., residual) at observation well OW-901. Discussion addressing this request is provided below.

Figures 16 and 17 show the simulated heads and residuals, respectively, for the calibration base case. As can be seen in these figures, in the vicinity of the Unit 3 power block the observed head values exhibit a steep hydraulic gradient that is not reproduced by the model. As a result, calibrated head values beneath the Reactor Building are approximately 4 ft lower than measured

(see the residual at well OW-901 in Table 8 and Figure 17). It is noted that OW-901 is about 200 ft from and about 14 ft upgradient of observation well OW-845 and the measured heads at these two wells in May 2007 (i.e., OW-901 is 288.46 ft NAVD 88 and OW-845 is 276.86 ft NAVD 88, respectively) differ by 11.6 ft (Figure 5). The difference in the measured heads between these two wells is likely due to local heterogeneities in the distribution and characteristics of fractures in the bedrock, which cannot be accounted for in the model. In general, the data from well pairs suggest that the vertical gradient is small. The nearest well pair to OW-901 is OW-845 and OW-846, screened at elevations 253.0 ft NAVD 88 and 273.5 ft NAVD 88, respectively. The measured heads at these two wells differ by 0.3 ft, with the deeper well (OW-845) having a higher head. One possible reason for the differences in observed elevations is that OW-901 is screened in shallow bedrock (Layer 2) while OW-845 is screened in saprolite (Layer 1).

Given the difference in the measured heads between wells OW-845 and OW-901, the calibration of the model produced model heads in the area of the two wells that are approximately between the measured values. As can be seen in Table 8, the model predicts a higher than observed head at well OW-845 and a lower than observed head at well OW-901. The uncertainty associated with the piezometric level difference between OW-901 and OW-845 is further evaluated through the sensitivity analysis presented in Section 4.6.2.

The calibrated groundwater levels in the calibration base case reflect the best overall match that can be obtained at present. Because of the inherent spatial variability in aquifer hydraulic conductivity associated with fractured bedrock systems, and potential spatial variability in actual infiltration versus runoff, it was to be expected that the model would not produce an exact match with the observed groundwater levels.

4.6 Sensitivity Simulations

Sensitivity analyses were performed to (1) assess the impact of a general head boundary condition along the southern edge of the model and (2) assess the residual sensitivity at well OW-901.

4.6.1 General Head Boundary

Previous Unit 3 groundwater modeling efforts included a general head boundary (GHB) condition for a portion of the southwest model boundary. This boundary was originally intended to represent the groundwater recharge occurring at higher elevations of the hill where this boundary is located. However, as described in Assumption #3 (Section 4.1.2), the groundwater contours in this area are perpendicular to the intermittent streams (drain boundaries), indicating that groundwater flow to either stream bank is parallel to the stream. Assigning a GHB condition at this location induces a groundwater flux into the active model domain that appears inconsistent with Assumption #3. Therefore, a sensitivity simulation was performed to evaluate the GHB effect on overall model calibration.

The GHB boundary condition requires two input values: specified head and conductance. Specified head is based on the hydrological feature being simulated and conductance can be calculated using the following equation (SWS 2008, p. 253):

$$C = \frac{(L \cdot W) \cdot K}{D} \qquad (8)$$

where

C is conductance;

$(L \cdot W)$ is surface area of the grid cell face exchanging flow with the external source or sink;

K is average hydraulic conductivity of the aquifer material separating the external source/sink from the model grid; and

D is distance from the external source/sink to the model grid.

This sensitivity simulation utilizes a specified head of 330 ft for every GHB cell along the southwest portion of the model domain (see Figure 14); this value of 330 ft was based on an elevation transect along the southern boundary of the model. Conductance was set to a value of 10 ft^2/day.

Residuals, as presented in Table 8, are generally similar to those of the calibration base case, indicating that the overall calibration is relatively insensitive to the GHB boundary. Groundwater head contours in the immediate area of the GHB cells appeared to be influenced, perhaps artificially, by the specified head value.

4.6.2 Observation Well OW-901 Residuals

As discussed in Section 4.5.2.1, ESBWR R-COLA RAI 02.04.12-1 requested additional discussion regarding the residual at observation well OW-901. As discussed in that section, there is a steep hydraulic gradient that is not reproduced by the model, indicated by the difference in residuals between well OW-901 and surrounding wells. This sensitivity case was based on the best fit of the simulated water level and observed water level for OW-901, which is located at the Reactor Building, by adjusting the rate of recharge of the site and keeping all other calibration parameters the same as in the calibration base case. The purpose of this simulation was to assess the model sensitivity of other observation wells surrounding well OW-901. Therefore, a higher recharge condition was performed for this sensitivity case to more closely match the groundwater elevation of 288.46 ft NAVD 88 for OW-901 (Table 4).

The value for recharge zone 1 (the model domain) was increased until the residual at OW-901 was minimized, resulting in a recharge value of approximately 0.0029 ft/day (12.7 in/yr). While the predicted water level for OW-901 was approximately -0.01 ft for this simulation, the residuals (i.e., difference between calculated and observed values) for the other observation wells ranged from a maximum of 6.09 ft to a minimum of -12.76 ft (Table 8). This calibration sensitivity test shows that the higher recharge condition produces unacceptable residuals at other observation wells. Therefore, the calibration base case (manual trial-and-error) is considered the best available calibration because it obtained a reasonable balance of residuals in the power block area.

4.6.3 Comparison of Calibration Scenarios

Results from the calibration base case and sensitivity cases are presented in Table 8. A review of the calibration statistics indicates that the calibration base case resulted in the best overall model calibration. Residuals from the GHB sensitivity case appear to be relatively unaffected by a GHB boundary condition along the southern model boundary, indicating that utilizing a GHB boundary condition along the model boundary only introduces unnecessary complexity into the model. Furthermore, the sensitivity case that assesses the variability of the residuals at observation well OW-901, demonstrates that the calibration base case provides the most well-balanced distribution of residuals. Because the calibration base case does not introduce unnecessary complexity to the model and because it meets the calibration criteria from Section 4.4, the calibration base case will be used as the basis for the post-construction simulations presented in Section 5.

5 POST-CONSTRUCTION SIMULATIONS

For the construction of Unit 3, the existing site will be graded to create a flat pad for the planned footprint of the new unit. Unit 3 will have a finished ground level grade of approximately 289.5 ft (NAVD 88). In the power block area, the hillside will be excavated to create a flat pad for the buildings. The hillside near the Unit 3 cooling tower will also be excavated for the same purpose.

5.1 Post-Construction Model Parameters and Assumptions (Design Input)

Excavations will also be completed for the building foundations. The Reactor Building, Fuel Building, and Control Building will have their foundations on or near the bedrock. The bottom of the foundation elevation for the Reactor Building, Fuel Building, Control Building, Fire Water Service Complex (FWSC), Turbine Building, Radwaste Building, Service Building, and Ancillary Diesel Building (ADB) are provided in Table 9. Also, some of the buildings will include concrete fill beneath their foundations. Consequently, the Reactor Building, Fuel Building, Control Building, FWSC, Turbine Building, and Radwaste Building are represented as inactive cells in the post-construction model with bottom foundation (including concrete fill) values as presented in Table 9. The Service Building and ADB are represented as active cells in Layer 1 of the post-construction model because they have relatively shallow foundations and no concrete fill.

Groundwater flow simulations for post-construction conditions were performed with the calibrated model. The following assumptions and modifications to the calibration base case were made for post-construction conditions.

5.1.1 Aquifer Extent

Assumption #15: Buildings whose foundations extend to or are close to bedrock are modeled as no flow cells in model layer 1. Concrete fill extends beneath the building foundation for some buildings. This fill is also considered as no flow cells in model layer 1.

> **Rationale:** Because these buildings extend deep into the aquifer, they are expected to act as barriers to lateral groundwater flow. Buildings with shallower foundations (the Service Building and ADB) are not expected to act as significant obstructions to lateral groundwater flow. Note that portions of the Turbine Building are deeper than the majority of its foundation and that the Reactor and Fuel Buildings contain a shear key that extends deeper than their foundations.

Assumption #16: The topography used in the model was modified to reflect the final grading of the site after the completion of the construction of Unit 3 (Figure 19).

> **Rationale:** At the edges of the proposed finish grade (i.e., where no modifications due to construction will be made), the post-construction grade level will merge with and match the existing ground surface.

5.1.2 Flow Boundary Conditions

Assumption #17: For both the constant head boundaries to the east (WHTF) and the north (Lake Anna), specified head values are increased by 0.3 ft. Thus, the cells representing the WHTF are assigned a value of 250.9 ft NAVD 88 (251.8 ft NGVD 29) and the cells representing Lake Anna are assigned a value of 249.4 ft NAVD 88 (250.3 ft NGVD 29).

Rationale A higher pool elevation for Lake Anna is based on the assumption of a 0.25 ft increase (rounded to 0.3 ft for this analysis) in the water level in Lake Anna for post-construction conditions. Use of the higher boundary condition in the WHTF implies that Units 1 and 2 are operating, which is conservative with respect to simulating maximum post-construction water levels in the Unit 3 power block area.

Assumption #18: The abandoned Units 3 & 4 intake near the north-central portion of the site is represented by constant head boundary conditions set to a value of 249.4 ft NAVD 88.

Rationale: After construction of Unit 3, the water surface in these two depressions will be allowed to equalize at the same level as Lake Anna, and these depressions will serve as the forebay for the Unit 3 water intake.

Assumption #19: The drain cells located south of the proposed Unit 3 forebay (i.e., the semi-dry depression) are removed in simulations of post-construction conditions.

Rationale: After construction of Unit 3, the tunnel between the southern and the two northern depressions will be blocked, and the southern depression will be filled. Finish grade drawings show the resulting ground surface elevation.

Assumption #20: The intermittent streams represented by drain cells in the calibrated model are applicable to the post-construction model as well. Boundary conditions for post-construction simulations are shown in Figure 20.

Rationale: These intermittent streams are based on ground surface elevation data and will still exist after construction. The stream near the Cooling Tower area, however, will be shortened due to the excavation planned for the Cooling Tower area.

Assumption #21: Drain cells were added to the model to represent the drainage ditch system planned around the power block and the cooling tower areas with a fixed conductance value of 25 ft^2/day. Figure 20 shows the location of the drain cells used in the post-construction model.

Rationale: In MODFLOW, the conductance of drain cells is often determined through calibration. The analysis presented below shows that the conductance of drain cells describing groundwater discharge into a drainage channel or a trench is a function of the dimensions of the cell and the hydraulic conductivity of the material behind the seepage face. The flow from a trench drain or French drain described by drain cells is:

$$Q_{drain} = C\Delta h = C\left(h_i - h_o\right) \tag{9}$$

where

Q_{drain} is the flow through the drain cell; and

C is the conductance of the drain; and

Δh is the head difference between the groundwater level in the drain cell and the elevation of the drain; and

h_i is the computed water table level at the drain cell; and

h_o is the elevation of the drain, i.e. the water level that is maintained in the trench.

Neglecting groundwater flows in and out of the drain from the y-direction (see Figure 21), then the flow out of the drain cell can be estimated using Darcy's law:

$$Q_{drain} = AK\left(\frac{\partial h}{\partial x}\right)_{i-1,i} + AK\left(\frac{\partial h}{\partial x}\right)_{i,i+1} \quad (10)$$

where A is the groundwater flow area into the trench from each side, i.e., upgradient and downgradient. The wetted perimeter of the drain, which defines the area through which groundwater discharges through the bottom and sides of the drain, is a function of the cross-sectional area of the drain geometry. The wetted perimeter (WP) of a trapezoidal channel is expressed as (Chaudhry 1993, p. 10):

$$WP(\text{trapezoidal channel}) = B_o + 2d\sqrt{1+s^2} \quad (11)$$

where B_o is the bottom width, s is the horizontal side slope (i.e., 1/s), and d is flow depth. Therefore, assuming Δy extends along a plane parallel to the channel and half of the wetted perimeter represents the flow area into one side of the drain, the seepage area can be approximated by the wetted perimeter multiplied by Δy:

$$A = \frac{\left(B_o + 2d\sqrt{1+s^2}\right)}{2}\Delta y \quad (12)$$

Using s=3 for Unit 3 drainage ditches, Eq. (12) can be simplified to be

$$A = \frac{\left(B_o + 2\sqrt{10}d\right)}{2}\Delta y \quad (13)$$

The hydraulic gradient can be approximated by:

$$\left(\frac{\partial h}{\partial x}\right)_{i-1,i} \approx \frac{h_{i-1} - h_o}{\Delta x} \quad (14)$$

$$\left(\frac{\partial h}{\partial x}\right)_{i,i+1} \approx \frac{h_{i+1}-h_o}{\Delta x} \qquad (15)$$

where Δx and Δy are the dimensions of the drain cell.

Substituting Eqns. (13), (14) and (15) into Eq. (10), the flow out of the drain cell can be approximated as:

$$Q_{drain} \approx K\frac{\left(B_o+2\sqrt{10}d\right)}{2}\Delta y\frac{h_{i-1}-h_o}{\Delta x}+K\frac{\left(B_o+2\sqrt{10}d\right)}{2}\Delta y\frac{h_{i+1}-h_o}{\Delta x}= \\ =K\frac{\left(B_o+2\sqrt{10}d\right)}{2}\frac{\Delta y}{\Delta x}\left(h_{i-1}+h_{i+1}-2h_o\right) \qquad (16)$$

Equations (9) and (16) suggest the following expression for the conductance of the drain cell:

$$C\left(h_i-h_o\right) \approx K\frac{\left(B_o+2\sqrt{10}d\right)}{2}\frac{\Delta y}{\Delta x}\left(h_{i-1}+h_{i+1}-2h_o\right)$$

$$C \approx K\frac{\left(B_o+2\sqrt{10}d\right)}{2}\frac{\Delta y}{\Delta x}\frac{\left(h_{i-1}+h_{i+1}-2h_o\right)}{\left(h_i-h_o\right)}$$

$$h_i \approx \frac{h_{i-1}+h_{i+1}}{2}$$

$$C \approx K\left(B_o+2\sqrt{10}d\right)\frac{\Delta y}{\Delta x} \qquad (17)$$

As can be seen in Eq. (17), the conductance is a function of the hydraulic conductivity, the dimensions of the cell, the bottom width of the drain ditch, and the difference between the simulated water levels and the drain bottom elevation. The latter is unknown a priori because it is part of the solution.

Drain conductance was estimated to be about 25 ft^2/day based on a calibrated hydraulic conductivity of 1.14 ft/day at the North Anna Unit 3 site. From Eq. (17), a conductance of approximately 25 ft^2/day is based on K=1.14 ft/day, a 4-ft bottom width (bottom widths of drainage ditches range from 3 to 8 ft), and a representative depth of 2.75 ft (i.e., 1.14 * (4 + (2 * 2.75 * sqrt(10))) = 24.4 ft^2/day). Therefore, a drain conductance of 25 ft^2/day is reasonable considering that the bottom widths and depth of water vary.

Furthermore, because the drainage ditches do not include any features, such as a concrete lining, that would impede the discharge of groundwater into the drainage ditches, the representation of these drainage ditches with drain boundary conditions is considered appropriate.

5.1.3 Groundwater Recharge

Assumption #22: The rate of groundwater recharge in the areas not affected by the construction of Unit 3 was based on the model calibration.

Rationale: The land cover of these areas will not be affected by construction and therefore the capacity of these areas to allow recharge from precipitation to reach the groundwater will not be affected.

Assumption #23: The rate of groundwater recharge in the areas affected by the construction of Unit 3 was changed to reflect post-construction conditions. The basic change in recharge was that a zero value was assigned to major buildings. The groundwater recharge zones used in the post-construction simulations are shown in Figure 22.

Rationale: Over their footprint area, buildings do not allow recharge from precipitation to reach the groundwater. Precipitation that falls on the buildings will be collected by the site drainage system (e.g., catch basins, pipes, and drainage ditches). For purposes of estimating maximum groundwater levels in the power block area, other areas (e.g., roads, concrete, seeded area) are set equal to the calibrated recharge rather than lower recharge areas.

5.1.4 Maximum Groundwater Recharge

Assumption #24: Groundwater recharge represents maximum groundwater conditions.

Rationale: For the purposes of estimating a maximum groundwater level, the base case condition should implement boundary conditions that represent maximum groundwater conditions. Groundwater levels were calibrated to May 2007 levels (Table 4). Groundwater levels in May 2007 were used as a recent local maximum based on available monitoring data (Figure 5) and subsequent analyses described in the below paragraphs. In addition, the May 2007 data are the most comprehensive set of available groundwater levels at the North Anna 3 site.

The groundwater level data used for the calibration of the model are representative of very high groundwater table conditions. The 2007 groundwater level data used from model calibration are close to the maximum groundwater level data for 2003, the wettest year on record (Table 1).

Because of the relatively short record of groundwater level data at the site, which consists of less than five years of total data (although measurements were not recorded in 2004 and only once in 2005), two proxy indicators were used to assess how close the available groundwater data were to historic maximum levels. The two indicators used are the standardized precipitation index and the Palmer drought indices.

5.1.4.1 Standardize Precipitation Index

As discussed in Section 2.4 and Powell and Abe (1985), the primary source of recharge to the water table is precipitation. For a site within Louisa County, the correlation between groundwater levels and precipitation is shown in Figure 23, which shows groundwater levels from 1962 to 1982 relative to monthly precipitation. As can be observed from Figure 23,

higher groundwater levels were observed in 1972 and 1973 following a period of above-normal precipitation from late 1970 and into 1972. Similarly, lower groundwater levels were observed in 1982 following below-normal precipitation in 1980 and 1981.

An analysis of the Standardized Precipitation Index (SPI) for the rainfall data for the Eastern Piedmont climate division in Virginia (state code: 44, division code: 02) from 1942 to 2012 is presented in Figure 24 (NCDC 2013b). The SPI is a transformation of the probability of observing a given amount of precipitation in a specified number of months. Negative SPI values correspond with drought conditions; SPI values close to zero indicate normal conditions; and positive SPI values correspond with wet conditions. The index allows for comparison of precipitation observations at different locations with markedly different climates; an index value at one location expresses the same relative departure from median conditions at one location as at another location (NCDC 2013b). A simple analysis of the SPI was performed to identify SPI values greater than one persisting for three continuous months. From 1942 to 2012, five continuous three-month periods exceeded an SPI value of one: February to April 1984, January to March 1998, May to July 2003, June to September 2004, and September to November 2006 (NCDC 2013b). Therefore, the high groundwater levels observed in May 2007 may be a function of above-normal precipitation from late 2006. With respect to the highest precipitation on record, the highest average value of the three-month SPI values occurred from January to March 1998 and the second highest average value of three-month SPI values from May to July 2003.

An alternative possibility for high groundwater levels in May 2007 is due to above-normal precipitation in 2003. For example, positive SPI values occurred from February 2003 to December 2003, averaging just over a value of one.

Therefore, based on the response of groundwater level documented for the Eastern Piedmont division, an increase in groundwater levels would be expected following a sustained above-normal period of precipitation.

5.1.4.2 Palmer Drought Indices

In the absence of groundwater pumping, changes in groundwater levels at the site are caused by changes in the rate of deep infiltration or recharge, which depends on precipitation, runoff and evapotranspiration. Deep infiltration, i.e., vertical groundwater flux below the root zone that is influenced by evapotranspiration, depends on the moisture content of this zone. In general, during wet periods, the moisture content in the root zone is high and deep infiltration is higher, while during dry periods the moisture content is low and water infiltrating through the ground surface is used to fill the pore space in the root zone, reducing or even stopping deep infiltration. Water that leaves the root zone as deep infiltration eventually becomes groundwater recharge after it travels through the vadose zone. The lag between the time when deep infiltration leaves the root zone and the time it becomes groundwater recharge depends on the depth to groundwater and on the materials and moisture content of the vadose zone. This means that even if the distribution of deep infiltration is uniform across a site, the rate of recharge will vary depending on the depth to the water table.

Despite the complications introduced by these factors it is still possible to use the moisture content in the root zone as an indicator of groundwater recharge, allowing of course for the

time lag between deep infiltration and groundwater recharge. As an approximate measure of moisture content in the root zone we can use the Palmer Drought Severity Index (PDSI) for the same Virginia climate division as the SPI data (i.e., the Eastern Piedmont). The PDSI is a meteorological drought index based on principles of a balance between moisture supply and demand. Man-made changes were not considered in this index (NCDC 2013b). The PDSI provides a measure for the cumulative effect of dry conditions. The PDSI is estimated on a scale ranging generally from -6 to 6, where values from -0.5 to 0.5 represent normal conditions, values from -3 to -4 represent severe drought and values less than -4 indicate extreme drought. At the other end of the spectrum values between 3 and 4 represent a severe wet spell and values greater than 4 an extreme wet spell.

In addition to the PDSI introduced by Palmer, different variations of the drought index are also often used. They include the following:

- Palmer Hydrological Drought Index (PHDI), which is used to assess long-term moisture supply
- Modified Palmer Drought Severity Index (PMDI), which was introduced by the National Weather Service Climate Analysis Center for operational meteorological purposes
- Palmer "Z" Index (ZNDX), which provides a measure of the departure from normal of the moisture climate for that month

Monthly estimates of these indices for the United States are available from the National Climatic Data Center (NCDC) of the National Oceanic and Atmospheric Administration (NOAA) for all climatological divisions in the country (NCDC 2013b). A climatological division is a region within a state that is fairly homogeneous in terms of its climate over which climatological statistics are computed. The state of Virginia is divided into six climatological divisions. The Unit 3 (North Anna) site is in Division 2, which is the Eastern Piedmont division.

Average annual values of PDSI, PHDI, PMDI, and ZNDX for the Eastern Piedmont division from 1895 through 2012 are plotted in Figure 25 (NCDC 2013b). Figure 26 shows the maximum and the minimum monthly value of PDSI for each year, along with the average PDSI value for the year for the Eastern Piedmont division from 1895 through 2012. As can be clearly seen in these two figures, 2003 is clearly the wettest year on record.

Figure 27 shows the recorded groundwater levels at selected wells at the site along with monthly PDSI values. It is evident in Figure 27 that periods of rising PDSI values are followed by rising groundwater levels, and periods of decreasing PDSI values are followed by declining groundwater levels.

The combination of the apparent correlation between PDSI and groundwater level trends and the fact that 2003 was the year of highest PDSI values in more than 100 years, leads to the conclusion that the available groundwater level data at the site are representative of very high water table conditions. For example, the maximum monthly PDSI value occurred in September 2003, the month of the last of four quarterly rounds of groundwater data collected in 2002-2003. It is conceivable that groundwater recharge continued to be high and the water

table may have continued to rise for few months after the PDSI peak. In the absence of local groundwater monitoring data between September 2003 and February 2005, it is not possible to know when the maximum groundwater level occurred and what it was. However, it is reasonable to assume that the available data are quite close to that level.

5.1.5 Hydraulic Conductivity

Assumption #25: A new hydraulic conductivity zone was introduced to describe the backfill material in the Unit 3 power block area. This new zone is shown in Figure 28. The hydraulic conductivity of the fill material used in the model was assumed to be 0.001 cm/s (2.8346 ft/day). This order of magnitude value was assumed due to lack of site-specific information about the fill that will be used for the construction of Unit 3. To address the uncertainty in the conductivity value for the fill material, a sensitivity analysis for this value is presented in Section 5.3, where values one order of magnitude lower and one order of magnitude higher are considered.

Rationale: The extent of structural fill generally coincides with the sheetpilings that will be installed during construction and removed following construction. With respect to the hydraulic conductivity of the structural fill, there are no site-specific data on the hydraulic properties of the materials that will be used for the construction of Unit 3. The assumed hydraulic conductivity value, 0.001 cm/s (2.8346 ft/day), is consistent with a conservative estimate of sandy material (Freeze & Cherry 1979, p. 29).

5.2 Base Case Simulation of Post-Construction Conditions

In order to evaluate simulated groundwater elevations at specific points in the model domain, simulated observation wells were added to the post-construction model. These points are placed around seismic Category I buildings (see GE [2008], Table 3.2-1): Reactor Building/Fuel Building, Control Building, and Fire Water Service Complex. Additional points are placed near the Ancillary Diesel Building and the Service Building. Figure 29 shows the location of the simulated observation wells.

Figure 30 shows the simulated water table for post Unit 3 construction conditions using the parameters and assumptions presented in Section 5.1 and the solver settings in Table 6. Figure 31 presents the simulated water table for the power block area. The predicted water table in the power block area is approximately 6 ft below the design plant grade level of 290 ft NAVD 88. Table 10 presents the simulated post-construction groundwater elevations at selected points shown in Figure 30. Tables 11 through 13 also present these values for comparison with post-construction sensitivity test results.

Similar to the calibrated base case, the post-construction base case produced small zones of flooded cells (Figure 30). These areas generally correspond to existing or proposed hydrological boundaries (e.g., detention and storm water basins, intermittent streams). Other areas of localized flooded cells occur in areas where the grid resolution is too coarse to accurately reflect depressed ground elevations.

5.3 Post-Construction Sensitivity Tests

Several sensitivity tests were performed to assess the effect of uncertainty on simulated groundwater levels in the power block area. These are referred to as post-construction cases 2 through 12. An additional case that evaluates the travel time from the power block area to the nearest water body is included to support the postulated release of radioactive effluents to ground and surface waters analysis for FSAR 2.4.13. Sensitivity cases include that evaluate:

- The hydraulic conductivity of the structural fill material
- The conductance of the drains
- The conductance of the drains with twice the calibrated recharge
- Simulated PMP water levels in the drainage ditches
- The inclusion of boundary conditions in model layer 2
- Recharge within the power block area

5.3.1 Sensitivity Cases 2 and 3 – Hydraulic Conductivity of the Fill

The base case post-construction model incorporates an additional zone of hydraulic conductivity for the structural fill. Because no site-specific data exist for the hydraulic properties of the structural backfill, the hydraulic conductivity was assumed to be 2.8346 ft/day (see Section 5.1.5).

However, to test the impact of differing fill hydraulic conductivities on simulated groundwater elevations, two order-of-magnitude sensitivity simulations were performed. Case 2 was simulated with a conductivity value one order of magnitude lower (i.e., 0.28346 ft/day) and Case 3 was simulated with one order of magnitude higher (i.e., 28.346 ft/day).

Table 10 presents the simulated groundwater elevations at several observation wells (observation well locations are shown in Figure 29). The sensitivity tests indicate that maximum simulated groundwater elevations could increase by 0.3 ft to 0.5 ft for the south end of the power block (i.e., observation points A, B, C, and D) (Table 10). The 0.3- to 0.5-ft increase in simulated water level elevations does not impact the minimum 2-ft depth requirement for the power block area (Section 1.2). Increasing the fill hydraulic conductivity by one order of magnitude decreases the maximum groundwater level by approximately 0.8 ft (Table 10).

5.3.2 Sensitivity Cases 4 and 5 – Drain Conductance

Sensitivity tests were performed to assess the impact of drain cell conductance on groundwater elevations near the power block area. The elevation of the drain cells around the cooling tower and power block areas was approximately set to the bottom elevation of the drainage ditch.

For this analysis, parameters that affect drain cell conductance include the ditch geometry and the hydraulic conductivity of the materials adjacent to the drain ditches. Therefore, sensitivity tests evaluating the effect of varying conductance for the drain cells around the cooling tower and in the power block area were developed for drain conductance values of 2.5 ft^2/day (Case 4) and 250

ft^2/day (Case 5). Note that the post-construction base case drain cells are assigned a conductance value of 25 ft^2/day (see Section 5.1.2).

Table 11 presents simulated groundwater elevations for each of these cases. As expected, higher groundwater elevations were produced with the values of lower conductance. In general, simulated groundwater elevations for both tests were highest for the south side of the power block area near observation points A, B, C, and D. The DCD maximum groundwater elevation criterion (Section 1.2) is met for both simulations. Note that the conductance value of 2.5 ft^2/day is not considered realistic because it is not consistent with the estimated conductance values using Eq. (17) and the local hydraulic conductivity. For example, the lowest measured hydraulic conductivity values (0.55 ft/day, 0.19 ft/day, 0.13 ft/day, 0.27 ft/day, and 0.62 ft/day for P-10, P-23, P-24, OW-844, and OW-847, respectively) occur for observation wells near the SWR (see Figure 6). Hydraulic conductivity values for observation wells near the power block are higher than those near the SWR (Figure 6). Therefore, as drain conductance values at the Unit 3 site are likely to exceed values of 10 ft^2/day, the impact of drain conductance on simulated groundwater elevations is considered to be negligible. Simulated head values as a function of drain conductance at the simulated observation points is included as Figure 32. This figure shows fairly consistent water levels as conductance increases past the expected conductance values.

5.3.3 Sensitivity Cases 6 through 8 – Drain Conductance with High Recharge

Sensitivity to drain conductance was also assessed for two levels of recharge in the drainage ditches surrounding the power block area. This higher level of recharge was based on twice the calibrated recharge for the Unit 3 site, or $R_2=2*R_1$ (i.e., 0.005 ft/day). This value of higher recharge was assigned to the drain cells around the power block only. Sensitivity cases were run for drain conductance values of 2.5 (Case 7), 25 (Case 6), and 250 ft^2/day (Case 8). Drain conductance values in these sensitivity cases were varied similar to cases 4 and 5 described in Section 5.3.2.

Simulated water levels for these cases are presented in Table 12. The sensitivity analysis indicated that, similar to Cases 4 and 5, maximum simulated groundwater levels were less than the DCD site parameter value of 0.61 m (2 ft) below the Unit 3 plant grade of 290 ft NAVD 88 (i.e., below 288 ft) for all simulated observation points. As discussed in Section 5.3.2, however, this value of conductance is not considered realistic as it is not consistent with estimated conductance values and local hydraulic conductivity estimates. Simulated head values as a function of drain conductance at the simulated observation points is included as Figure 33. This figure shows fairly consistent water levels as conductance increases past the expected conductance values.

5.3.4 Sensitivity Case 9 – PMP Transient Simulation

For Case 9, a transient run was performed to approximately simulate the effect on the water table of increased precipitation and the rise and fall of water levels in the drainage ditch during a Probable Maximum Precipitation (PMP) event. The total duration of the sensitivity simulation was set to twenty days: 10 days for stress period 1, 0.5 days for stress period 2 (PMP event), 0.5 days for stress period 3, 9 days in stress period 4. Each stress period was set-up with 10 time steps

and a time step multiplier of 1.2. A twelve-hour duration for the peak water level was assumed to be conservative as the time of concentration ranges from twelve to sixteen minutes.

For the ditches, the boundary condition for the transient run was changed from a drain to a constant head boundary. Water level elevations during the PMP event were based on a simple rectangular hydrograph of water surface elevations in the north, east, and west ditches derived from modeling performed from the local PMP drainage analysis. The portion of the west drainage ditch that falls to north of the power block area and the portion of the east ditch from the Turbine Building to the north were not converted to constant head cells because their PMP water levels are generally two to four feet below the PMP water levels of the other drainage ditches.

For the 10 days preceding the PMP event and the 9.5 days following, constant head elevations in the drainage ditches were set equal to the base case post-construction water levels (Figure 30) by assigning the constant head values equal to the base case water levels at the start and end of each drainage ditch. This configuration assumes a linear head variation from start to end of the drainage ditch; the assigned values approximately match the simulated water levels of the post-construction base case (Figure 30). During the PMP event, the constant head elevations are based on the maximum water level values at the start and end of each drainage ditch in the local PMP analysis. Consequently, PMP water levels in the east ditch range from 288 ft NAVD 88 at the southern end of the ditch to 286 ft NAVD 88 at the northern end of the constant head cells. In the south ditch, PMP water levels range from 288.4 ft NAVD 88 near the Administration Building to 288.1 ft NAVD 88 at the western end of this ditch. In the west ditch, the water levels range from 288 ft NAVD 88 at the southern end to 287.9 ft NAVD 88 near the northern end of the Turbine Building. The initial heads for the transient run were based on the steady-state solution for the base case post-construction simulation (Section 5.2; Figure 30). The transient solution also requires an estimate of the specific yield. The specific yield was set equal to 0.25, which is equal to the estimated effective porosity for the saprolite (Dominion 2008).

In addition to setting the constant head water level values in the drainage ditches, the amount of precipitation over the model domain was also increased. Using the 6-hr PMP depth of 27 inches, it is assumed that 10 percent of that precipitation becomes recharge. For this sensitivity case, this depth is assumed to become groundwater recharge over a twelve-hour period (i.e. percolate through the vadose zone until it reaches the groundwater table). Therefore, 3 inches in 12 hours is approximately 0.5 ft/day, producing a recharge rate over the model domain of 0.5025 (0.5 + 0.0025) ft/day. This value of recharge is approximately 200 times the value of calibrated recharge over the model domain. Using a recharge multiplier of 200 for stress period 2 in GWV, this increased PMP rainfall is implemented in the model. The remainder of the PMP rainfall would mostly become runoff. The assumption that 10 percent of the PMP precipitation becomes recharge is reasonable considering the degree of imperviousness of the power block area and that the PMP rainfall would primarily be collected by the site drainage system for catch basins and drainage pipes and ditches).

Table 13 presents the maximum simulated water levels at model observation points. The maximum simulated groundwater elevation for the transient run was estimated to be 284.9 ft NAVD 88, which meets the DCD maximum water level criterion.

5.3.5 Sensitivity Case 10 – Boundary Conditions in Model Layer 2

Case 10 was performed to assess the impact of including boundary conditions for the Waste-Heat Treatment Facility (WHTF) and Lake Anna in the second model layer. These constant head boundary conditions were copied from model layer 1 to model layer 2 without further modification. The results of this sensitivity case are shown in Table 13. The resulting water levels do not vary significantly from those of the base case (Figure 30). The differences in groundwater elevation at the observation points between Case 10 and the base case post-construction simulation (Table 13) are approximately 0.1 to 0.2 ft.

5.3.6 Sensitivity Case 11 – MODPATH Particle Tracking

This sensitivity case is included to support the postulated accidental release of radioactive effluents to ground and surface waters of FSAR Section 2.4.13. In this simulation, MODPATH particles were placed in the model to simulate the minimum travel time through the aquifer to a surface water body. MODPATH, version 5, is an advective transport program (ESI 2011) included with GWV that utilizes the flow field simulated by MODFLOW to estimate travel times and directions of simulated particles (Pollock 1994). Because the simulation is steady state, the particles will terminate at the location of a model boundary condition.

MODPATH particle options are set to forward tracking and to 0.5 for the weak sink option. A weak sink value of 0.5 indicates that a particle will stop in a cell where the discharge to a sink is larger than 50 percent of the total inflow to the cell. Particles are placed around the Radwaste Building and the Condensate Storage Tank (shown on Figure 34). Particles were inserted at the water table.

Particle pathlines are presented in Figure 35. Total travel times for each particle are located in the endpoint file (*.ept) and indicate that the minimum travel time for a particle to reach the proposed Unit 3 intake is approximately 6700 days (18 yrs.). The fastest particle originates from the CST area.

5.3.7 Sensitivity Case 12 – Recharge Within the Power Block Area

Sensitivity case 12 was performed to evaluate the effect of runoff from the Unit 3 buildings. Currently, these buildings are simulated as zones of zero recharge. In reality, the precipitation that falls on these buildings would become runoff and actually increase the recharge rate of the areas surrounding the buildings. Thus, to simulate the effect of increased recharge from building precipitation in the power block area, the power block area is assigned a recharge value equal to twice the calibrated recharge (i.e., 0.005 ft/day). The areas outside the power block area are not considered in this analysis as any precipitation runoff would be collected by drains and conveyed to the storm water basin and/or Lake Anna.

The resulting water levels at each observation point are included in Table 13. The maximum water level is approximately 284.9 ft NAVD 88, approximately 1 ft higher than the maximum water level of the base case simulation (also presented in Table 13).

6 CONCLUSIONS

A two-layer model was developed to simulate groundwater flow under present and post-construction conditions at Unit 3. The model was developed using available historic data and data collected in support of Units 1 & 2 and the Unit 3 ESP and COL applications (Dominion 2006 and 2008, respectively). The analysis supports the following conclusions:

- The sensitivity test for the higher recharge conditions that better matches the observed water level for OW-901 minimizes the residual at this well but produces unacceptably high residuals at other observation wells, indicating that the calibration base case produces the best overall model calibration.
- Based on the post-construction results, the groundwater elevations in the power block area are controlled by the surrounding drainage ditches.
- Using the base case post-construction simulation, i.e., that using the calibrated parameters and the most reasonable value for parameters describing new features, the maximum groundwater elevation estimated at the site is approximately 283.9 ft NAVD 88, approximately 6 ft below the design plant grade of 290 ft NAVD 88, which meets the DCD minimum depth to groundwater requirement of 0.61 m (2 ft). This base case used an estimated drain conductance of 25 ft^2/day.
- For all sensitivity cases the 0.61-m (2-ft) minimum depth to water requirement is met for all Seismic Category I structures in the power block area.
- Decreasing the hydraulic conductivity of the structural fill by one order of magnitude raises the water level for the south area of the power block by approximately 0.3 to 0.5 ft. Increasing the fill hydraulic conductivity by one order of magnitude decreases the maximum groundwater level by approximately 0.8 ft.
- Decreasing the conductance of the drainage ditches surrounding the power block area by an order of magnitude produces a maximum groundwater level approximately 3.7 ft higher than the post-construction base case, or 2.3 ft below the plant grade level, which meets the DCD depth to groundwater requirement of 2 ft. Increasing the drain conductance by an order of magnitude lowers the maximum water level by approximately 0.4 ft.
- Sensitivity of groundwater elevations at Unit 3 buildings to drain conductance and high recharge in the drain cells is relatively minimal. Water levels did not change significantly from the post-construction base case. For the sensitivity cases with high recharge in addition to lower and higher drain conductance, water levels increased approximately 3.8 ft and decreased approximately 0.4 ft, respectively, as compared to the base case, which still meets the DCD requirements within the range of this sensitivity analysis.
- A transient simulation of a PMP event that includes higher water levels in the drainage ditches and higher recharge increases the maximum groundwater level by approximately 1 ft, which still meets the DCD depth to groundwater requirement.
- Including model boundary conditions in model layer 2 have very little impact (i.e., 0.1 to 0.2 ft differences from the base case) on groundwater elevations.
- A sensitivity case evaluating the increased recharge from precipitation over the power block buildings increases the maximum groundwater level by approximately 1 ft, which still meets the DCD depth to groundwater requirement.

- Particle tracking indicates that the minimum travel time for a particle starting at the Condensate Storage Tank and terminating at the Unit 3 intake is approximately 18 yrs.

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Table 1. Precipitation at Louisa Observation Station (Inches)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	SUM
1942	3.63	1.42	5.81	0.81	2.73	4.36	8.32	8.25	3.27	7.35	1.62	3.62	51.19
1943	3.26	1.39	3.60	2.52	3.06	1.84	6.10	1.15	1.88	1.99	2.50	2.69	31.98
1944	2.41	4.00	6.25	3.82	1.60	1.93	4.25	4.95	6.13	3.22	3.14	2.94	44.64
1945	3.49	2.57	1.12	3.86	4.13	2.63	11.10	2.85	7.06	0.90	3.92	5.75	49.38
1946	2.23	2.94	5.28	2.46	7.16	3.10	7.31	4.27	2.67	2.38	1.88	2.66	44.34
1947	5.38	2.36	2.16	1.95	3.09	4.16	3.17	3.02	3.90	1.66	5.96	0.96	37.77
1948	4.64	2.58	5.17	5.53	8.47	3.08	3.19	NA	NA	NA	NA	NA	NA
1949	5.32	2.34	3.42	3.16	3.24	2.64	7.98	6.81	2.27	2.91	1.78	2.11	43.98
1950	2.20	2.83	3.91	1.53	4.78	1.41	4.47	3.30	6.94	3.46	1.50	3.27	39.60
1951	1.49	2.74	3.56	4.15	1.47	8.10	1.34	2.47	2.71	1.16	5.69	4.78	39.66
1952	5.31	1.98	5.36	5.35	5.84	3.27	1.53	5.18	3.85	1.37	6.91	2.37	48.32
1953	2.34	2.21	5.41	3.49	3.23	3.08	1.29	0.57	1.75	3.43	1.14	4.19	32.13
1954	3.42	1.69	3.85	2.99	4.58	2.63	3.12	3.30	0.47	4.70	2.24	3.73	36.72
1955	0.82	3.50	3.84	3.48	2.90	2.79	4.88	13.12	0.96	2.11	1.53	0.57	40.50
1956	1.28	3.93	2.32	2.54	0.79	2.61	9.22	1.59	6.36	4.65	4.02	3.08	42.39
1957	3.05	4.44	2.03	4.86	2.26	4.76	1.33	3.34	4.64	4.43	4.51	5.13	44.78
1958	3.77	3.88	5.93	3.28	2.19	4.39	4.83	6.52	2.46	2.98	1.75	3.67	45.65
1959	2.30	1.30	2.90	4.01	2.53	4.16	8.12	3.87	1.32	3.56	3.13	2.81	40.01
1960	2.64	5.44	3.43	2.97	4.21	2.60	4.16	3.91	5.19	2.23	1.29	2.20	40.27
1961	2.67	5.78	5.12	3.27	5.40	2.52	3.90	4.69	2.45	8.08	1.78	4.58	50.24
1962	2.59	3.72	5.32	3.27	3.98	4.53	4.07	3.69	3.59	1.01	5.37	3.50	44.64
1963	2.01	2.13	6.60	0.96	1.30	3.40	2.09	3.29	2.53	0.11	6.80	2.17	33.39
1964	4.60	5.70	2.09	3.99	0.56	1.59	3.05	1.86	2.01	3.55	2.23	3.62	34.85
1965	3.47	3.47	4.28	2.58	2.12	3.34	3.36	5.34	2.10	1.79	0.65	0.24	32.74
1966	4.72	4.78	0.92	3.02	3.20	2.49	3.72	1.16	8.61	3.78	1.33	3.61	41.34
1967	1.32	2.47	4.09	1.05	3.90	0.87	3.27	6.98	0.91	3.83	1.94	6.99	37.62
1968	2.99	0.79	3.80	1.81	4.40	6.24	2.87	5.13	1.26	2.57	3.70	1.97	37.53
1969	2.68	2.60	4.16	1.38	1.82	5.54	5.90	16.33	2.57	1.07	1.60	7.20	52.85
1970	1.53	2.81	3.41	4.45	1.80	0.35	4.10	2.49	1.03	2.83	5.53	2.84	33.17
1971	2.23	5.84	3.27	2.31	10.40	4.63	4.42	4.15	2.82	8.89	3.98	1.27	54.21
1972	2.46	5.38	2.04	3.22	7.49	10.82	5.77	1.81	2.22	10.82	6.88	3.56	62.47
1973	2.67	3.05	3.77	6.10	2.67	2.06	1.94	3.35	3.85	4.70	1.49	6.78	42.43
1974	2.49	1.56	3.30	2.38	3.46	4.37	5.41	2.74	5.49	0.23	1.81	5.16	38.40
1975	3.32	2.34	6.45	1.82	3.36	10.51	7.95	3.07	9.44	1.90	2.02	3.88	56.06
1976	3.65	1.54	2.84	1.61	3.22	4.57	2.68	4.30	4.20	8.78	1.44	1.89	40.72
1977	1.71	0.38	2.45	1.83	1.43	1.52	2.05	2.10	2.04	4.52	5.79	4.96	30.78
1978	8.53	0.29	4.06	3.67	4.77	5.75	5.38	8.26	2.36	1.15	2.58	3.63	50.43
1979	5.55	5.13	3.76	3.34	3.43	4.08	0.90	5.01	7.74	5.49	3.23	0.83	48.49
1980	4.58	1.08	3.83	2.08	3.11	0.56	3.28	4.31	0.91	3.16	2.51	0.40	29.81

Table 1. Precipitation at Louisa Observation Station (Inches) (Cont.)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	SUM
1981	0.10	3.08	1.35	2.14	4.05	2.11	6.46	3.59	2.74	3.80	0.70	3.54	33.66
1982	2.77	5.01	3.98	2.91	1.99	5.02	2.97	4.34	3.99	2.35	3.27	1.81	40.41
1983	0.93	2.21	4.07	7.17	3.80	3.62	1.52	2.29	2.25	5.25	6.33	5.47	44.91
1984	1.87	6.86	6.64	5.46	4.08	1.17	4.70	4.20	1.86	2.43	3.48	1.66	44.41
1985	2.57	3.25	1.12	0.49	4.79	1.63	6.37	9.33	1.30	5.87	10.88	0.42	48.02
1986	2.13	2.61	1.12	3.18	1.10	0.80	6.17	3.98	1.02	2.62	3.29	5.14	33.16
1987	5.60	1.72	3.62	7.07	4.30	5.35	2.69	1.27	11.14	2.11	6.07	2.99	53.93
1988	3.25	1.96	1.82	1.31	5.32	1.99	4.40	2.96	1.48	1.07	6.90	1.09	33.55
1989	1.49	3.31	5.54	2.41	6.44	8.74	7.77	3.35	4.34	4.21	4.80	2.90	55.30
1990	3.74	2.47	3.57	3.15	9.03	2.89	3.49	3.80	1.19	4.73	1.90	4.35	44.31
1991	4.67	0.98	3.08	2.03	0.92	4.20	11.71	0.48	1.59	1.34	1.63	5.03	37.66
1992	1.75	2.35	2.99	2.68	3.59	2.76	1.42	1.92	5.44	2.58	4.96	5.73	38.17
1993	4.52	2.61	8.78	3.70	4.36	1.77	2.65	2.15	4.43	2.01	9.32	3.15	49.45
1994	3.63	4.53	8.94	1.79	2.11	1.46	6.53	8.13	5.77	1.64	1.69	1.55	47.77
1995	5.35	1.50	2.59	1.79	4.87	5.26	4.98	1.18	2.67	10.31	4.19	2.74	47.43
1996	6.80	3.41	2.73	2.78	3.96	3.02	7.01	2.99	9.45	7.51	3.40	5.56	58.62
1997	2.70	2.60	4.88	2.85	0.70	1.69	5.17	3.63	3.92	3.78	4.93	1.73	38.58
1998	6.21	8.22	6.05	4.35	4.83	3.24	0.52	1.04	1.02	1.43	1.17	2.04	40.12
1999	4.45	2.49	3.68	1.68	1.06	0.76	4.99	4.95	8.96	1.73	2.37	2.16	39.28
2000	2.75	2.11	3.26	4.78	3.02	6.14	2.25	4.07	5.86	0.00	1.48	0.65	36.37
2001	2.26	1.21	NA	1.20	4.11	4.91	4.06	2.31	1.47	0.94	0.32	2.14	NA
2002	1.80	0.82	3.72	3.56	2.27	4.28	6.18	3.92	2.05	5.92	4.68	4.46	43.66
2003	2.64	7.38	5.27	3.83	8.92	8.29	4.55	3.88	10.26	3.69	6.89	5.97	71.57
2004	1.86	2.12	1.99	3.33	7.10	3.30	7.95	6.14	6.95	1.17	5.19	2.54	49.64
2005	3.46	2.19	4.32	3.38	3.94	2.91	3.44	4.89	1.50	8.56	3.13	3.83	45.55
2006	3.31	2.11	0.00	2.62	3.09	4.64	4.22	2.30	9.49	8.24	6.70	1.54	48.26
2007	2.89	1.94	3.84	3.20	3.24	3.72	3.55	6.66	0.51	5.66	1.18	2.66	39.05
2008	1.12	2.88	2.73	6.69	5.49	2.82	5.75	2.17	5.48	1.05	3.32	2.46	41.96
2009	1.80	0.54	2.81	3.03	6.48	6.96	2.60	2.59	2.50	3.06	7.10	7.18	46.65
2010	2.81	3.03	4.54	2.58	4.66	3.38	2.00	2.79	4.77	3.36	2.53	1.55	38.00
2011	1.60	1.59	5.21	3.72	5.09	4.09	2.85	5.43	7.95	4.13	3.11	4.80	49.57
2012	1.89	3.21	2.54	2.08	4.47	5.04	2.04	4.84	3.12	3.92	0.49	NA	NA
Mean	**3.09**	**2.91**	**3.82**	**3.10**	**3.85**	**3.68**	**4.43**	**4.09**	**3.83**	**3.56**	**3.49**	**3.25**	**43.30**
St. Dev.	1.53	1.64	1.71	1.42	2.07	2.15	2.37	2.65	2.70	2.48	2.24	1.74	7.94
Max	8.53	8.22	8.94	7.17	10.40	10.82	11.71	16.33	11.14	10.82	10.88	7.20	71.57
Min	0.10	0.29	0.00	0.49	0.56	0.35	0.52	0.48	0.47	0.00	0.32	0.24	29.81

Note: NA indicates Not Available

Source: NCDC (2013a)

Table 2. Hydraulic Conductivity Values from Site Hydraulic Conductivity Tests

Well ID	Unit (1)	Conductivity Values						
		Slug 1 Falling Head	Slug 1 Rising Head	Slug 2 Falling Head	Slug 2 Rising Head	Maximum	Minimum	Geometric Mean
		ft/day	ft/day	ft/day	ft/day	ft/day	ft/day	ft/day
OW-841	S	2.2	2.3	-	-	2.3	2.2	2.27
OW-842	S	0.94	0.94	-	-	0.94	0.94	0.935
OW-843	S	1.28	1.39	-	-	1.4	1.3	1.33
OW-844	S	0.25	0.28	-	-	0.28	0.25	0.266
OW-845	QG	1.8	3.1	-	-	3.1	1.8	2.36
OW-846	S	1.9	3.4	-	-	3.4	1.9	2.56
OW-847	S	0.60	0.65	-	-	0.65	0.60	0.623
OW-848	S	3.4	2.8	-	-	3.4	2.8	3.09
OW-849	S	2.0	3.1	-	-	3.1	2.0	2.49
OW-945	S	2.8	-	3.4	4.0	4.0	2.8	3.37
OW-946	S	9.1	7.4	9.9	8.2	9.9	7.4	8.59
OW-947	S	0.68	0.60	0.45	0.54	0.68	0.45	0.56
OW-949	QG	2.0	-	1.9	2.4	2.4	1.9	2.08
P-10	S	1.7	0.17	-	-	1.7	0.17	0.547
P-23	S	0.19	-	-	-	0.19	0.19	0.187
P-24	S	0.82	0.019	-	-	0.82	0.019	0.125
Packer Tests								
B-949	QG	Test 1: 6.28		Test 2: 0.48		**6.28**	**0.48**	-
Hydraulic Conductivity by Geologic Unit								
Saprolite						**9.9**	**0.019**	**1.3**
Bedrock						**6.3**	**0.48**	**2.1**
Hydraulic Conductivity Relative to Unnamed Fault								
North of fault						**9.9**	**1.3**	**3.2**
South of fault (excluding packer tests)						**2.4**	**0.019**	**0.55**

Notes:
1 S = Saprolite and QG = Quartz Gneiss

Table 3. Top of Bedrock Elevations

Boring	Easting (ft)	Northing (ft)	Elev (ft NAVD 88)	Zone
1	11687895	3910422	238.1	III-IV
2	11687731	3910699	252.1	IV
3	11687562	3910985	225.1	IV
4	11687663	3910318	266.1	III-IV
5	11687565	3910493	250.1	III-IV
6	11687462	3910666	233.1	III-IV
7	11687338	3910877	219.1	IV
8	11687436	3910215	288.1	IV
9	11687271	3910494	214.1	IV
10	11687106	3910781	222.1	IV
11	11687204	3910112	211.1	IV
12	11687101	3910282	267.1	IV
13	11686998	3910457	239.1	III-IV
14	11686874	3910676	210.1	IV
15	11686978	3910060	248.1	IV
16	11686812	3910289	266.1	IV
17	11686653	3910571	202.1	IV
18	11686749	3909900	224.1	IV
19	11686647	3910069	233.1	IV
20	11686547	3910250	244.1	IV
21	11686421	3910462	205.1	IV
22	11686519	3909797	253.1	III-IV
23	11686354	3910076	273.1	IV
24	11686189	3910359	232.1	IV
25	11686287	3909689	204.1	IV
26	11686124	3909973	287.1	III-IV
27	11685957	3910256	209.1	IV
28	11687550	3910378	269.1	III-IV
29	11687513	3910447	273.1	III-IV
30	11687416	3910333	268.1	III-IV
31	11687254	3910354	229.1	III-IV
32	11687292	3910278	272.1	IV
34	11687383	3910615	240.1	IV
36	11687137	3910524	211.1	III-IV
37	11687199	3911029	200.1	IV
38	11687101	3910993	203.1	IV
39	11687580	3910303	261.1	IV
40	11687318	3910210	227.1	III-IV

Table 3. Top of Bedrock Elevations (Cont.)

Boring	Easting (ft)	Northing (ft)	Elev (ft NAVD 88)	Zone
49	11687488	3910540	248.1	III-IV
50	11687230	3910441	233.1	IV
101	11686049	3911505	235.1	IV
104	11687194	3910158	297.1	III-IV
105	11687070	3910359	241.1	IV
106	11686928	3910524	203.1	III-IV
601	11686693	3910881	244.1	III-IV
602	11686508	3910808	254.1	III-IV
603	11686613	3910813	229.1	III-IV
604	11686729	3910818	189.1	IV
606	11686841	3910656	222.1	III-IV
607	11686568	3910553	226.1	III-IV
608	11686880	3910588	187.1	IV
610	11686703	3910506	189.1	III-IV
611	11686608	3910483	220.1	III-IV
612	11686513	3910443	211.1	IV
614	11686823	3910478	223.1	III-IV
615	11686721	3910443	225.6	III-IV
616	11686636	3910418	226.1	III-IV
617	11686546	3910381	215.6	IV
618	11686928	3910458	235.1	IV
619	11686747	3910383	257.1	III-IV
620	11686857	3910426	256.1	IV
621	11686698	3910323	245.1	IV
622	11686958	3909828	239.1	IV
623	11686668	3910233	253.1	IV
624	11686983	3910278	260.1	IV
625	11686843	3910223	264.1	III-IV
626	11686696	3910161	263.1	III-IV
627	11687066	3910229	245.1	III-IV
628	11686978	3910196	241.1	IV
629	11686778	3910113	261.1	III-IV
630	11686723	3910093	249.1	III-IV
631	11687003	3909663	233.1	III-IV
633	11687568	3910198	228.1	III-IV
635	11687958	3910313	235.1	IV

Table 3. Top of Bedrock Elevations (Cont.)

Boring	Easting (ft)	Northing (ft)	Elev (ft NAVD 88)	Zone
637	11686568	3910658	226.1	III-IV
638	11686658	3910978	238.1	III-IV
639	11686473	3910908	217.1	IV
641	11686853	3909523	196.1	IV
642	11686653	3910493	207.1	IV
643	11686584	3910427	217.1	III-IV
644	11686743	3910143	252.1	III-IV
645	11687008	3910213	265.1	III-IV
B-801	11686738	3910352	228.9	III-IV or IV
B-802	11686381	3909957	263.2	III-IV or IV
B-803	11685764	3909922	243.6	III-IV or IV
B-804	11685135	3909497	286.6	III-IV or IV
B-805	11686247	3910362	232.4	III-IV or IV
B-806	11683977	3909416	288.4	III-IV or IV
B-807	11683980	3909849	253.5	III-IV or IV
B-901	11685929	3909778	229.4	III-IV
B-902	11685884	3909874	278.4	IV
B-903	11686029	3909812	220.8	III-IV
B-904	11685970	3909692	235.1	III-IV
B-905	11685822	3909733	271.4	III-IV
B-906	11685795	3909670	262	III-IV
B-907	11685938	3909608	207.2	III-IV
B-908	11686061	3909717	241.3	IV
B-909	11686107	3909695	225	III-IV
B-910	11685883	3909668	226.1	III-IV
B-911	11685993	3909920	268.7	III-IV
B-911A	11686001	3909916	268.7	III-IV
B-912	11686051	3910022	238.3	IV
B-913	11686115	3910149	215.5	IV
B-914	11685922	3909940	236.9	III-IV
B-915	11686089	3909877	279.4	III-IV
B-916	11686009	3910050	250.6	IV
B-917	11686029	3910161	187.1	III-IV
B-918	11686194	3910115	239.8	IV
B-919	11685765	3909575	264.7	III-IV
B-920	11685980	3909545	221.5	IV
B-922	11686233	3909944	257.3	III-IV

Table 3. Top of Bedrock Elevations (Cont.)

Boring	Easting (ft)	Northing (ft)	Elev (ft NAVD 88)	Zone
B-922A	11686244	3909949	254.8	III-IV
B-923	11686309	3910077	266.8	III-IV
B-924	11686475	3909970	252.9	III-IV
B-925	11686576	3910037	249.6	III-IV
B-926	11685709	3910043	225.2	III-IV
B-927	11685879	3909966	252.7	III-IV
B-928	11686159	3910223	220.1	III-IV
B-928A	11686165	3910220	220.1	III-IV
B-933	11685791	3909827	248.3	III-IV
B-933A	11685802	3909826	248.3	III-IV
B-934	11685686	3909860	246.4	IV
B-936	11685929	3910746	190.6	III-IV
B-937	11686672	3910689	220	III-IV
B-940	11688901	3910267	212.1	III-IV
B-941	11688913	3910404	205.8	IV
B-942	11684326	3909615	263	IV
B-943	11683892	3909355	268.5	III-IV
B-944	11684128	3908772	281.2	III-IV
B-945	11683780	3910136	221	III-IV
B-946	11683811	3908787	291.6	III-IV
B-948	11685566	3909619	274.7	III-IV
B-949	11685157	3909018	258.4	III-IV
B-950	11686282	3910836	232.2	III-IV
B-951	11686822	3910548	179.9	IV
M-1	11685484	3909611	260.6	III-IV
M-2	11685586	3909531	251.4	III-IV
M-3	11685679	3909539	274.8	III-IV
M-4	11685695	3909456	252.8	III-IV
M-6	11685760	3909401	231.4	III-IV
M-7	11685836	3909504	219.7	III-IV
M-8	11685847	3909414	242.9	III-IV
M-9	11685946	3909334	203.7	IV
M-10	11685962	3909244	212.8	III-IV
M-12	11685560	3909723	243.1	III-IV
M-13	11686025	3909520	255.8	III-IV
M-16	11685802	3909990	224.4	IV
M-17	11686214	3909775	214.3	III-IV
M-19	11685856	3910053	213.8	III-IV
M-20	11686068	3909794	246.6	III-IV

Table 3. Top of Bedrock Elevations (Cont.)

Boring	Easting (ft)	Northing (ft)	Elev (ft NAVD 88)	Zone
M-21	11686270	3909811	222.1	III-IV
M-27	11685938	3909426	215.2	III-IV
M-28	11685672	3909636	265.2	III-IV
M-29	11685460	3909711	268.3	III-IV
M-30	11685382	3909695	269.6	III-IV
M-31	11685460	3909799	247.9	III-IV
M-32	11685527	3909876	256	III-IV
M-34	11685736	3910122	232.9	III-IV
W-1	11685959	3909853	211.2	III-IV
W-2	11685864	3909822	275.6	III-IV
W-3	11685899	3909715	241.6	III-IV
W-4	11686002	3909749	241.3	III-IV
W-5	11686142	3909979	268.8	III-IV
W-6	11686206	3909831	208	III-IV
W-7	11686147	3909731	226.9	III-IV
W-8	11686273	3909768	227.8	III-IV
W-9	11686022	3909601	187.2	III-IV
W-10	11685820	3909599	226.1	III-IV

Table 4. Observed Groundwater Elevations for May 2007

Well Name	Easting (ft)	Northing (ft)	Observed Groundwater Level (ft NAVD 88)	Model Layer
OW-841	11,686,804	3,910,556	248.7	Layer 1
OW-842	11,685,149	3,909,035	314.2	Layer 1
OW-843	11,685,057	3,909,725	290.2	Layer 1
OW-844	11,686,590	3,909,909	265.6	Layer 1
OW-845	11,685,741	3,909,859	276.9	Layer 1
OW-846	11,685,722	3,909,845	276.6	Layer 1
OW-847	11,686,448	3,908,945	294.2	Layer 1
OW-848	11,686,273	3,910,853	242.6	Layer 1
OW-849	11,684,731	3,910,786	270.0	Layer 1
OW-901	11,685,917	3,909,772	288.5	Layer 2
OW-945	11,683,793	3,910,136	271.6	Layer 1
OW-946	11,683,823	3,908,788	312.6	Layer 1
OW-947	11,686,372	3,909,580	297.9	Layer 1
OW-949	11,685,153	3,909,025	314.4	Layer 2
OW-950	11,686,285	3,910,842	238.4	Layer 2
OW-951	11,686,786	3,910,521	249.4	Layer 2
P-10	11,687,804	3,909,391	274.3	Layer 1
P-14	11,687,540	3,909,800	273.2	Layer 1
P-18	11,687,038	3,909,702	290.0	Layer 1
P-19	11,686,949	3,909,666	289.6	Layer 1
P-20	11,687,344	3,909,798	276.0	Layer 1
P-21	11,687,797	3,909,563	263.0	Layer 1
P-22	11,687,507	3,909,267	278.5	Layer 1
P-23	11,687,869	3,909,524	262.4	Layer 1
P-24	11,687,551	3,909,189	277.2	Layer 1
WP-3	11,685,738	3,907,958	294.1	Layer 1

Table 5. PEST Input Parameters

Parameter	Transformation	Change Limit	Initial Value (ft/d)	Lower Bound (ft/d)	Upper Bound
Kx1	log	factor	3.2	3.000e-03	30
Kx2	log	factor	0.55	3.000e-03	30
Kz1	Tied Kx1	n.a.	3.2	3.000e-03	30
Kz2	Tied Kx2	n.a.	0.55	3.000e-03	30
R1	none	relative	2.5114e-03	1.507e-03	2.73973e-03
R2	none	relative	2.73973e-03	2.511e-03	6.849e-03

Table 6. PCG2 Solver Settings

Maximum Outer Iterations	Maximum Inner Iterations	Head Change Criterion	Residual Criterion for Convergence	Relaxation and Damping Factors
50	25	0.0001	0.0001	1

Table 7. Final Calibrated Parameters (Manual Trial-and-Error)

Parameter	Value
Hydraulic Conductivity Zone 1 (North of Fault)	1.14 ft/d
Hydraulic Conductivity Zone 2 (South of Fault)	0.43 ft/d
Recharge Zone 1 (Domain)	0.0025 ft/d (11.0 in/yr)
Recharge Zone 2 (SWR)	0.0033 ft/d (14.5 in/yr)

Table 8. Calibration Residuals

Observation Well	Observed Water Level (ft NAVD 88)	Base Case		Sensitivity: South GHB		Sensitivity: OW-901	
		Calculated (ft NAVD 88)	Residual	Calculated (ft NAVD 88)	Residual	Calculated (ft NAVD 88)	Residual
OW-841	248.7	247.23	1.47	247.27	1.43	247.58	1.12
OW-951	249.4	248.02	1.38	248.05	1.35	248.35	1.05
OW-842	314.2	306.29	7.91	308.58	5.62	311.18	3.02
OW-949	314.4	306.31	8.09	308.61	5.79	311.18	3.22
OW-843	290.2	294.25	-4.05	295.77	-5.57	298.70	-8.50
OW-844	265.6	270.69	-5.09	271.01	-5.41	273.27	-7.67
OW-845	276.9	284.78	-7.88	285.69	-8.79	288.75	-11.85
OW-846	276.6	285.35	-8.75	286.28	-9.68	289.36	-12.76
OW-847	294.2	301.63	-7.43	302.32	-8.12	306.36	-12.16
OW-848	242.6	243.62	-1.02	243.78	-1.18	244.69	-2.09
OW-950	238.4	242.63	-4.23	242.78	-4.38	243.61	-5.21
OW-849	270	273.82	-3.82	274.44	-4.44	276.55	-6.55
OW-901	288.5	284.56	3.94	285.39	3.11	288.51	-0.01
OW-945	271.6	281.56	-9.96	282.39	-10.79	283.92	-12.32
OW-946	312.6	308.12	4.48	312.27	0.33	312.68	-0.08
OW-947	297.9	288.04	9.86	288.64	9.26	292.13	5.77
WP-3	294.1	294.28	-0.18	295.25	-1.15	295.36	-1.26
P-10	274.3	273.21	1.09	273.34	0.96	275.59	-1.29
P-14	273.2	272.18	1.02	272.30	0.90	274.35	-1.15
P-18	290	280.96	9.04	281.21	8.79	283.91	6.09
P-19	289.6	282.83	6.77	283.12	6.48	285.97	3.63
P-20	276	274.96	1.04	275.11	0.89	277.35	-1.35
P-21	263	270.89	-7.89	271.00	-8.00	273.00	-10.00
P-22	278.5	282.92	-4.42	283.13	-4.63	286.03	-7.53
P-23	262.4	268.91	-6.51	269.00	-6.60	270.90	-8.50
P-24	277.2	282.17	-4.97	282.38	-5.18	285.32	-8.12
Maximum Residual		9.86		9.26		6.09	
Minimum Residual		-9.96		-10.79		-12.76	
RMS		5.93		5.87		6.83	
NRMS		7.8%		7.7%		9.0%	
Mass Balance Discrepancy		0.00		0.00		0.00	

Note: Residuals are presented as observed minus calculated..

Table 9. Foundation Elevations of Major Structures

Structure	Bottom of Mat Foundation Elevation (ft)	Embedment Depth (ft)	Model Bottom of Foundation Elevation (including concrete fill)
Reactor/Fuel Building (RB/FB)	223.9	65.6	223.9
Control Building (CB)	240.6	48.9	230
Fire Water Service Complex (FWSC)	281.8	7.7	230
Turbine Building (TB)	263.6	25.9	260.3
Radwaste Building (RWB)	237.5	52.0	225
Service Building (SB)	274.1	15.4	--
Ancillary Diesel Building (ADB)	286.2	3.3	--

Notes: Elevations relative to NAVD 88. Some buildings include concrete fill beneath the foundation. The post-construction groundwater flow model includes the concrete fill as no flow zones, in addition to the proposed buildings. Because of their shallow foundations, the SB and ADB are not incorporated into the post-construction simulations as no flow cells (see Section 5.1).

Table 10. Simulated Post-Construction Groundwater Elevations: Cases 1 - 3

	Case 1: Base Case	Case 2: Fill K 0.1x		Case 3: Fill K 10x	
Observation Point	Calculated (ft NAVD 88)	Calculated (ft NAVD 88)	Difference (1 - 2)	Calculated (ft NAVD 88)	Difference (1 - 3)
A	283.9	284.2	-0.3	283.1	0.8
B	283.8	284.2	-0.3	283.0	0.8
C	283.3	283.8	-0.5	282.3	1.1
D	283.1	283.5	-0.4	282.3	0.8
E	282.6	282.9	-0.4	281.3	1.3
F	282.5	283.0	-0.6	281.1	1.4
G	281.0	281.1	-0.1	280.4	0.7
H	280.9	281.2	-0.3	280.2	0.7
I	281.2	281.8	-0.6	280.3	0.9
J	281.5	282.2	-0.7	280.3	1.1
K	278.5	277.9	0.6	279.4	-0.9
L	278.3	278.2	0.0	278.1	0.1
M	278.0	277.8	0.3	278.5	-0.4
N	277.6	277.3	0.3	278.3	-0.7
O	278.1	277.0	1.1	279.4	-1.3
P	278.8	278.2	0.6	279.6	-0.8
Maximum	283.9	284.2		283.1	
Minimum	277.6	277.0		278.1	

Note: Point locations are shown in Figure 29. All simulated groundwater elevations are from model layer 1. Values shown above have been rounded from the complete simulated results. Consequently, there may be slight discrepancies in the difference columns as they are based on the complete simulated values and not the rounded values above.

Table 11. Simulated Post-Construction Groundwater Elevations: Cases 1 and 4 - 5

	Case 1: Base Case	Case 4: Drain Cond. 0.1x		Case 5: Drain Cond. 10x	
Observation Point	Calculated (ft NAVD 88)	Calculated (ft NAVD 88)	Difference (1 - 4)	Calculated (ft NAVD 88)	Difference (1 - 5)
A	283.9	287.6	-3.7	283.5	0.5
B	283.8	287.6	-3.7	283.4	0.5
C	283.3	287.0	-3.7	282.8	0.5
D	283.1	286.9	-3.8	282.5	0.5
E	282.6	286.1	-3.5	282.1	0.5
F	282.5	286.0	-3.5	282.0	0.5
G	281.0	284.3	-3.3	280.6	0.5
H	280.9	284.2	-3.2	280.5	0.5
I	281.2	284.5	-3.3	280.7	0.5
J	281.5	284.7	-3.3	281.0	0.4
K	278.5	281.2	-2.7	278.1	0.4
L	278.3	281.0	-2.8	277.8	0.5
M	278.0	280.7	-2.7	277.6	0.4
N	277.6	280.2	-2.6	277.2	0.4
O	278.1	280.7	-2.6	277.7	0.4
P	278.8	281.4	-2.6	278.4	0.4
Maximum	283.9	287.6		283.5	
Minimum	277.6	280.2		277.2	

Note: Point locations are shown in Figure 29. All simulated groundwater elevations are from model layer 1. Values shown above have been rounded from the complete simulated results. Consequently, there may be slight discrepancies in the difference columns as they are based on the complete simulated values and not the rounded values above.

Table 12. Simulated Post-Construction Groundwater Elevations: Cases 1 and 6 - 8

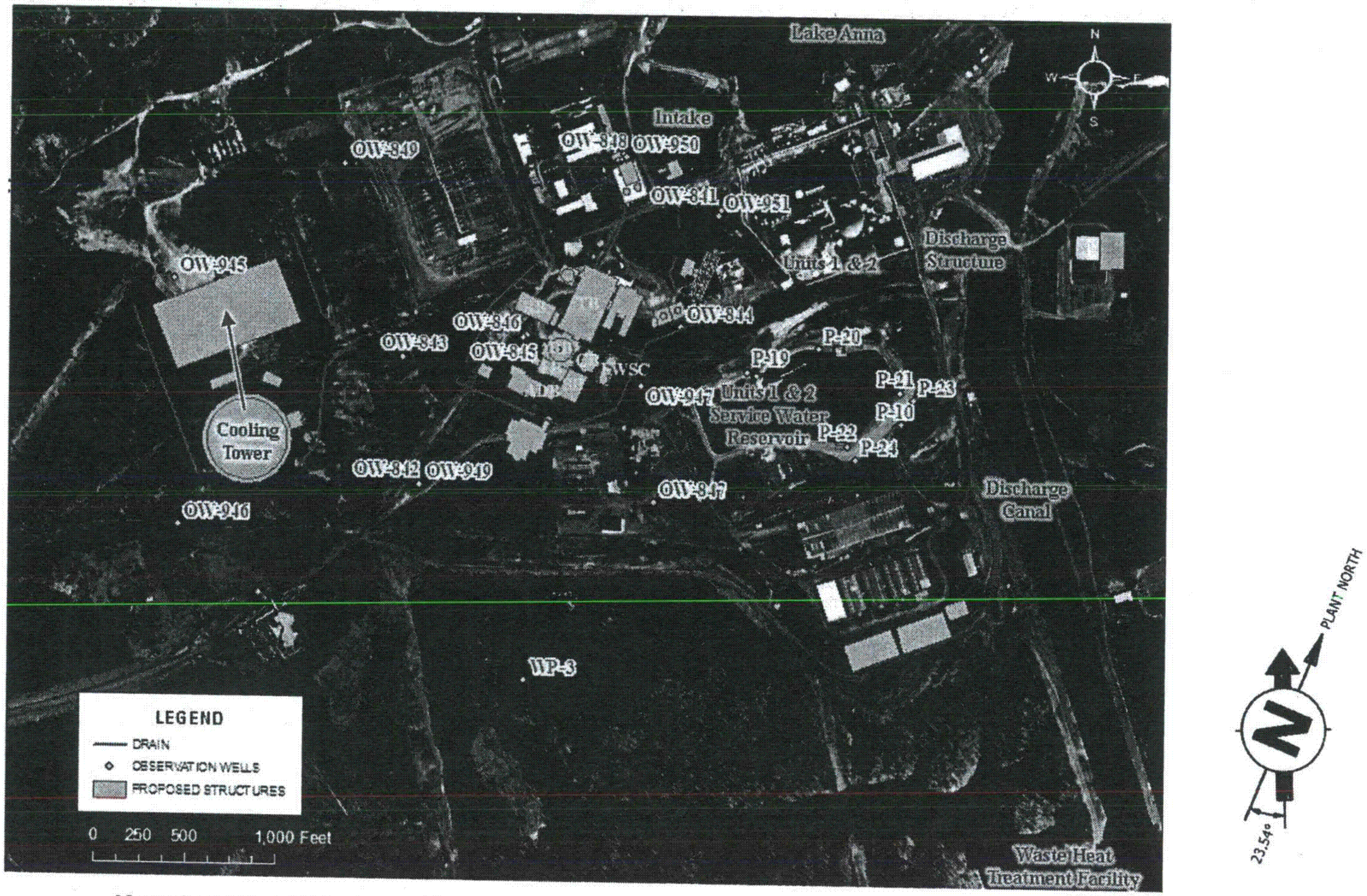
Observation Point	Case 1: Base Case	Case 6: Drain Cond. 1x, Recharge 2x		Case 7: Drain Cond. 0.1x, Recharge 2x		Case 8: Drain Cond. 10x, Recharge 2x	
	Calculated (ft NAVD 88)	Calculated (ft NAVD 88)	Difference (1 - 6)	Calculated (ft NAVD 88)	Difference (1 - 7)	Calculated (ft NAVD 88)	Difference (1 - 8)
A	283.9	284.0	0.0	287.7	-3.8	283.5	0.4
B	283.8	283.9	0.0	287.7	-3.8	283.4	0.5
C	283.3	283.3	0.0	287.1	-3.8	282.9	0.5
D	283.1	283.1	0.0	287.0	-3.9	282.6	0.5
E	282.6	282.6	0.0	286.2	-3.6	282.1	0.5
F	282.5	282.5	0.0	286.1	-3.6	282.0	0.4
G	281.0	281.1	0.0	284.4	-3.4	280.6	0.4
H	280.9	281.0	0.0	284.3	-3.3	280.5	0.4
I	281.2	281.2	0.0	284.6	-3.4	280.8	0.4
J	281.5	281.5	0.0	284.8	-3.4	281.0	0.4
K	278.5	278.6	-0.1	281.4	-2.9	278.1	0.4
L	278.3	278.3	-0.1	281.1	-2.9	277.9	0.4
M	278.0	278.1	-0.1	280.9	-2.8	277.7	0.4
N	277.6	277.7	-0.1	280.4	-2.8	277.3	0.3
O	278.1	278.2	-0.1	280.9	-2.8	277.7	0.3
P	278.8	278.9	-0.1	281.5	-2.7	278.5	0.3
Maximum	283.9	284.0		287.7		283.5	
Minimum	277.6	277.7		280.4		277.3	

Notes: Point locations are shown in Figure 29. All simulated groundwater elevations are from model layer 1. Values shown above have been rounded from the complete simulated results. Consequently, there may be slight discrepancies in the difference columns as they are based on the complete simulated values and not the rounded values above.

Table 13. Simulated Post-Construction Groundwater Elevations: Cases 1, 9, 10, and 12

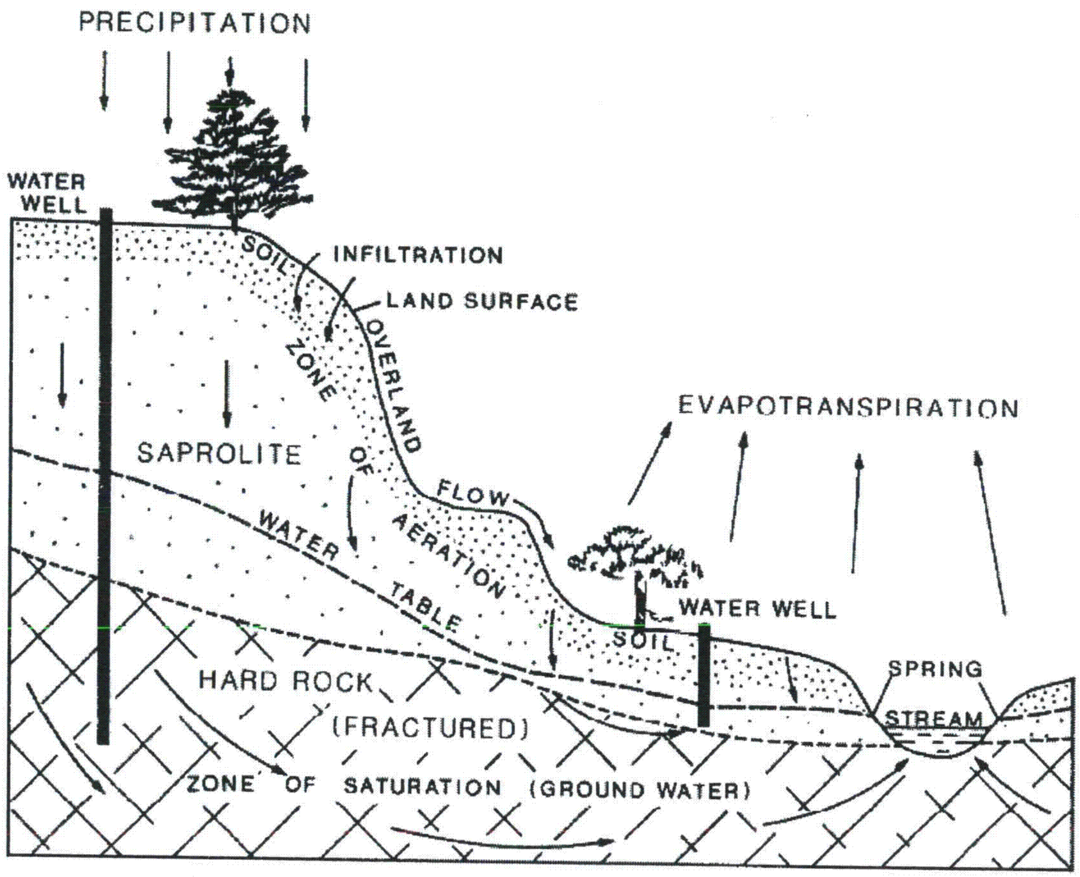
	Case 1: Base Case	Case 9: PB Drains as CH Cells Transient		Case 10: BCs in Layer 2		Case 12: Bldg. Recharge	
Observation Point	Calculated (ft NAVD 88)	Calculated (ft NAVD 88)	Difference (1 - 9)	Calculated (ft NAVD 88)	Difference (1 - 10)	Calculated (ft NAVD 88)	Difference (1 - 12)
A	283.9	284.9	-0.9	283.9	0.1	284.9	-1.0
B	283.8	284.8	-0.9	283.8	0.1	284.9	-1.1
C	283.3	284.0	-0.7	283.3	0.1	284.5	-1.2
D	283.1	283.9	-0.8	283.0	0.1	284.1	-1.1
E	282.6	283.6	-1.0	282.5	0.1	284.0	-1.4
F	282.5	283.0	-0.6	282.4	0.1	283.8	-1.4
G	281.0	282.0	-1.0	281.0	0.1	282.6	-1.6
H	280.9	281.9	-0.9	280.8	0.1	282.5	-1.6
I	281.2	282.2	-1.0	281.1	0.1	282.6	-1.5
J	281.5	282.4	-1.0	281.4	0.1	282.7	-1.2
K	278.5	279.5	-1.0	278.4	0.1	280.4	-2.0
L	278.3	279.3	-1.0	278.1	0.2	280.4	-2.2
M	278.0	279.1	-1.0	277.9	0.1	280.2	-2.1
N	277.6	278.6	-1.0	277.5	0.1	279.8	-2.2
O	278.1	279.1	-1.0	278.0	0.1	280.1	-2.0
P	278.8	279.8	-1.0	278.7	0.1	280.5	-1.7
Maximum	283.9	284.9		283.9		284.9	
Minimum	277.6	278.6		277.5		279.8	

Note: Point locations are shown in Figure 29. All simulated groundwater elevations are from model layer 1. Values shown above have been rounded from the complete simulated results. Consequently, there may be slight discrepancies in the difference columns as they are based on the complete simulated values and not the rounded values above.



Notes: See Section 1.2 for names of Unit 3 structures.

Figure 1. Site Map Showing Proposed Unit 3 Structures and Observation Wells



Source: Powell and Abe (1985)

Figure 2. Conceptual Illustration of Piedmont Groundwater Flow Paths

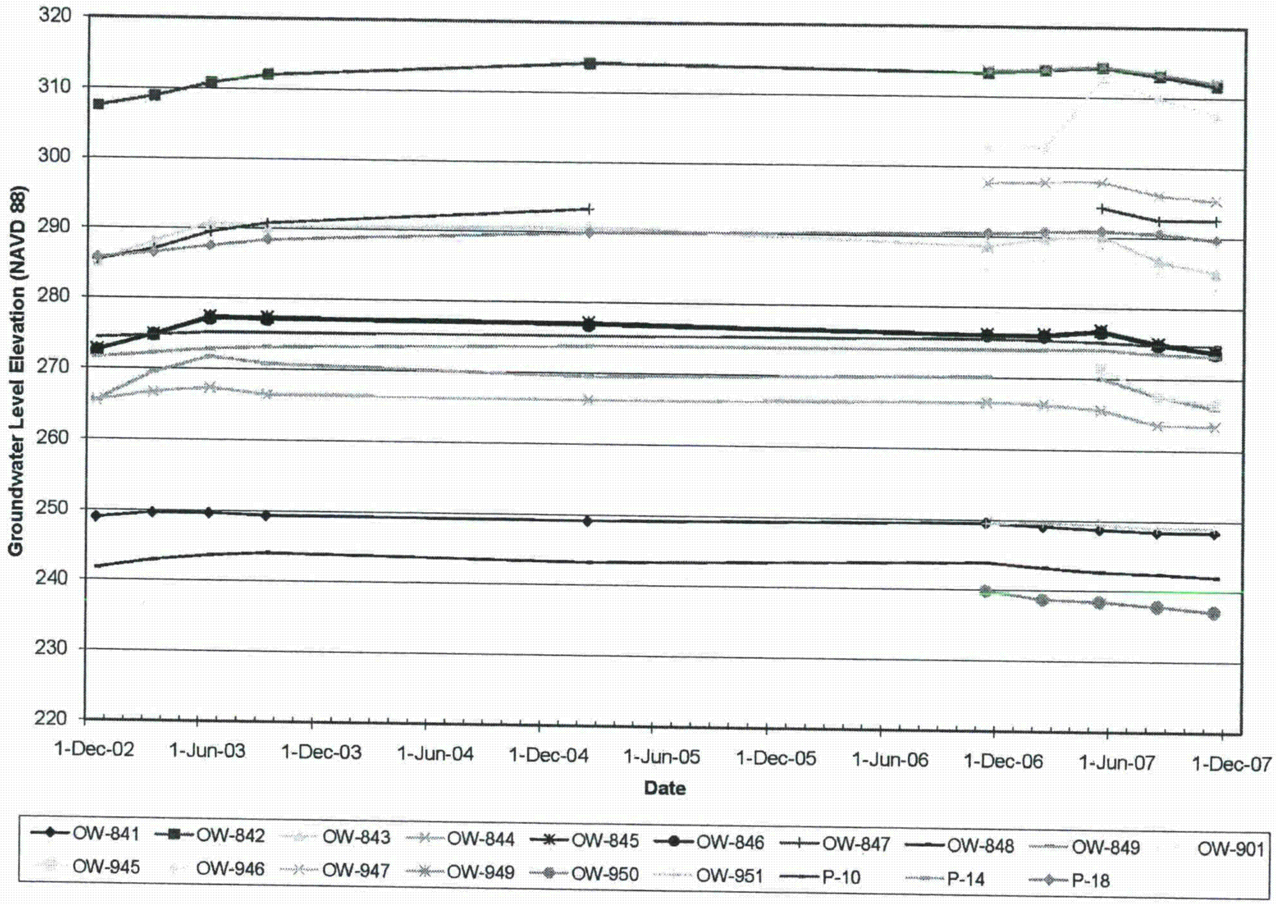
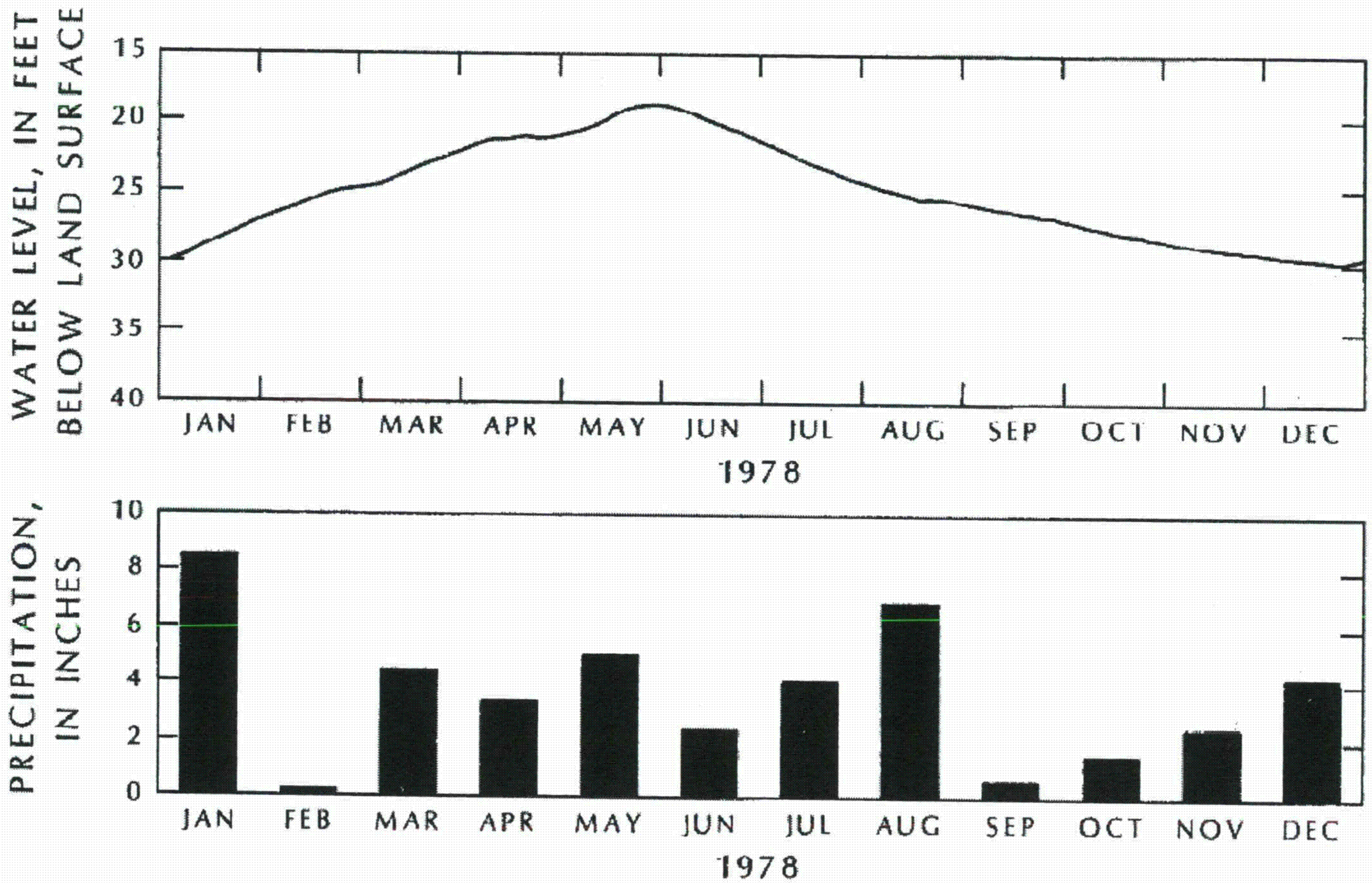


Figure 3. Groundwater Observation Well Hydrographs



Source: Powell and Abe (1985)

Figure 4. Seasonal Variation of Groundwater Levels for Louisa County

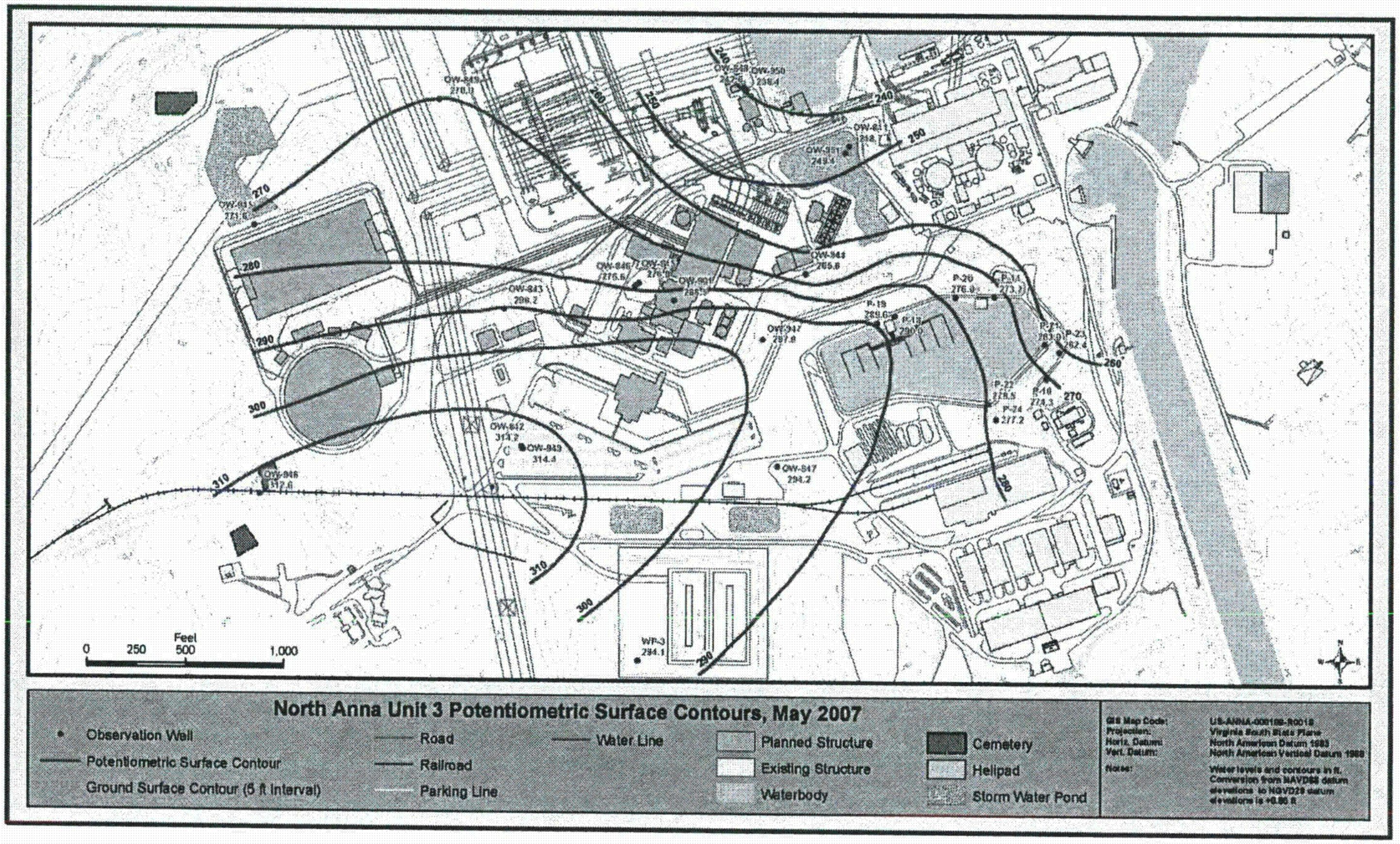
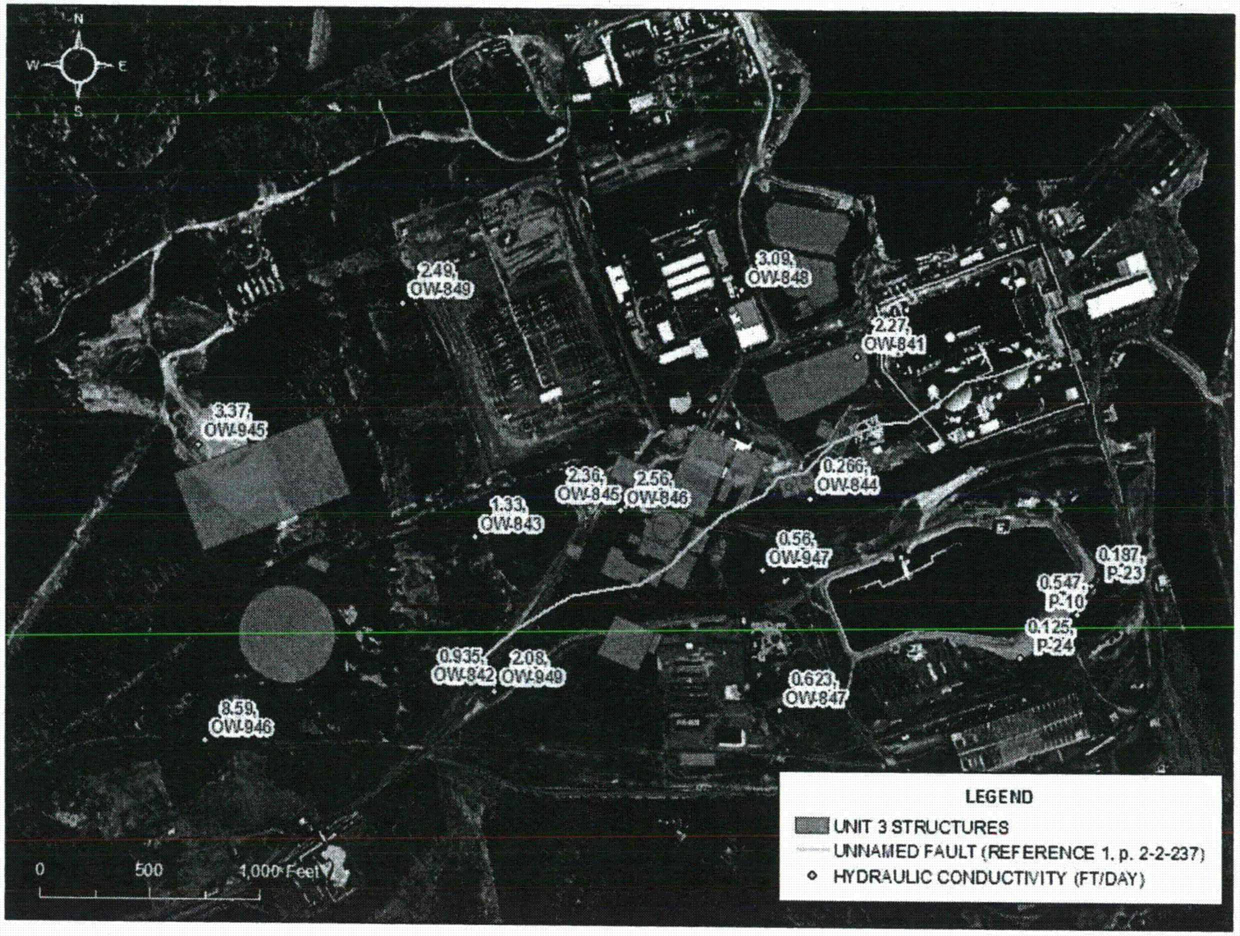
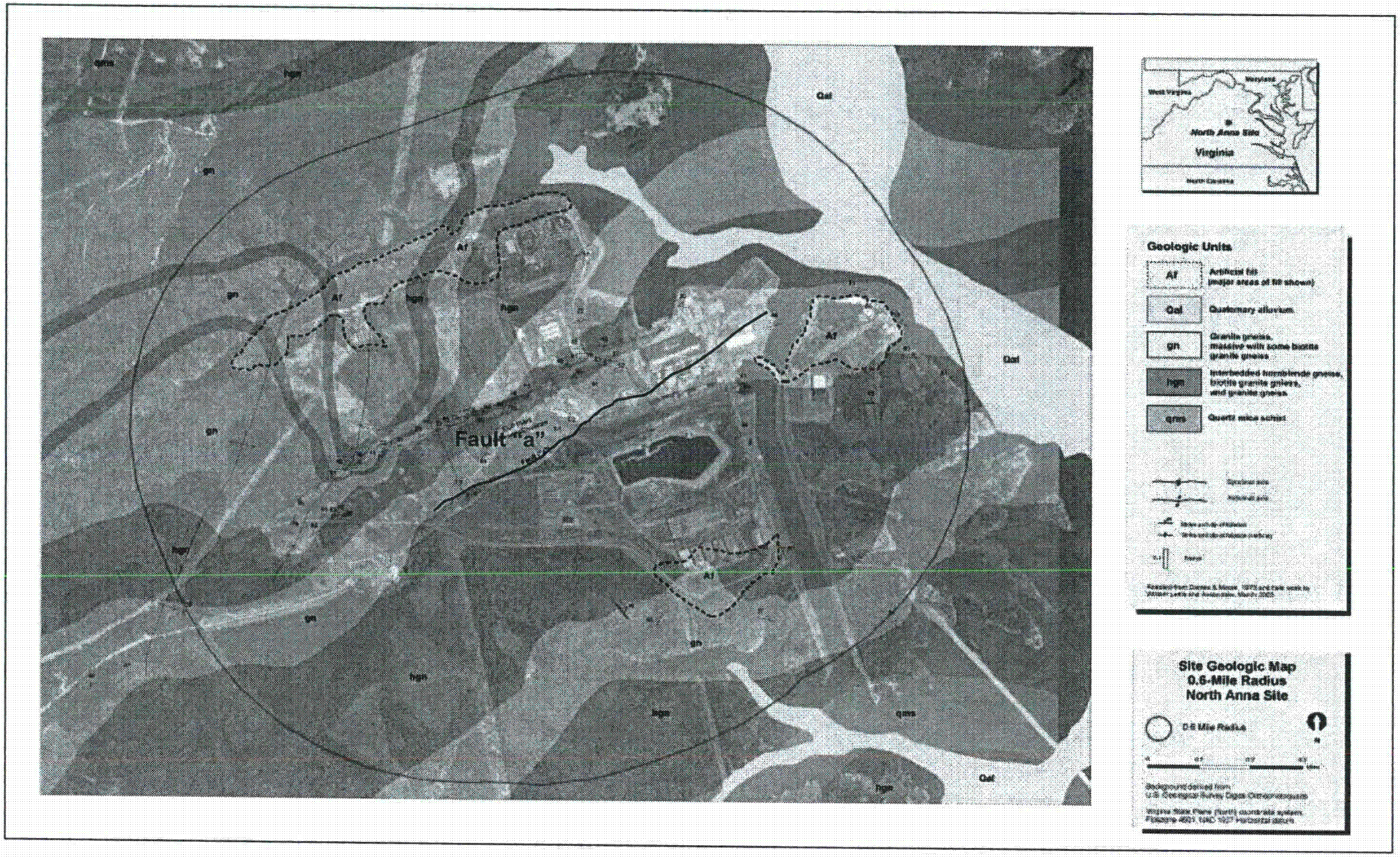


Figure 5. Piezometric Surface Contour Map: May 2007



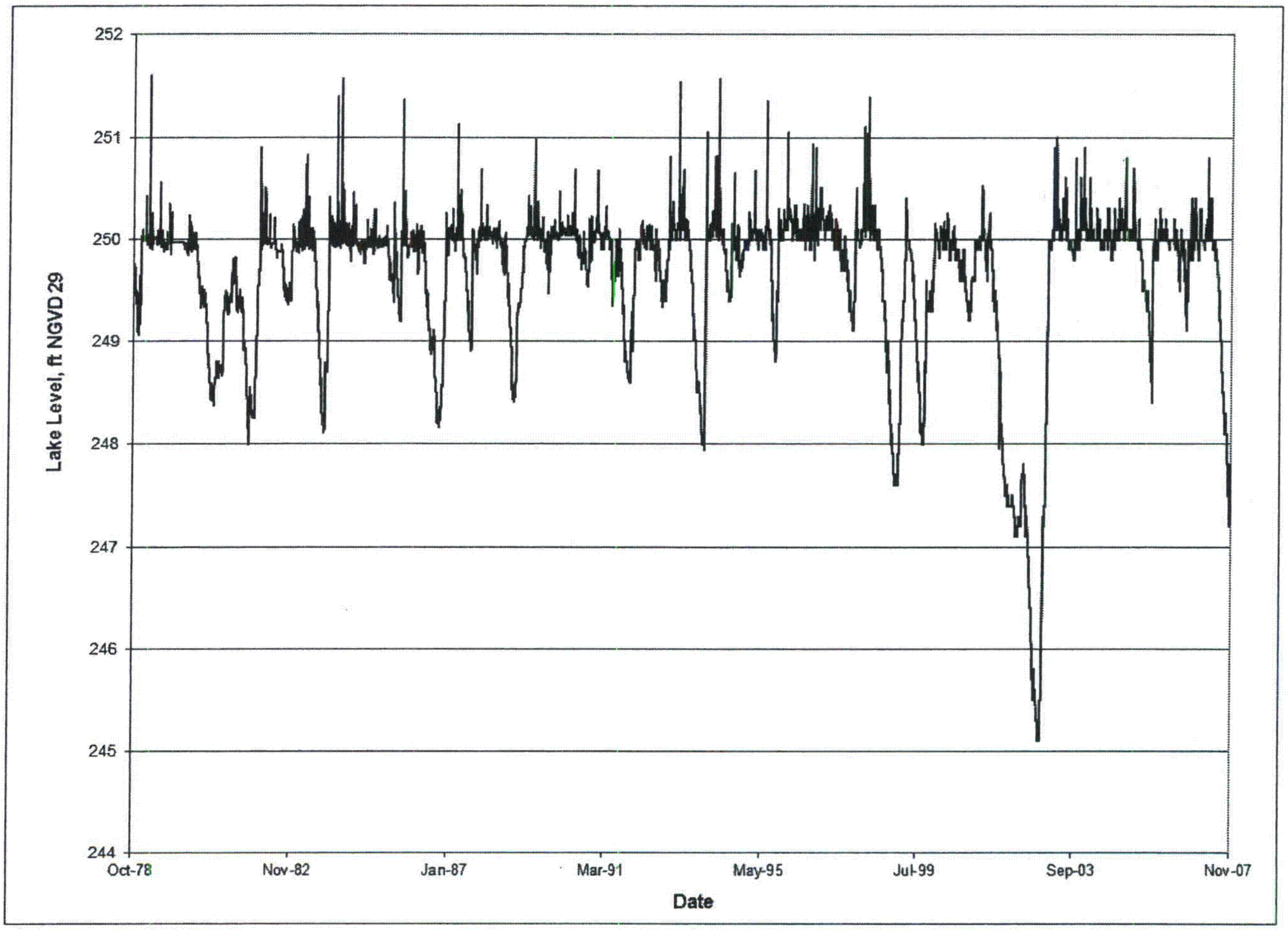
Note: Reference 1 in the figure legend refers to Dominion (2006). Geometric means in above figure from Table 2.

Figure 6. Geometric Mean of Hydraulic Conductivity (ft/day) from Slug Tests



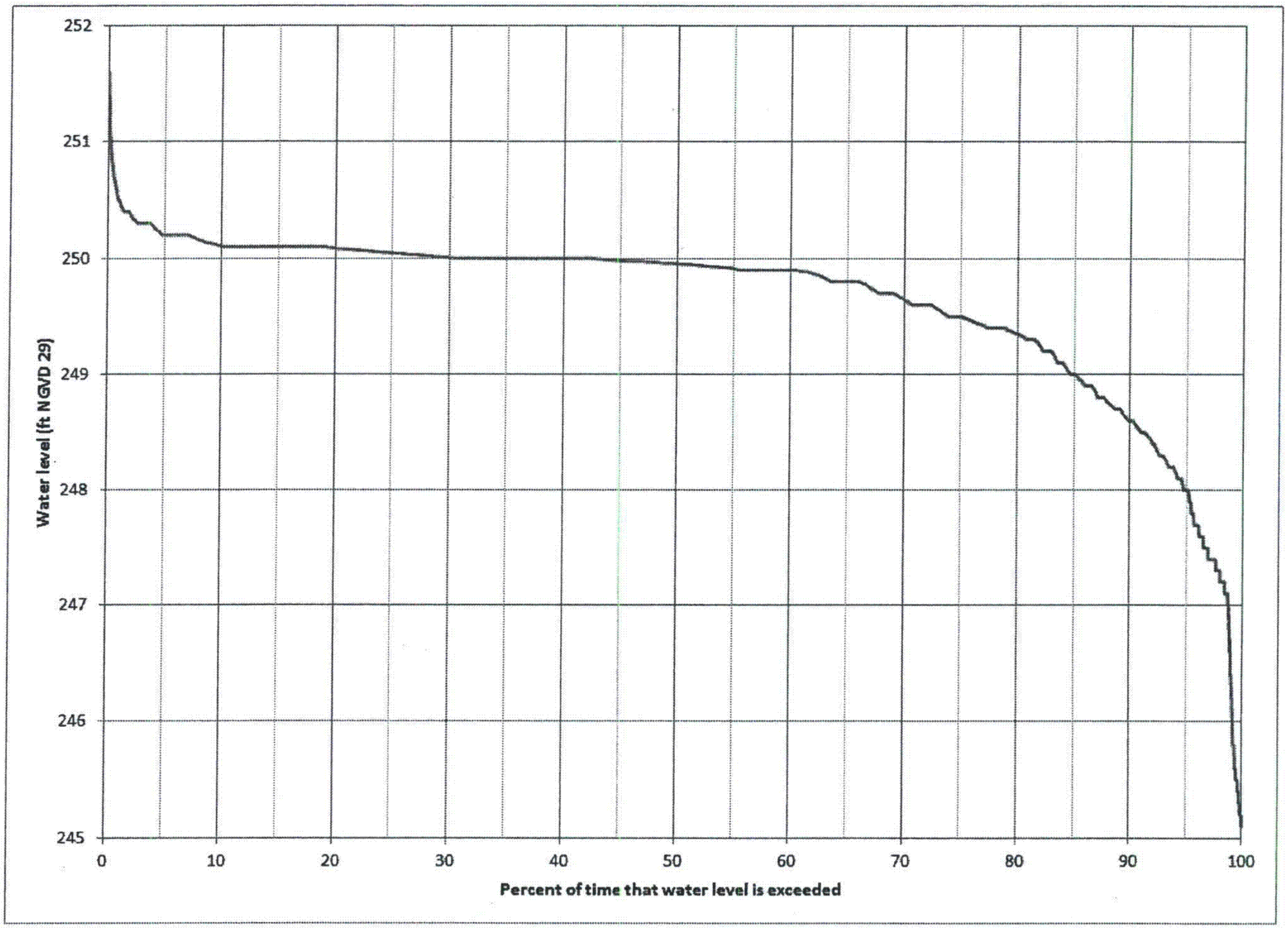
Source: Dominion (2006).

Figure 7. Unnamed Fault at Unit 3 Site



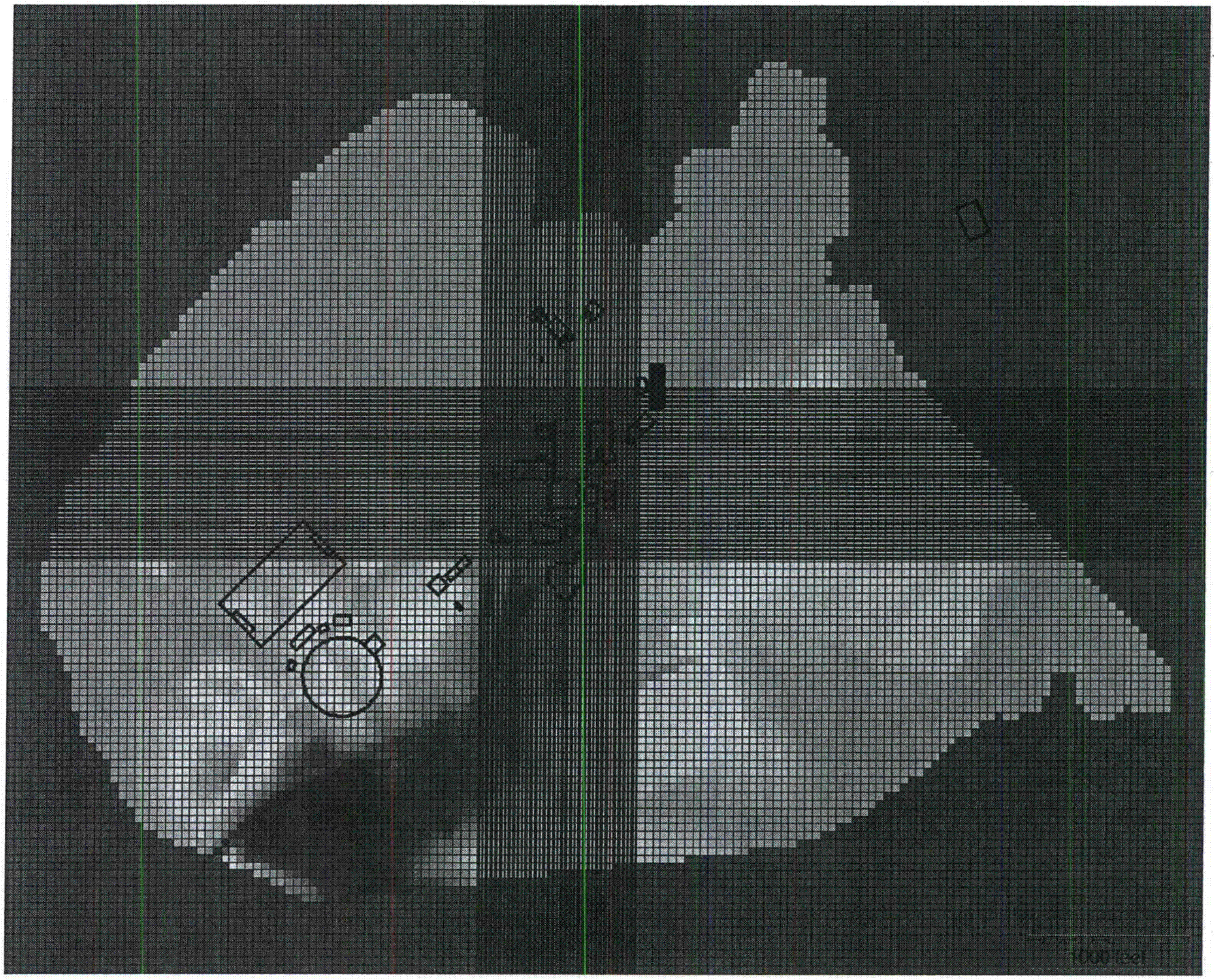
Note that water levels are recorded in ft NGVD 29 by Dominion.

Figure 8. Lake Anna Water Level from October 1978 through October 2007



Note that water levels are in ft NGVD 29.

Figure 9. Duration Curve of Lake Anna Daily Water Levels



Note: Color flood corresponds to ground surface elevation (see Figure 11). Building outlines indicate Unit 3 structures.

Figure 10. Numerical Grid for Unit 3 Model

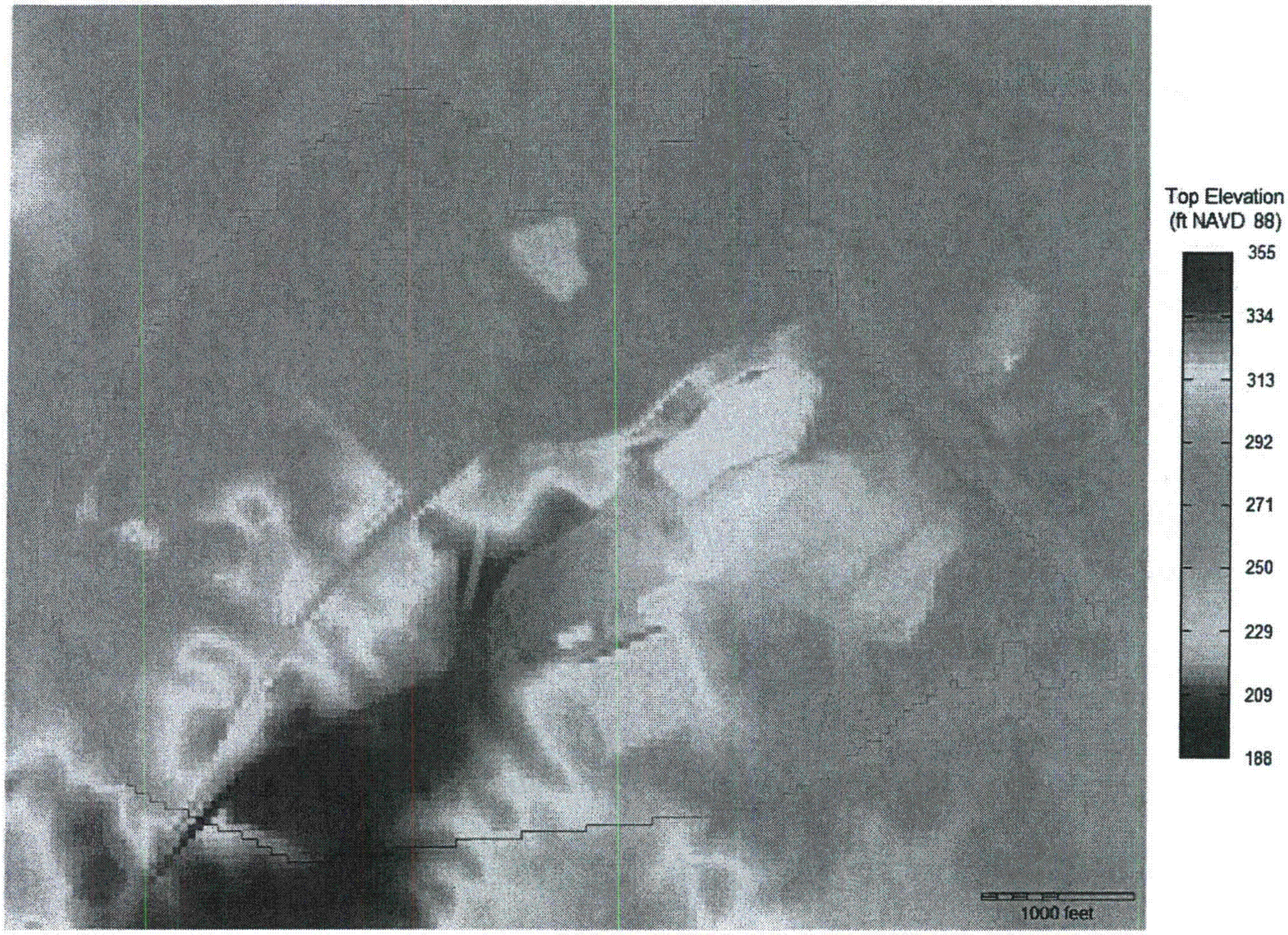


Figure 11. Model Layer 1 Top Elevation (Ground Surface)

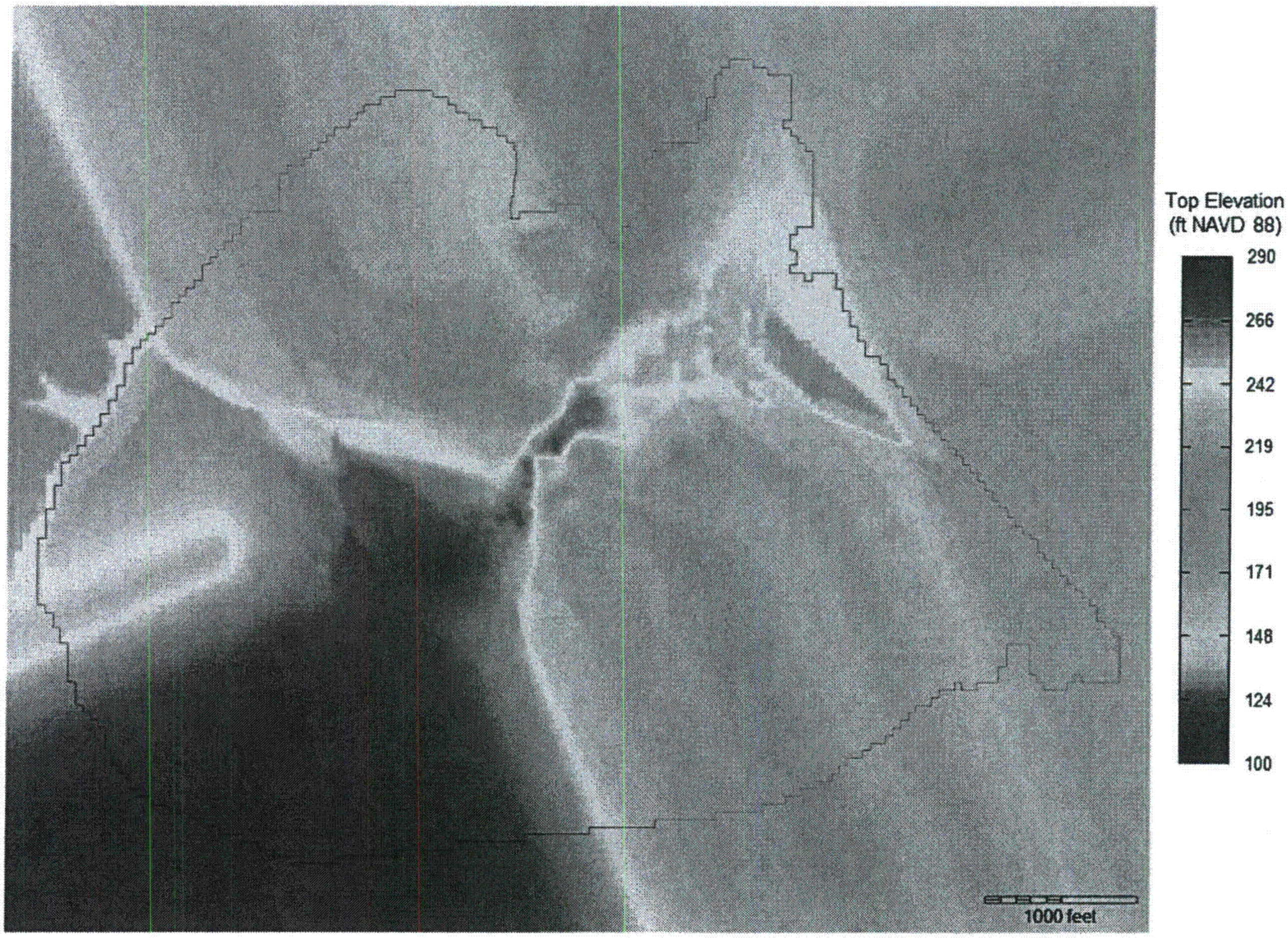


Figure 12. Model Layer 1 Bottom Elevation

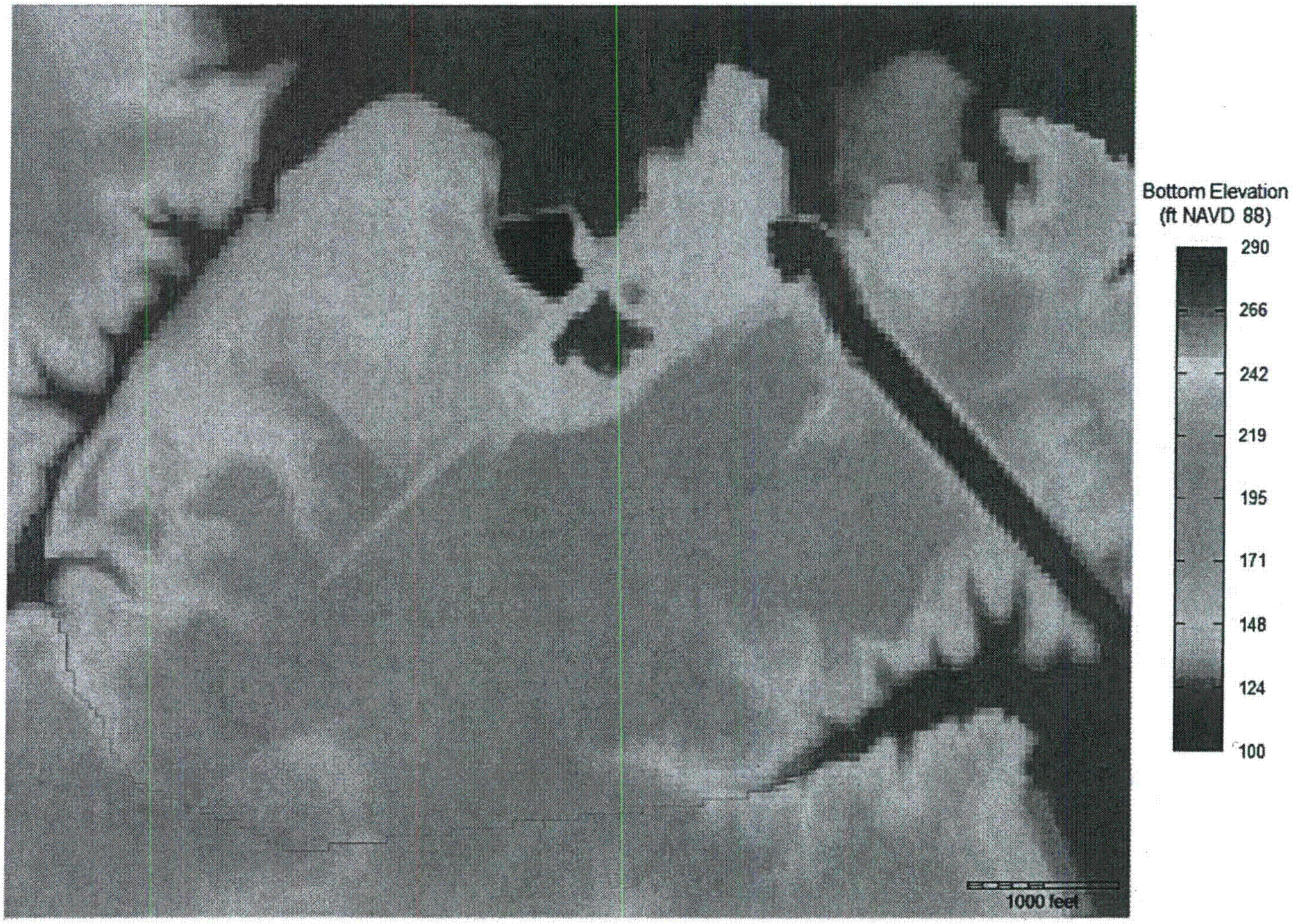
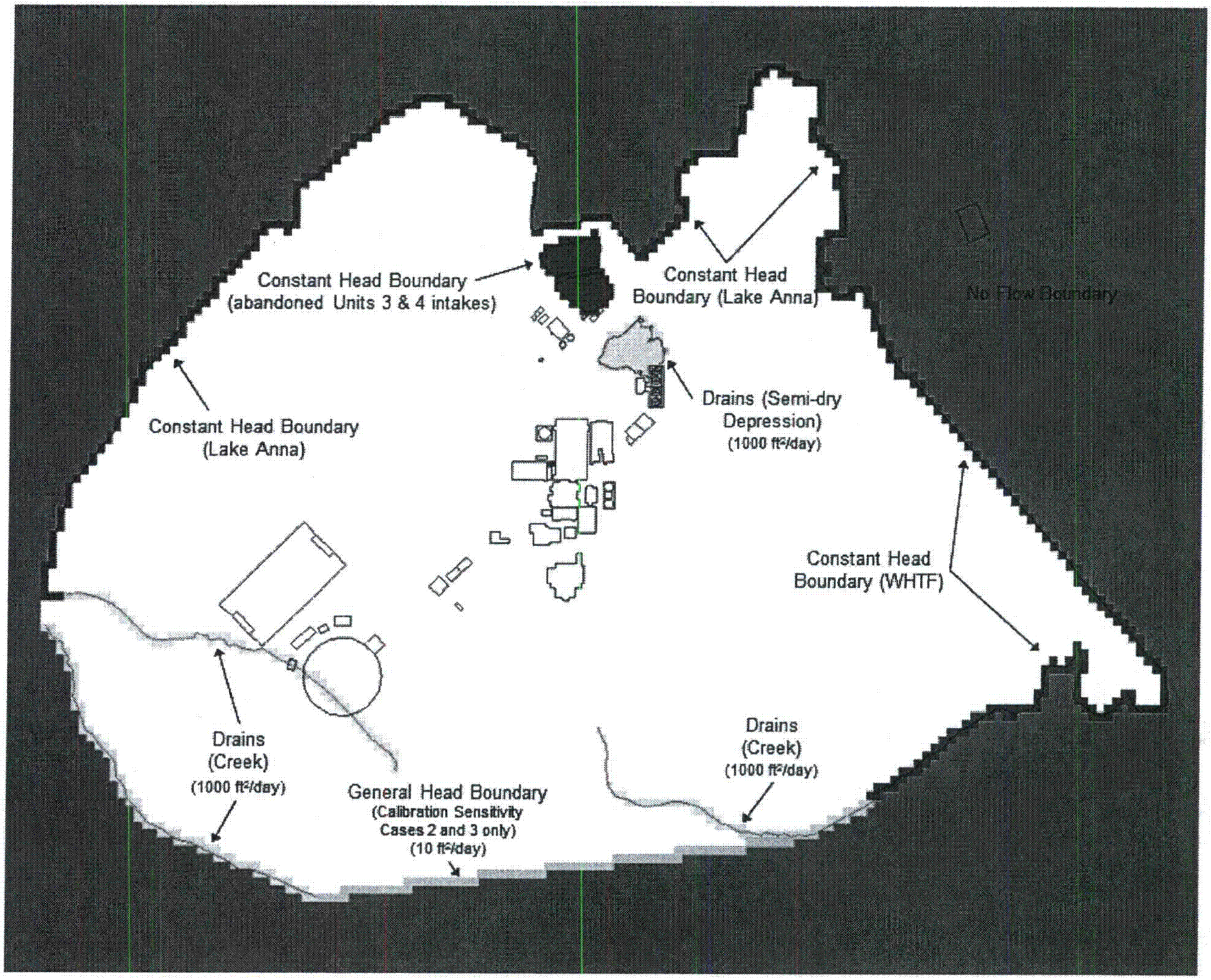
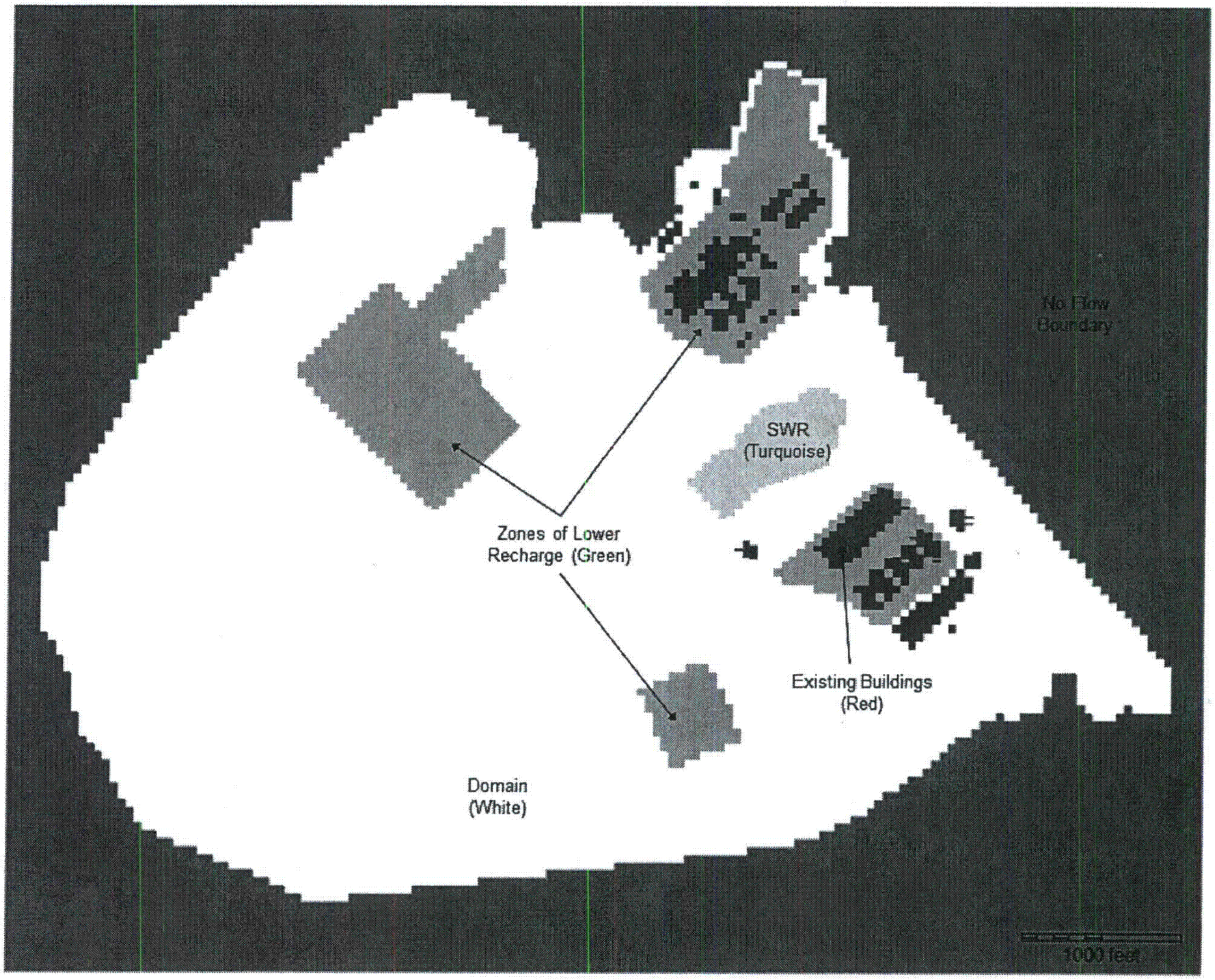


Figure 13. Model Layer 2 Bottom Elevation



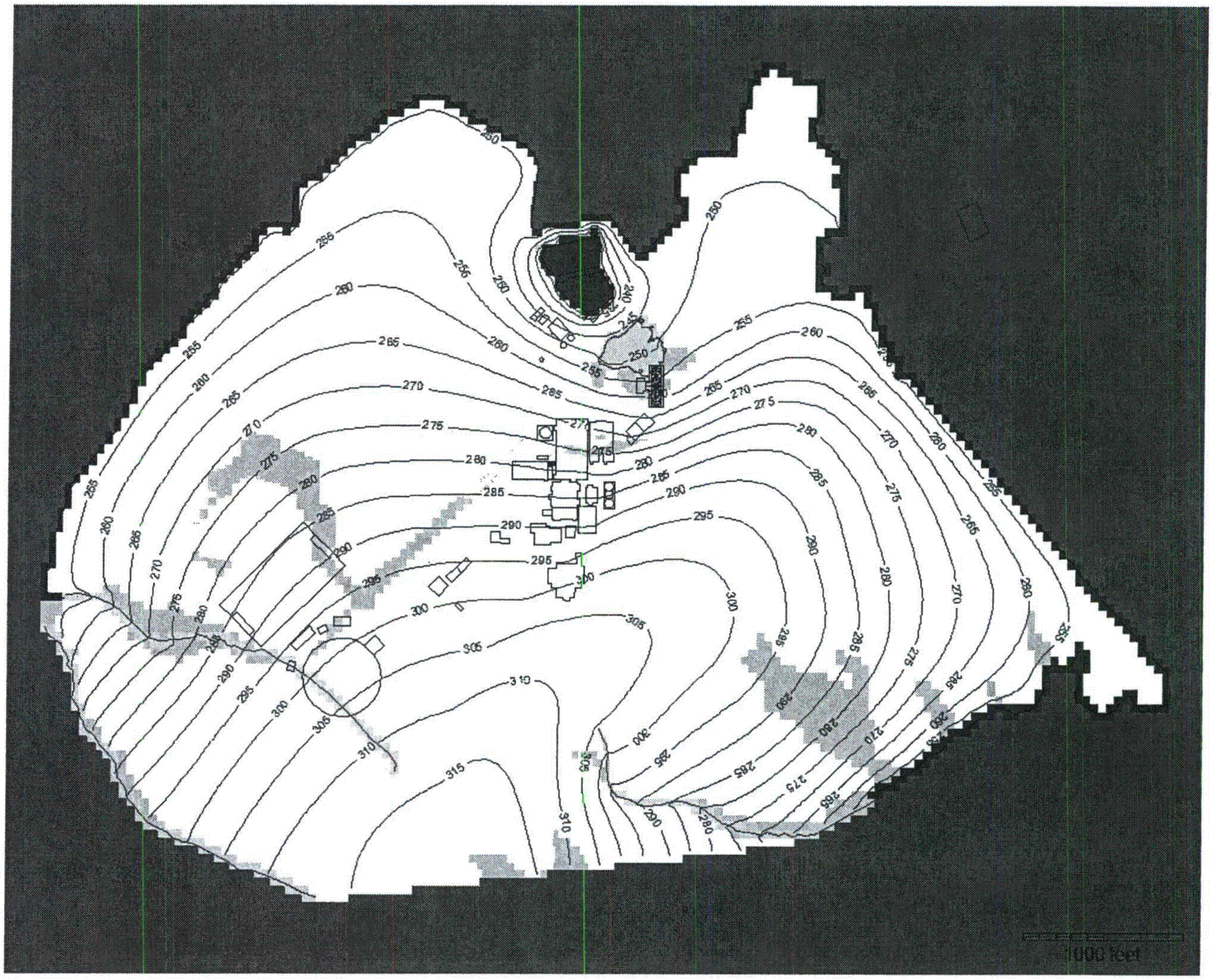
Note: Building outlines indicate Unit 3 structures.

Figure 14. Calibration Boundary Conditions



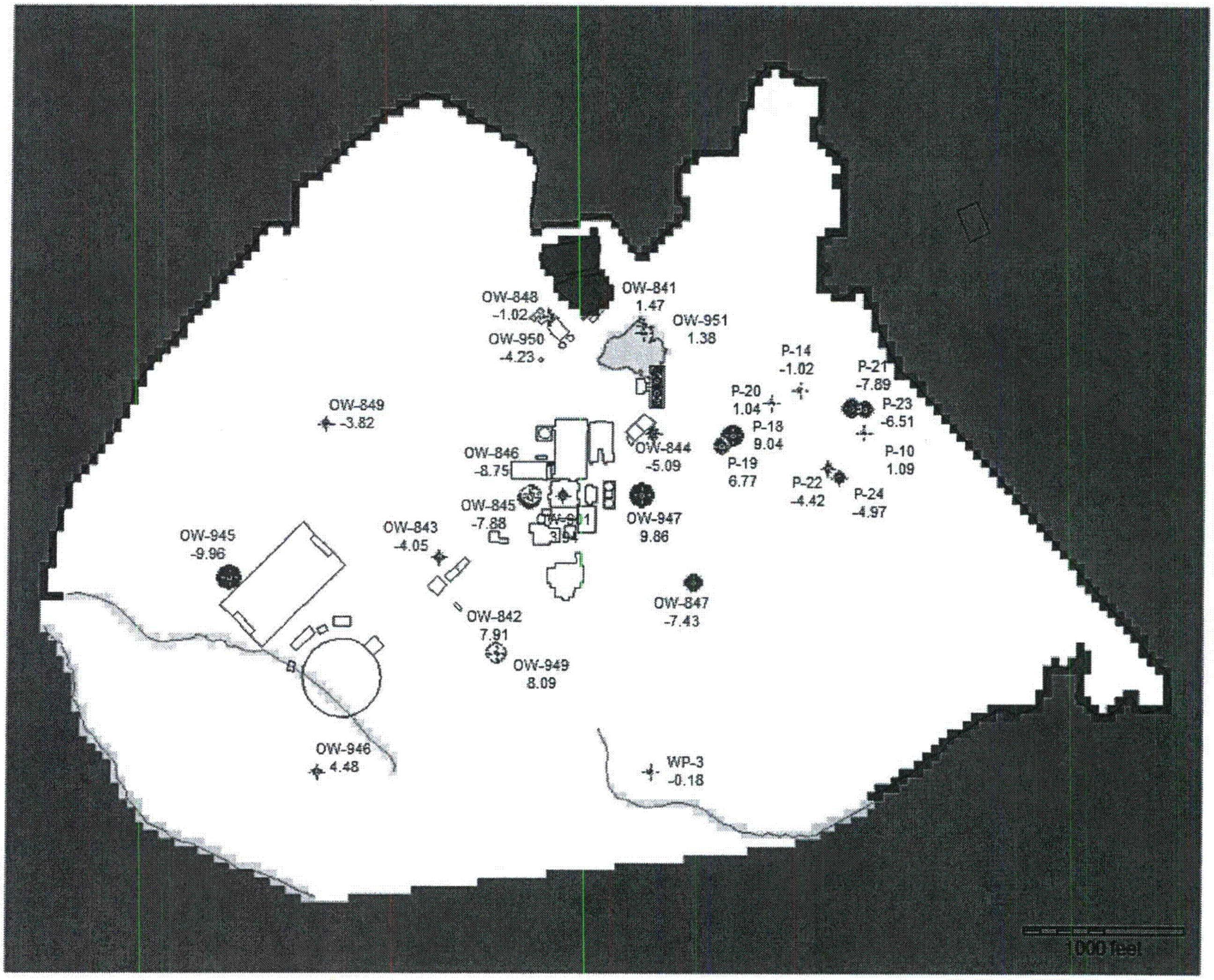
Notes: Recharge for the domain (white, R_1=0.0025 ft/day [11.0 in/yr]), lower recharge areas (green, R_2=0.0004655 ft/day [2 in/yr]), the Service Water Reservoir (turquoise, R_3=0.0033 ft/day [14.5 in/yr]), and existing buildings (i.e., Units 1 & 2) (red, R_4=0 ft/day).

Figure 15. Calibration Recharge Zones



Notes: Yellow shading indicates drain cells, blue cells indicate constant heads, turquoise cells indicate flooded cells, and gray cells indicates no flow boundary condition cells.

Figure 16. Calibration Base Case Simulated Groundwater Elevations



Notes: Residual are defined as observed minus calculated. Building outlines indicate Unit 3 structures. Yellow shading indicates drain cells, blue indicates constant head cells, light blue indicates flooded cells, gray cells indicates no flow boundary cells.

Figure 17. Calibration Base Case Residuals

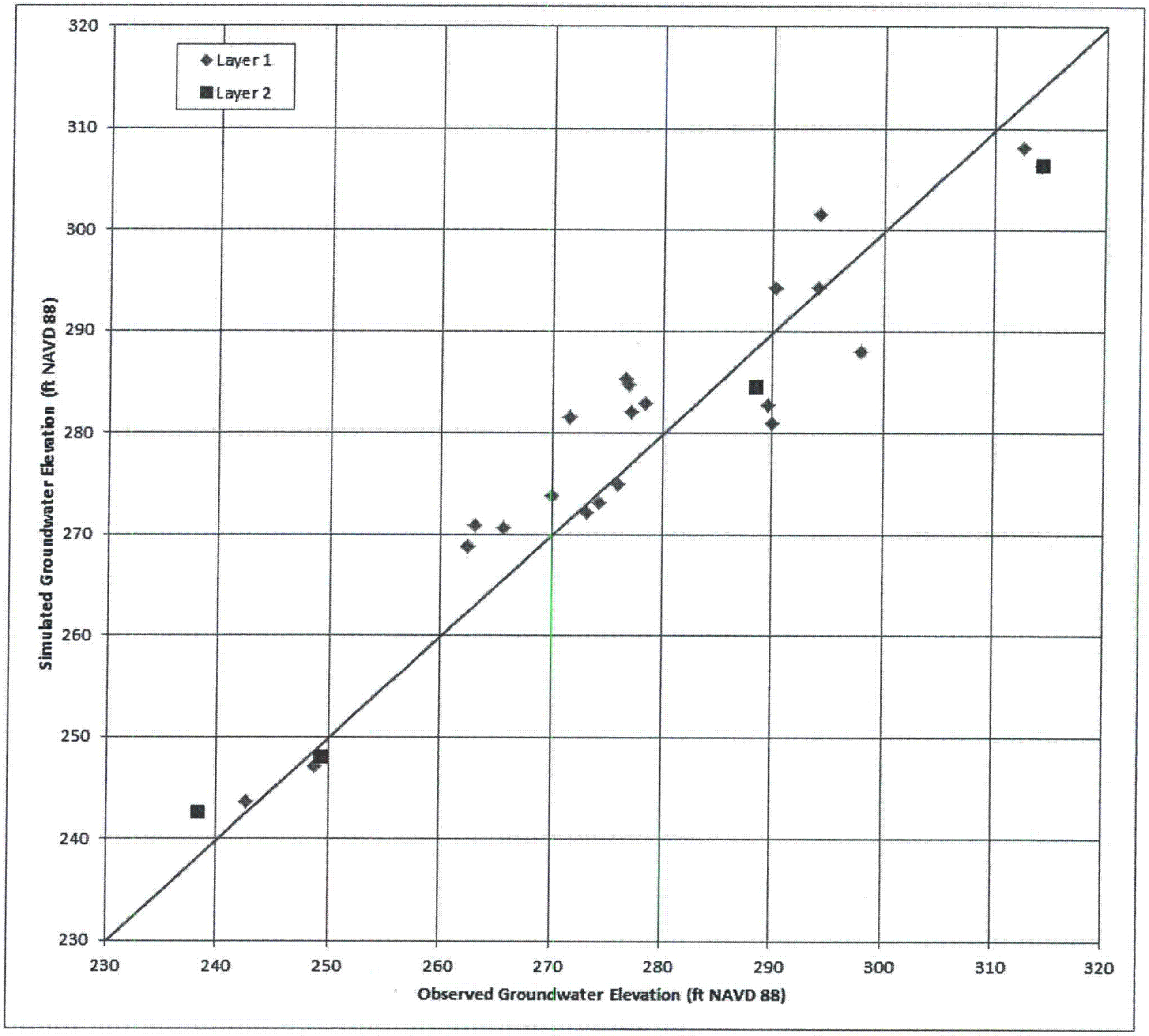


Figure 18. Calibration Base Case Calculated vs. Observed Heads

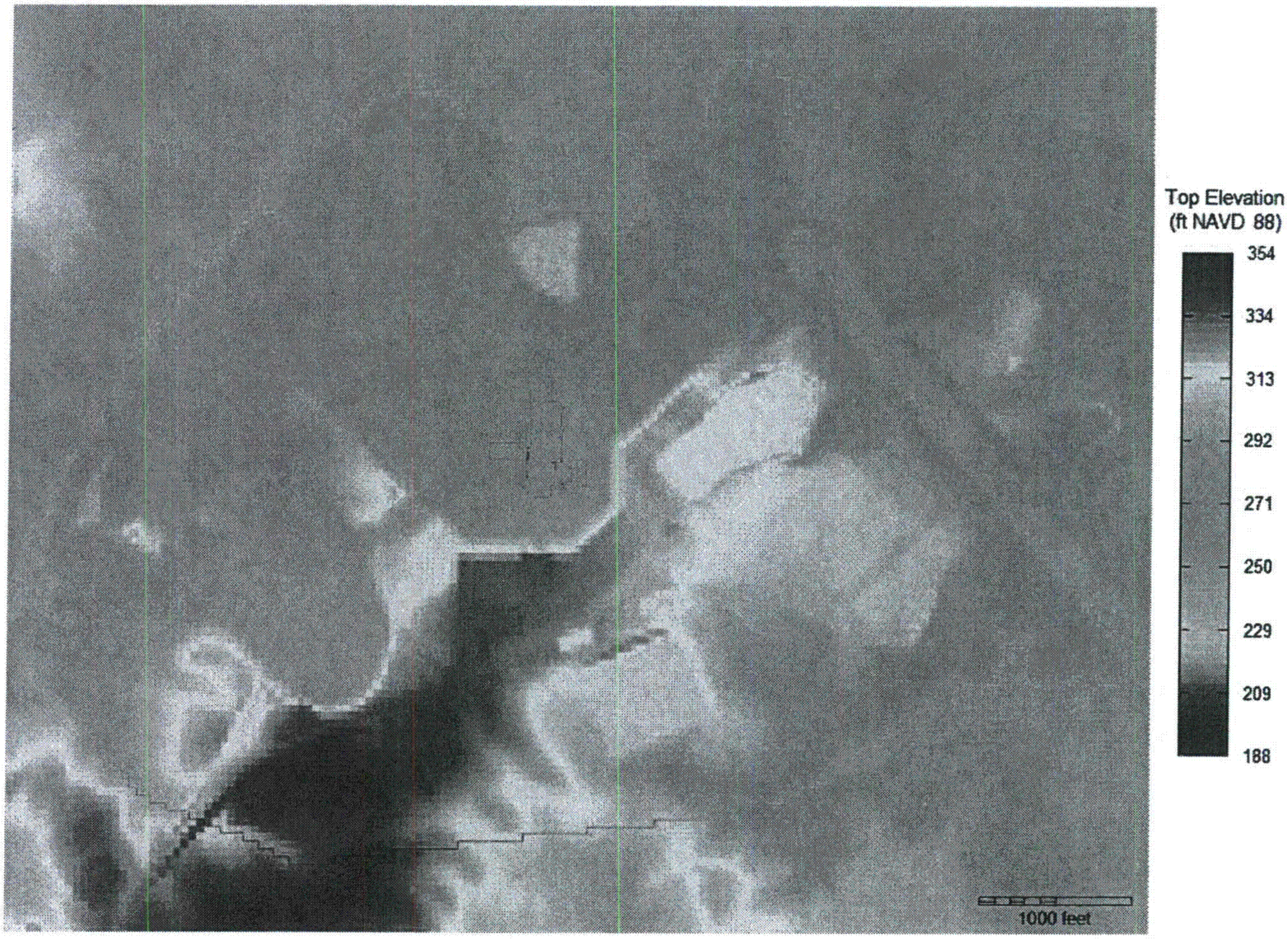
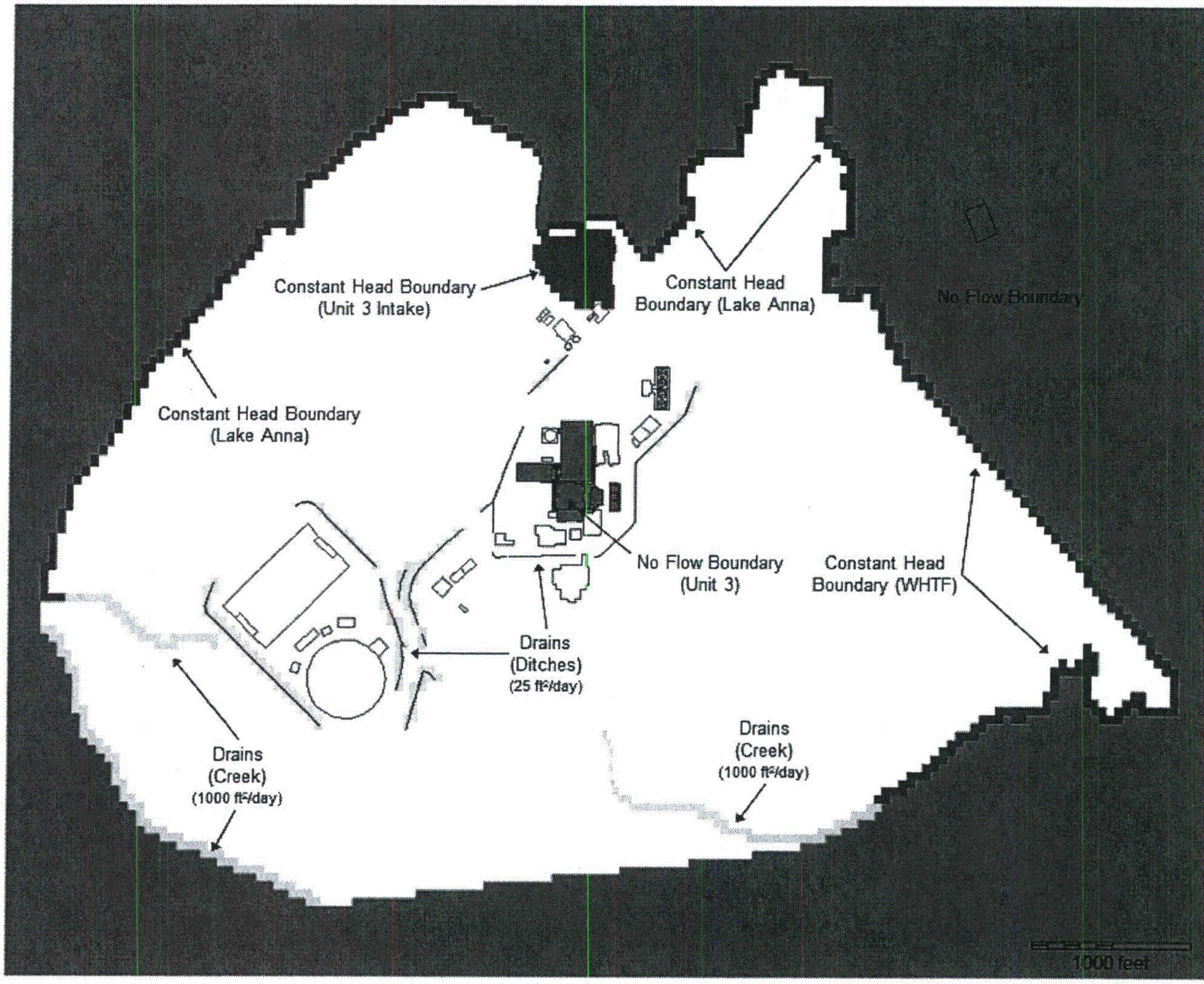


Figure 19. Post-Construction Model Layer 1 Top Elevation (Finish Grade)



Notes: Building outlines indicate Unit 3 structures. Yellow shading indicates drain cells, blue indicates constant head cells, light blue indicates flooded cells, gray cells indicates no flow boundary cells.

Figure 20. Post-Construction Boundary Conditions

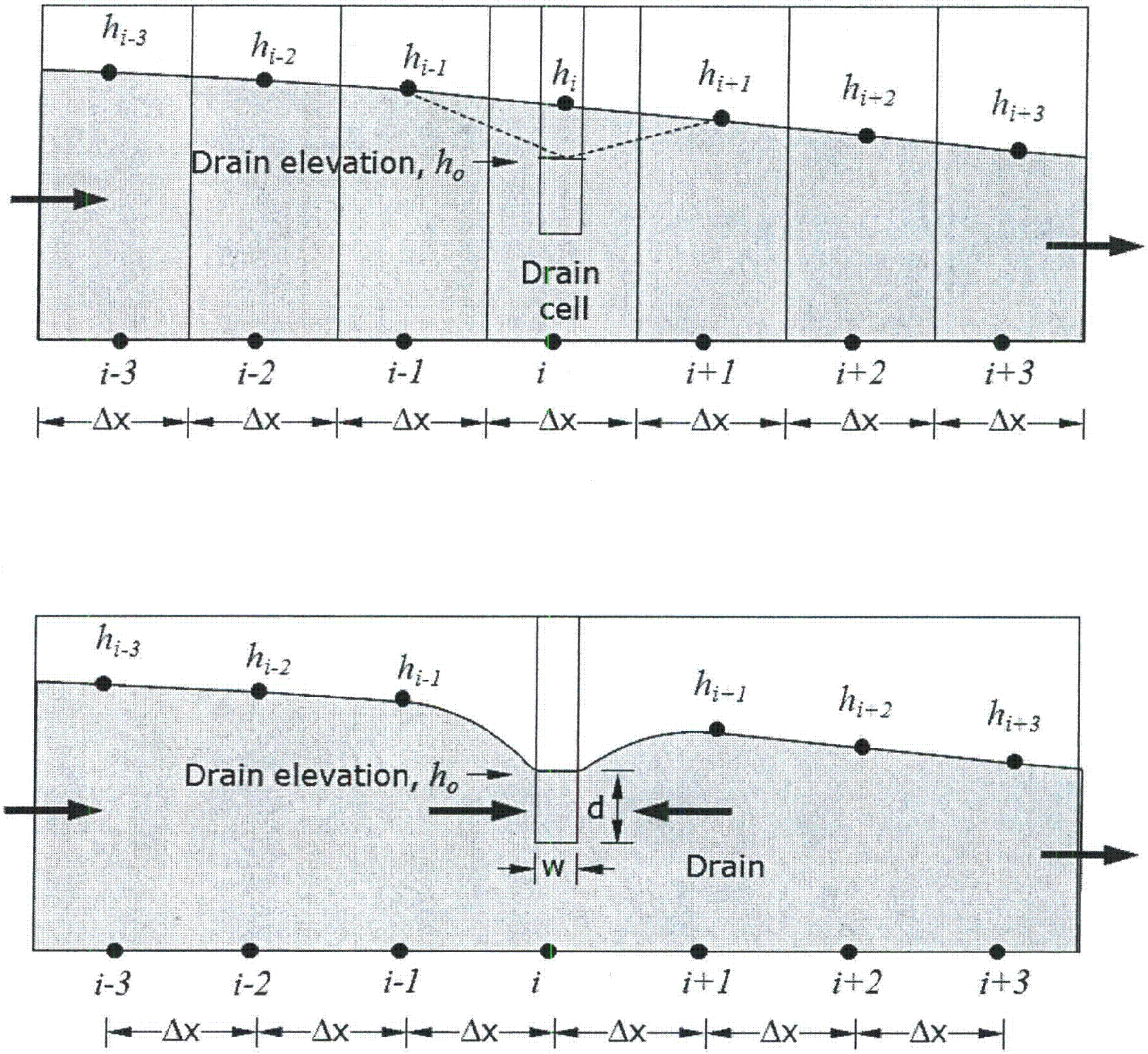
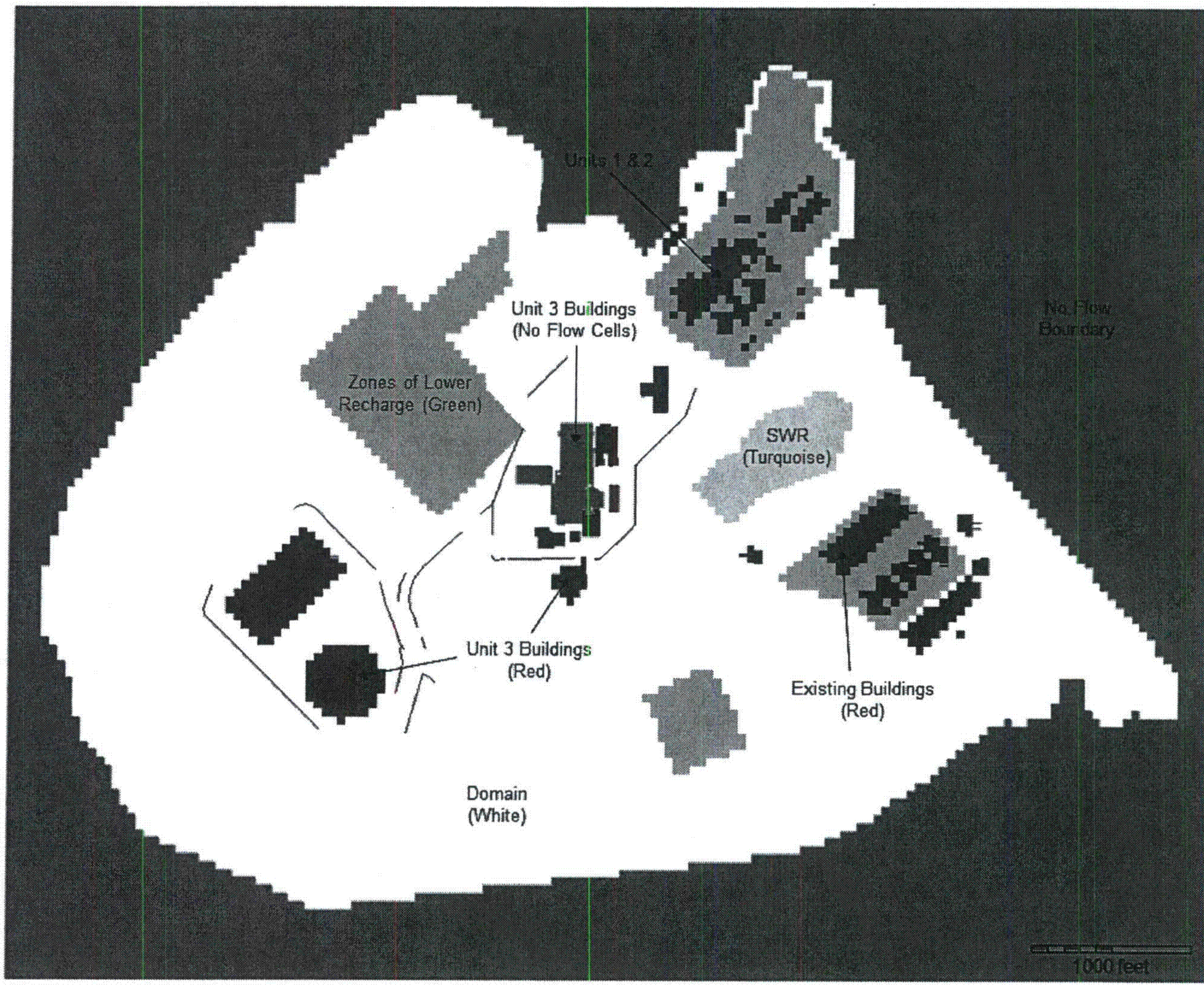
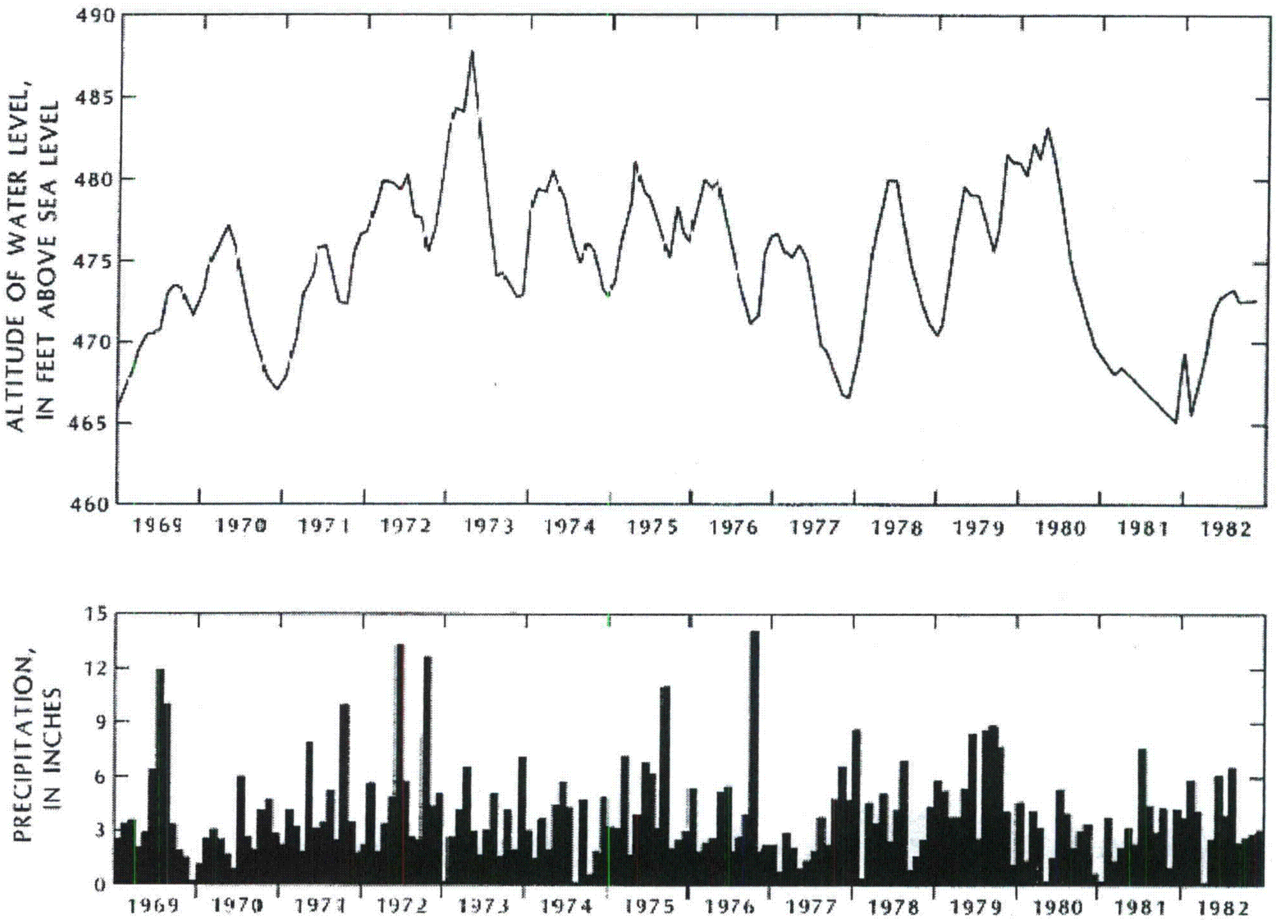


Figure 21. Drain Cells Conceptual Illustration



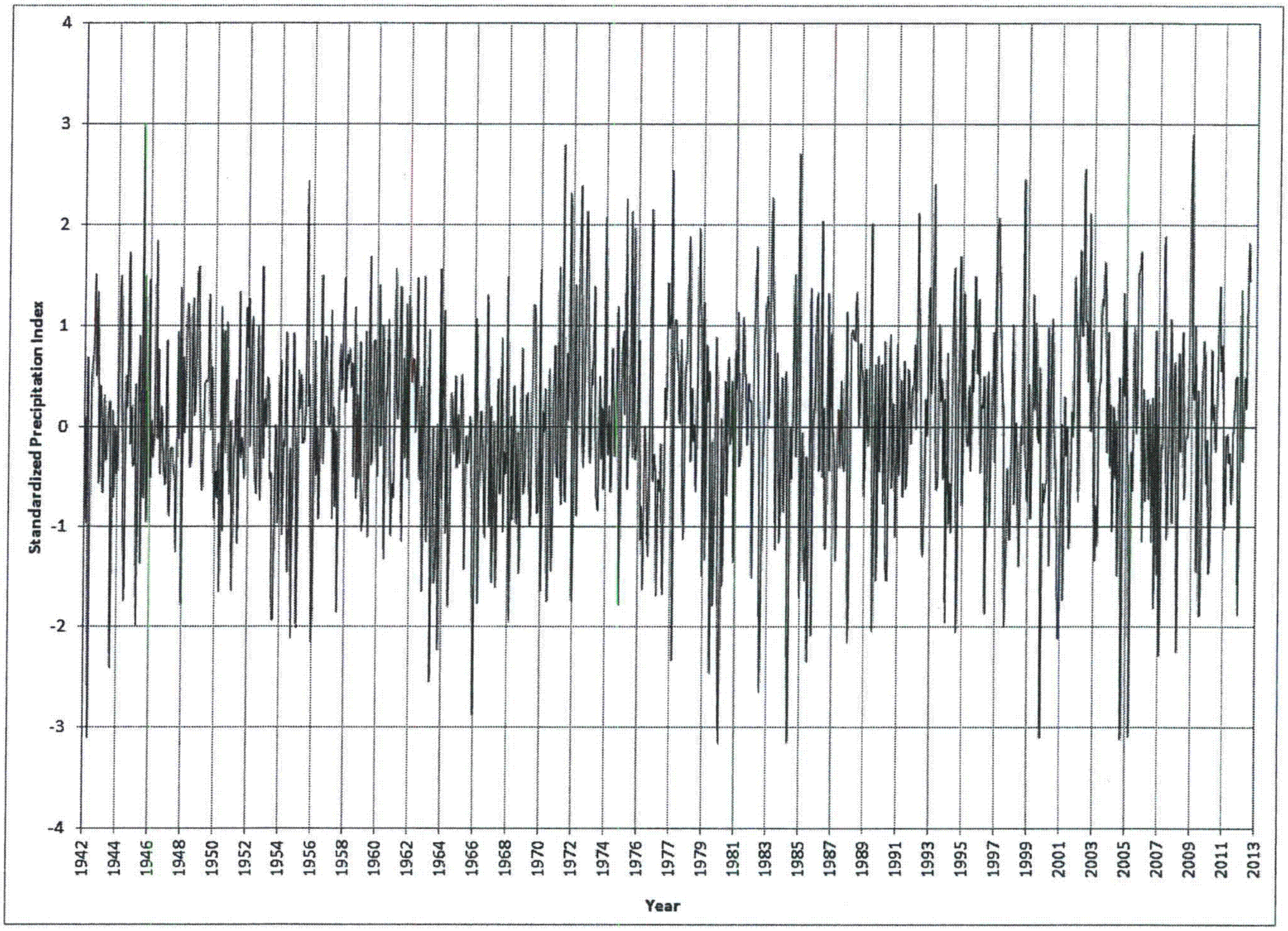
Note: Recharge for the domain (white, R_1=0.0025 ft/day [11.0 in/yr]), lower recharge areas (green, R_2=0.0004655 ft/day [2 in/yr]), the Service Water Reservoir (turquoise, R_3=0.0033 ft/day [14.5 in/yr]), and Unit 3 and existing buildings (i.e., Units 1 and 2) (red, R_4=0 ft/day).

Figure 22. Post-Construction Recharge Zones



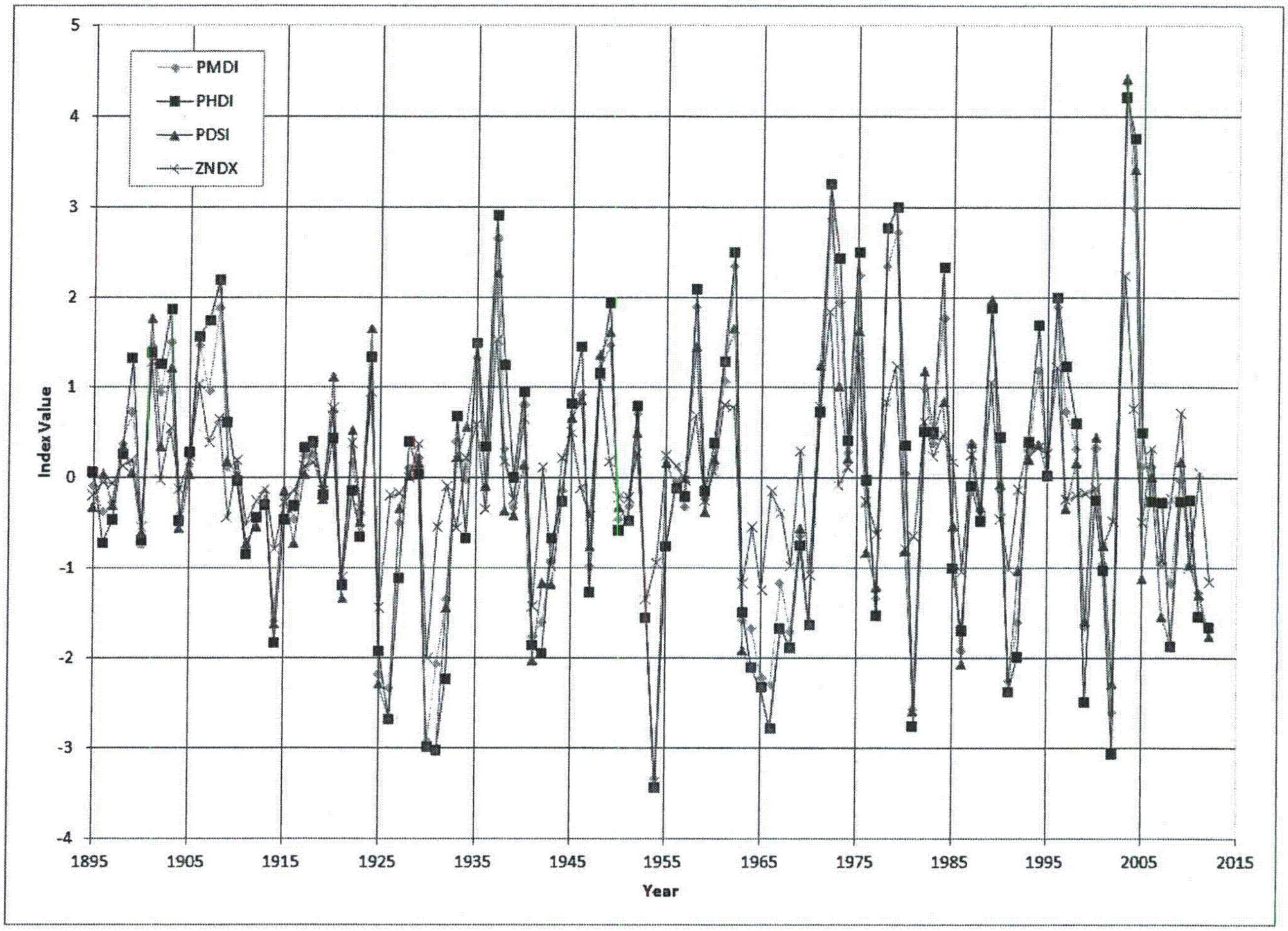
Note: Powell and Abe (1985).

Figure 23. Observation Well Hydrograph, Louisa County, 1969-1982



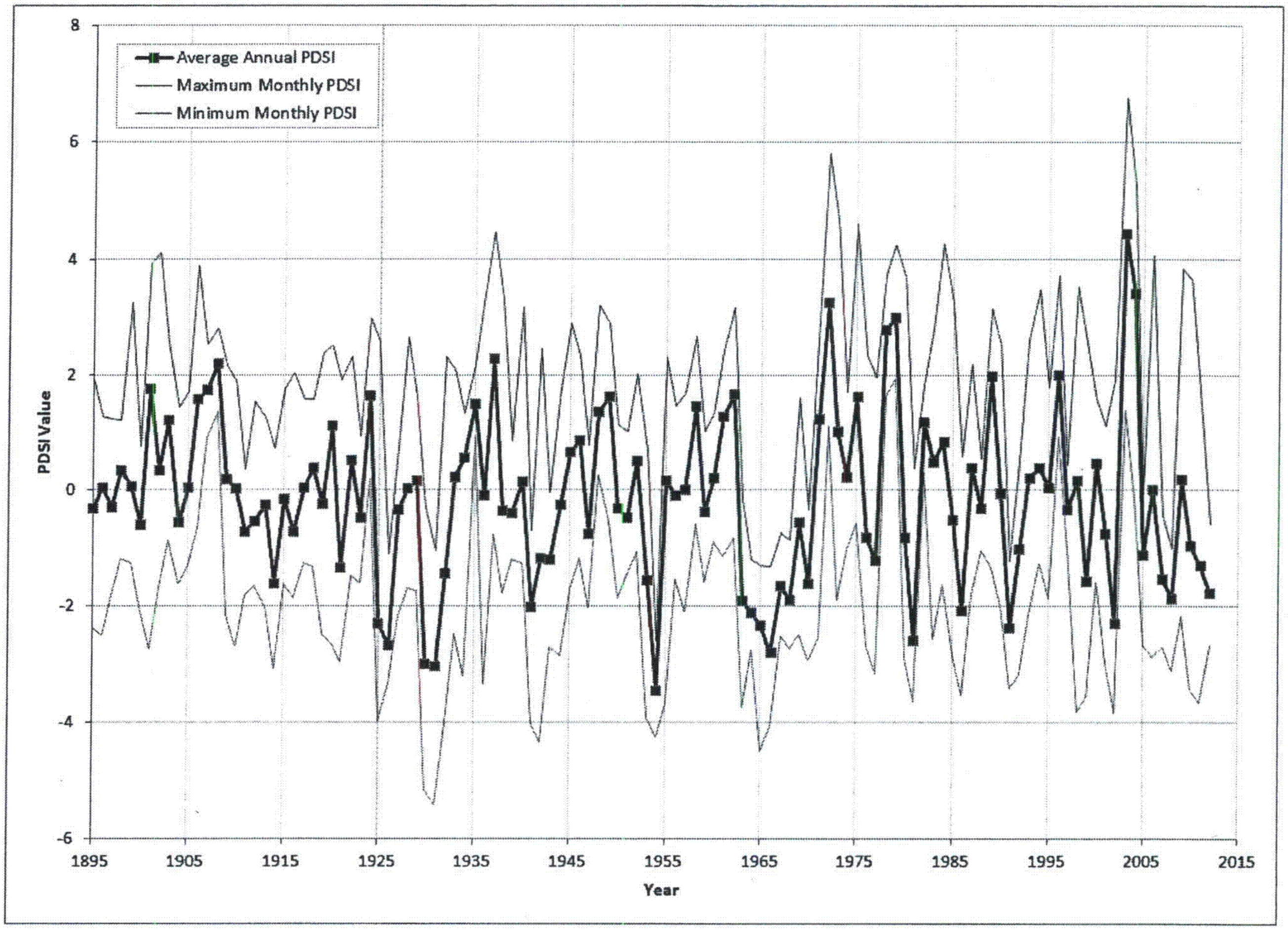
Data Source: NCDC (2013b). Note that SPI data is for the Eastern Piedmont climate division for the state of Virginia.

Figure 24. Standardized Precipitation Index from 1942 to 2012



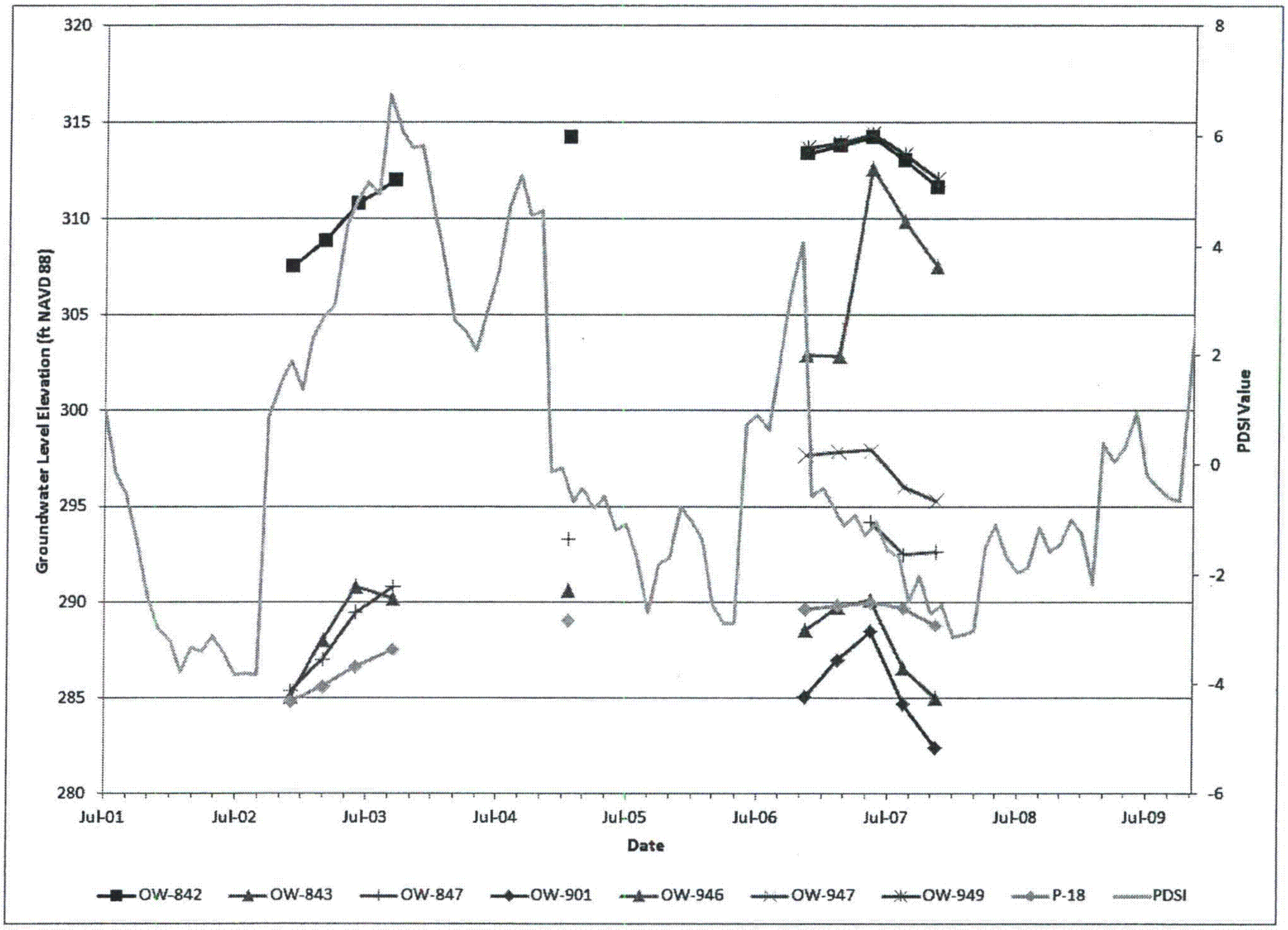
Data Source: NCDC (2013b).

Figure 25. Palmer Drought Indices – Average Annual Values



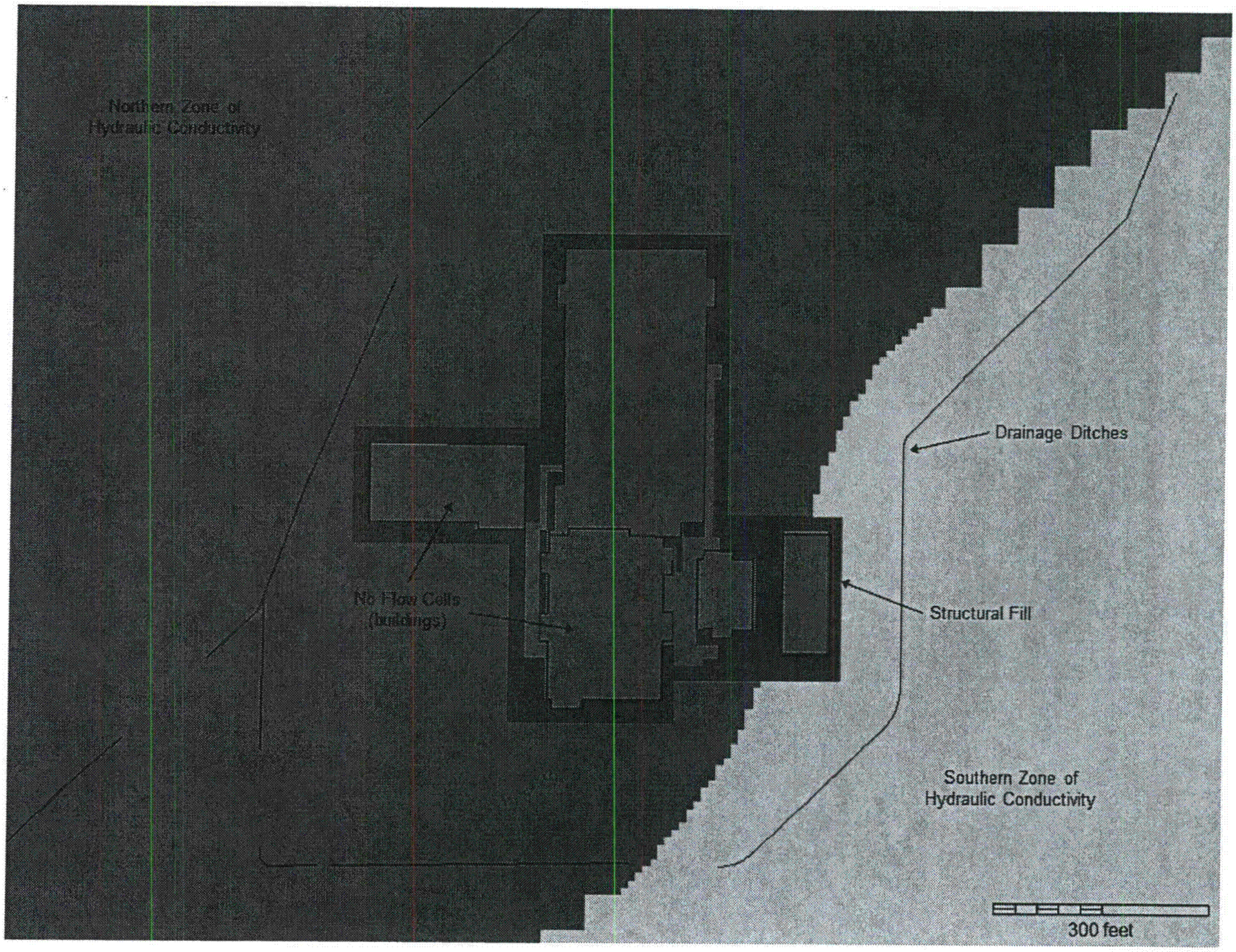
Data Source: NCDC (2013b).

Figure 26. PDSI Monthly Maximum and Minimum and Annual Average Values



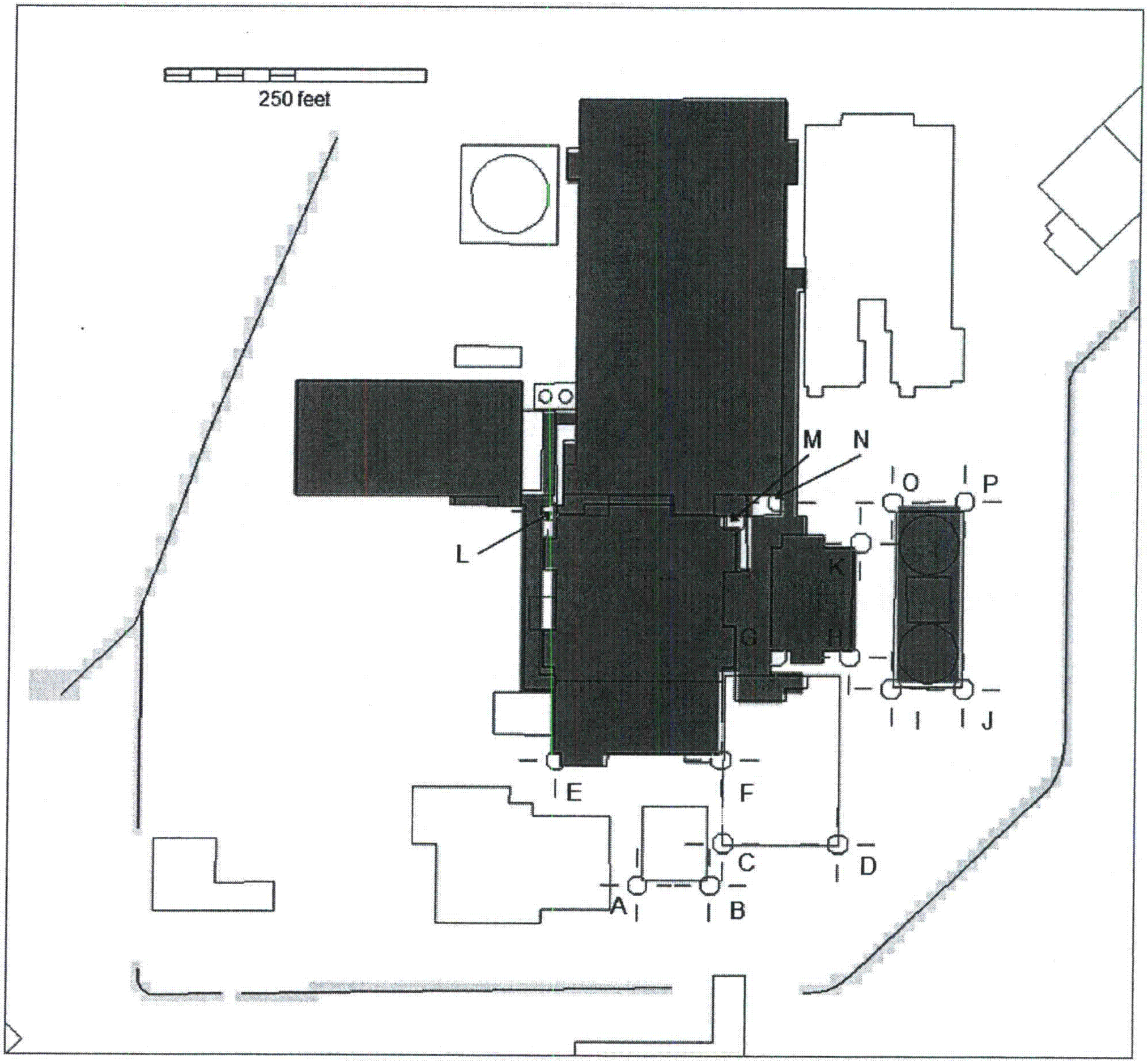
Data Source: NCDC (2013b).

Figure 27. PDSI with Selected Observation Wells



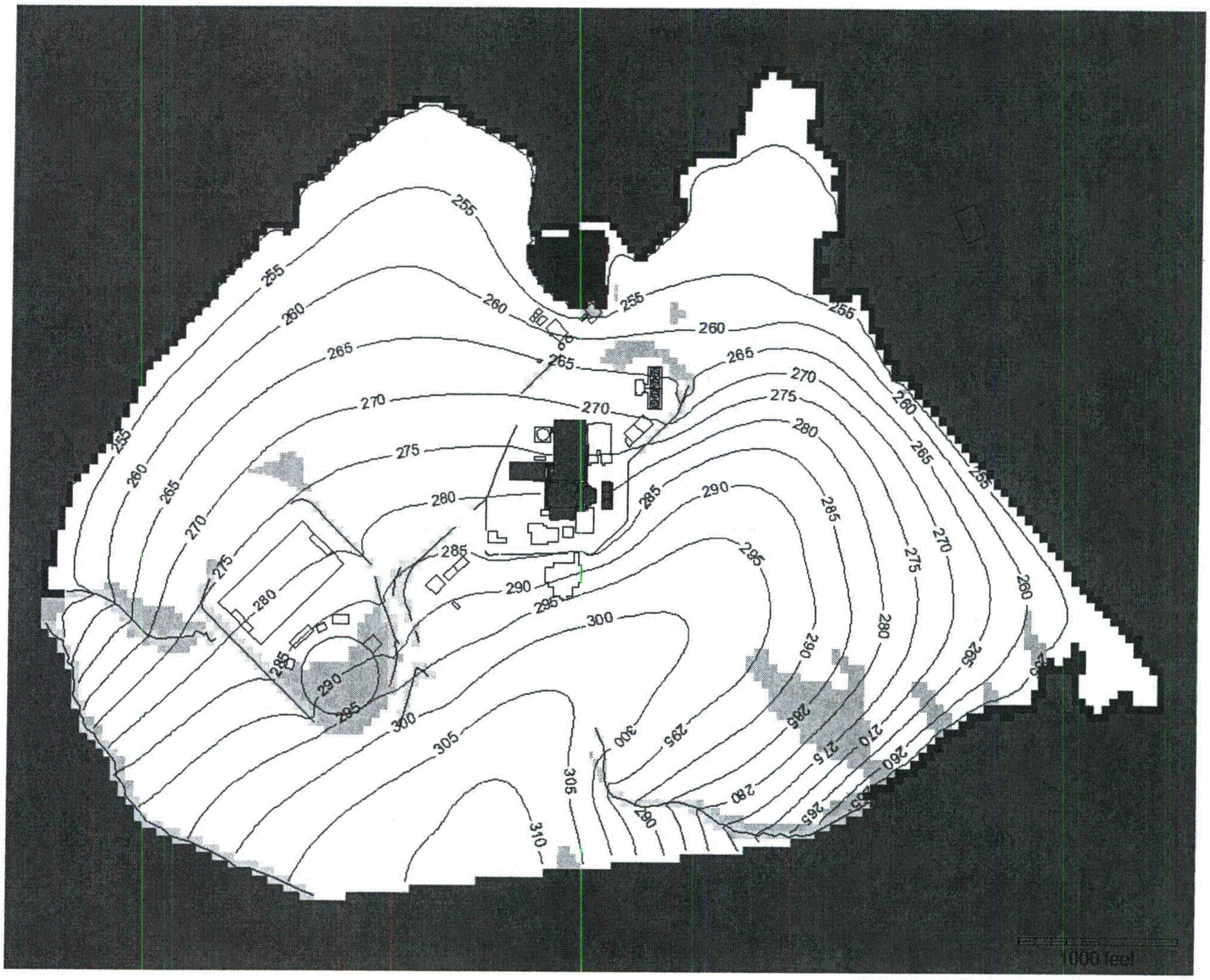
Note: Conductivity for the zones above are as follows: Northern Zone of Hydraulic Conductivity (K_1=1.14 ft/day), Southern Zone of Hydraulic Conductivity (K_2=0.43 ft/day), and the structural fill (K_3=2.8346 ft/day).

Figure 28. Structural Fill Hydraulic Conductivity Zone in Model Layer 1



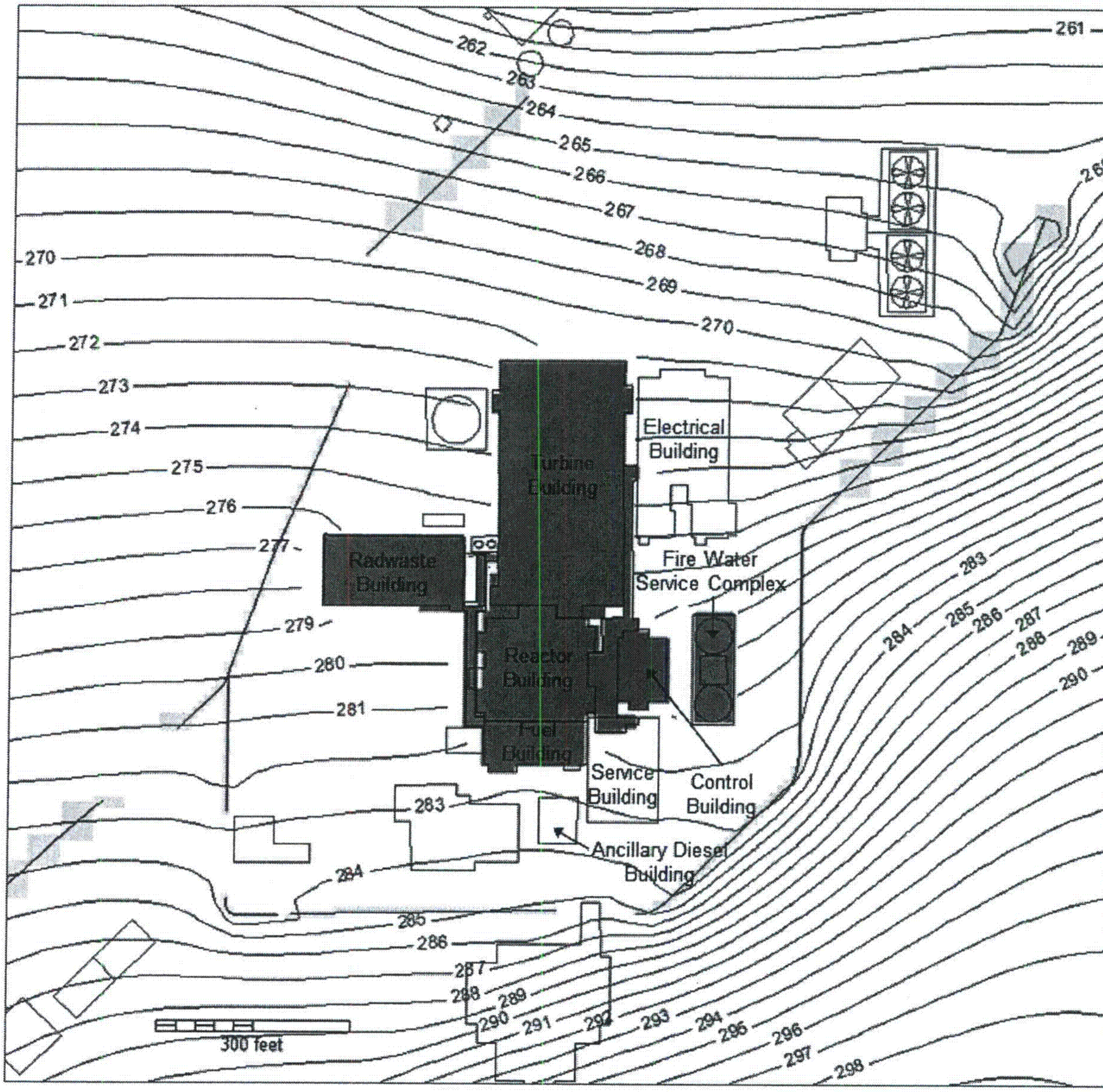
Note: Yellow shading indicates drain cells; gray shading indicates no flow cells.

Figure 29. Post-Construction Simulated Observation Points



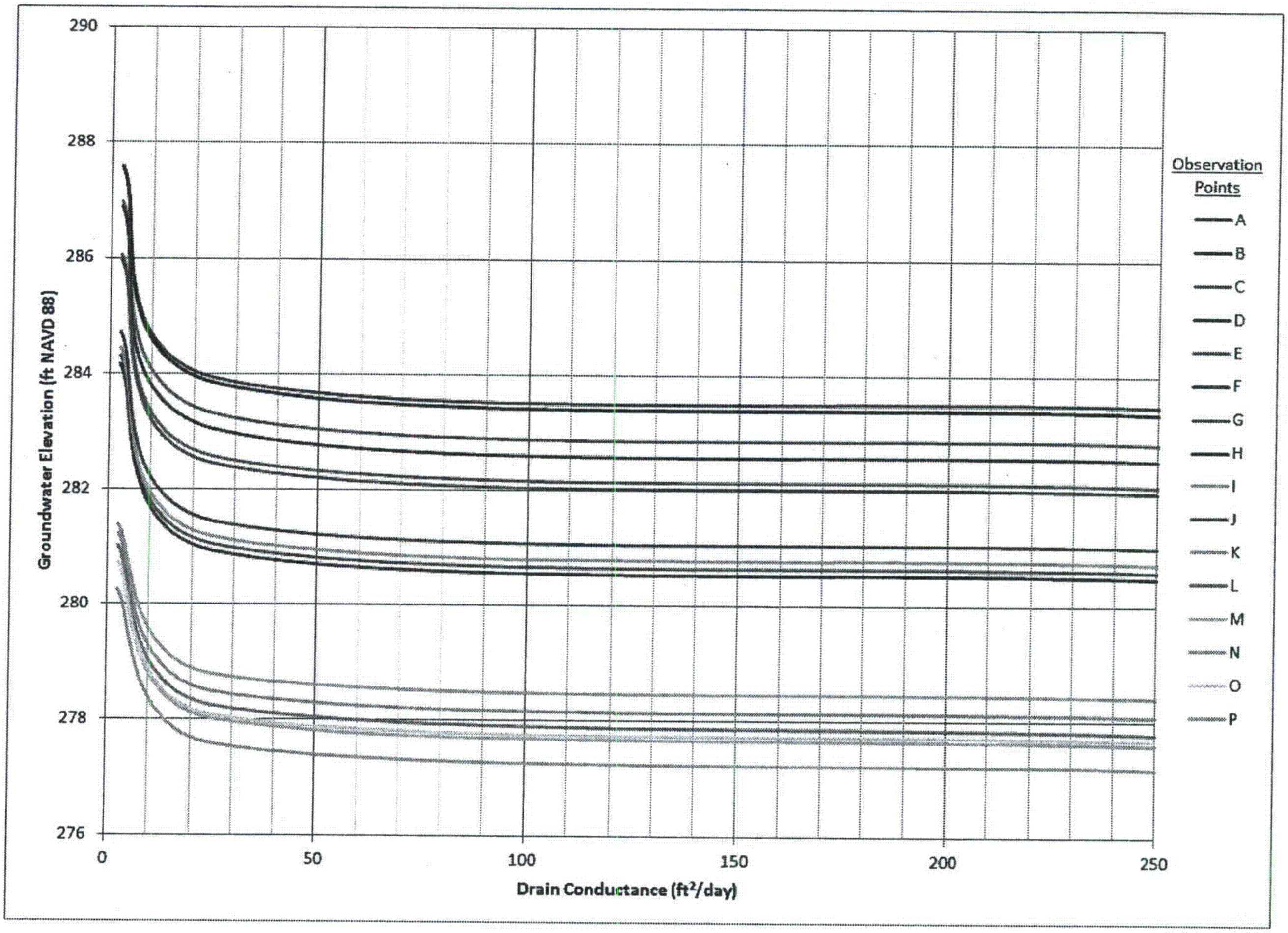
Notes: Water levels in ft NAVD 88. Building outlines indicate Unit 3 structures. Yellow shading indicates drain cells, blue indicates constant head cells, light blue indicates flooded cells, gray cells indicates no flow boundary cells.

Figure 30. Post-Construction Water Levels



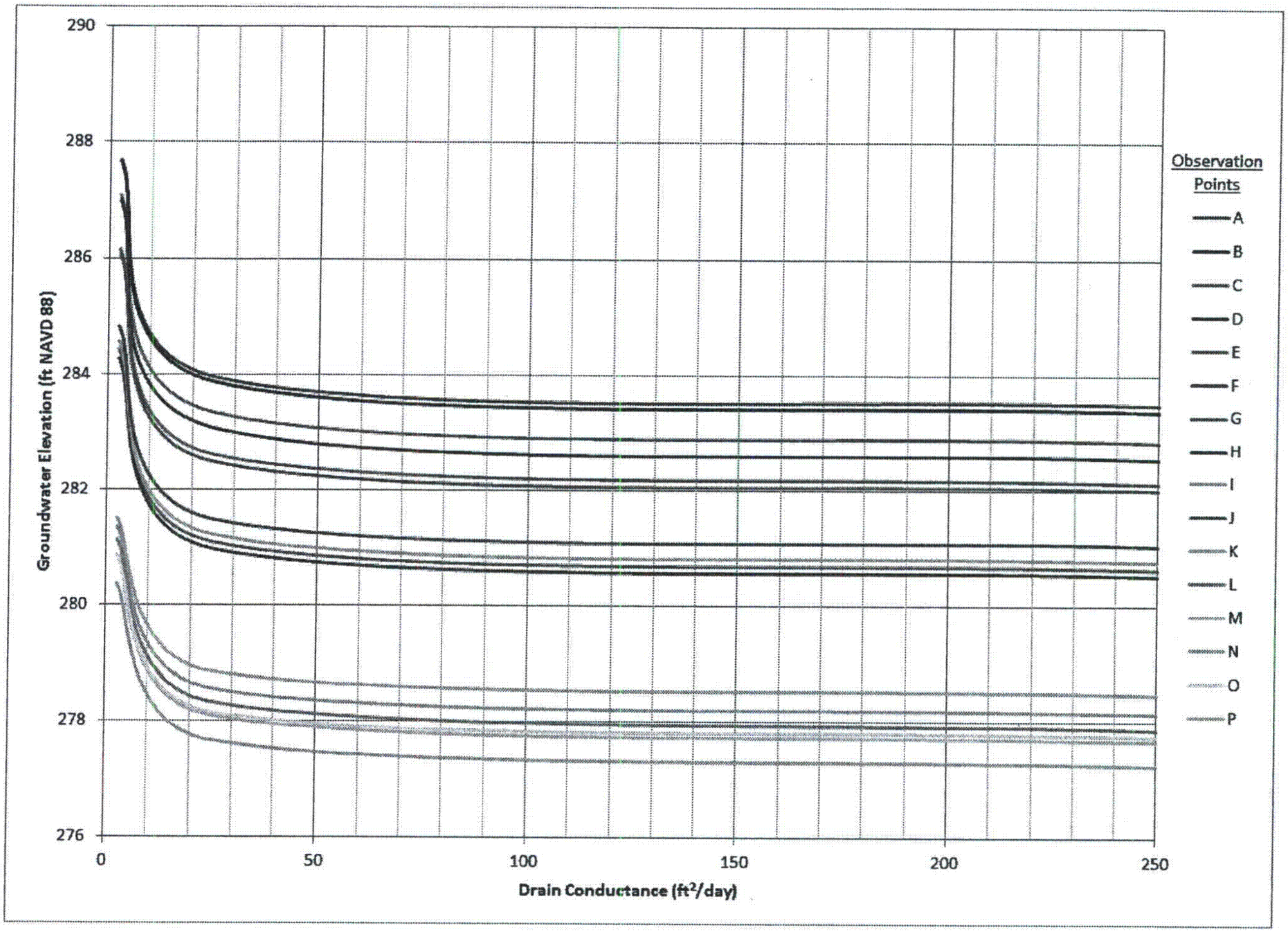
Note: Water levels in ft NAVD 88. Yellow shading indicates drain cells; gray shading indicates no flow cells.

Figure 31. Post-Construction Water Levels in the Power Block Area



Note: Simulations were performed for drain conductance values of 2.5 ft^2/day, 25 ft^2/day, and 250 ft^2/day only.

Figure 32. Post-Construction Simulated Water Levels vs. Drain Conductance



Note: Simulations were performed for drain conductance values of 2.5 ft²/day, 25 ft²/day, and 250 ft²/day only.

Figure 33. Post-Construction Simulated Water Levels vs. Drain Conductance with Twice the Calibrated Recharge (Cases 6 – 8)

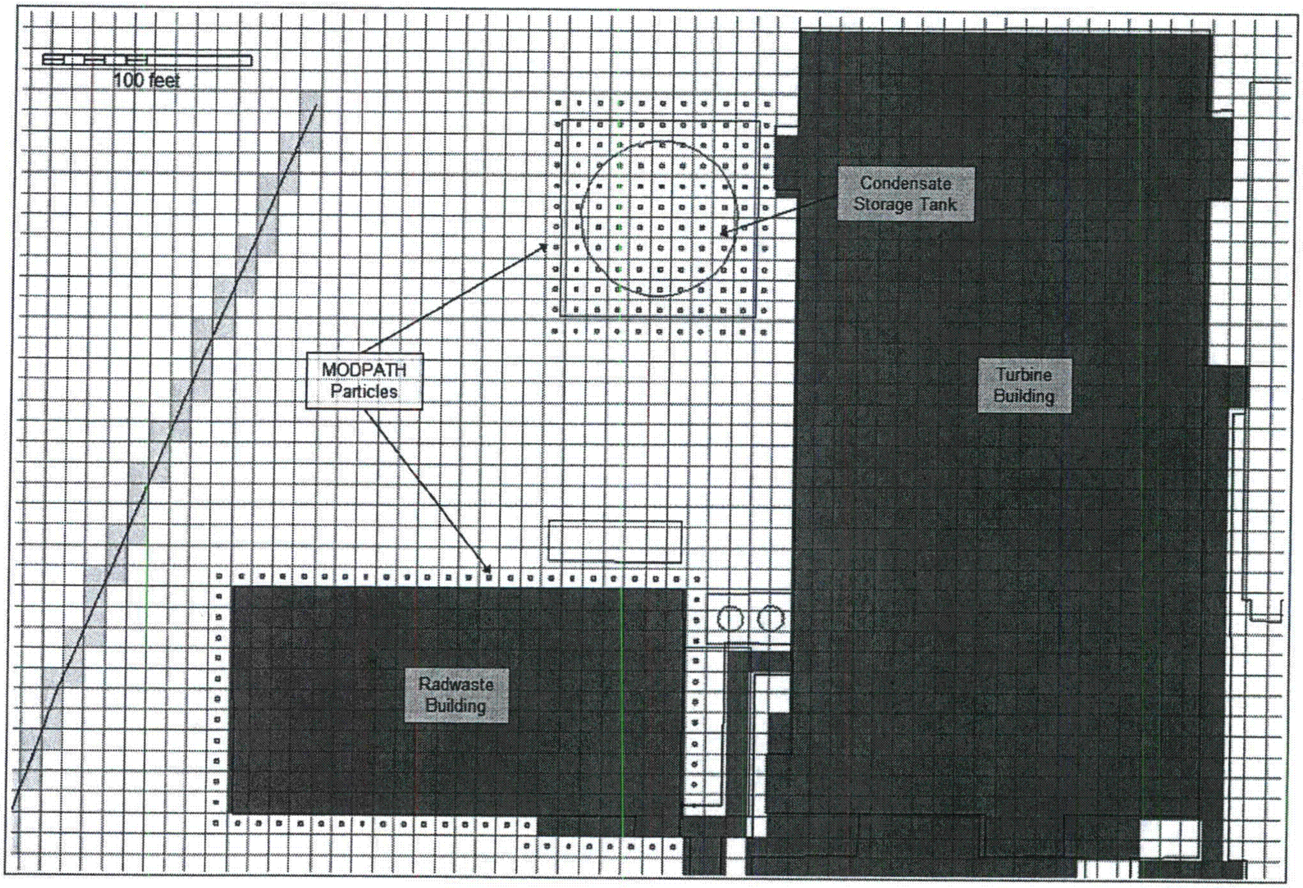


Figure 34. MODPATH Particle Locations

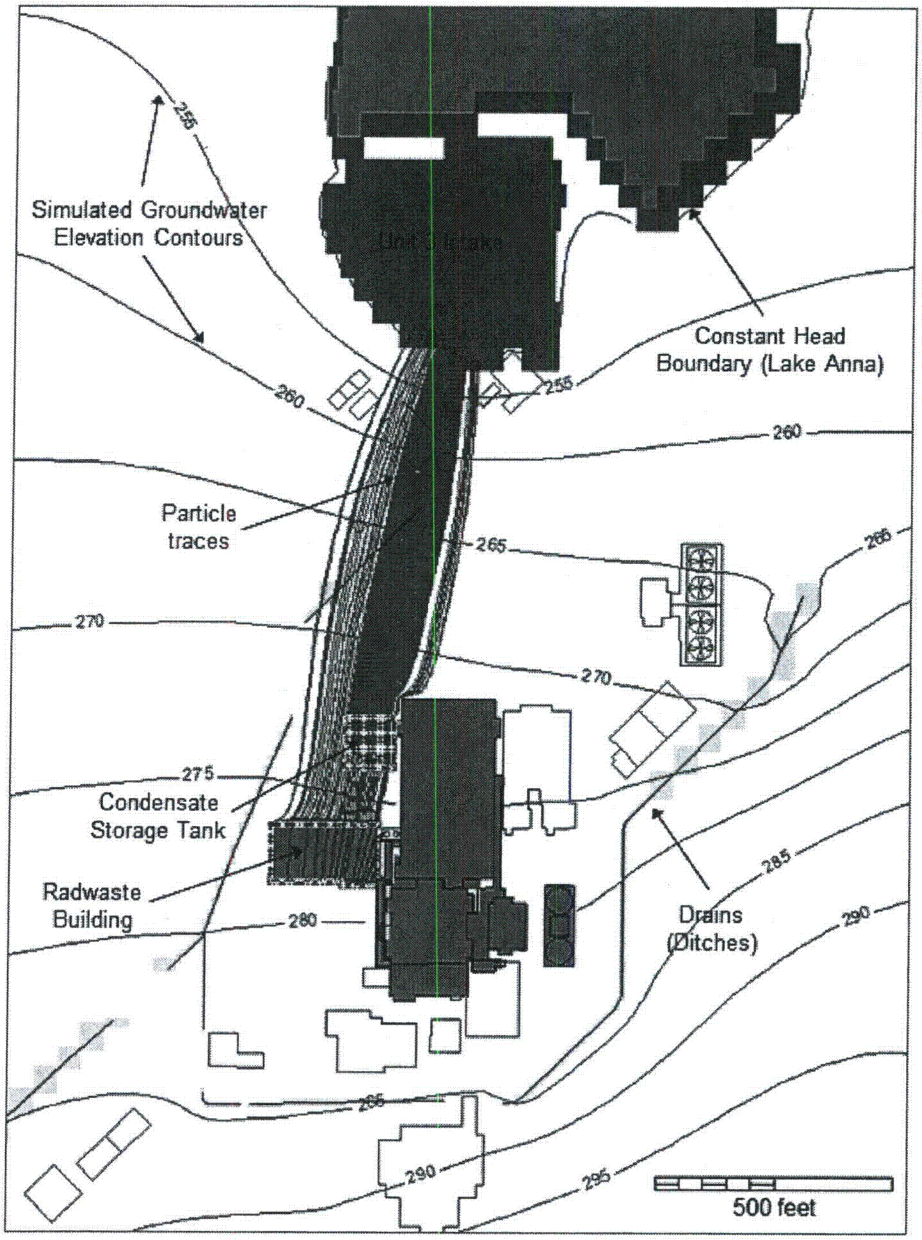


Figure 35. MODPATH Particle Pathlines

ENCLOSURE 8

Revised Response to NRC RAI Letter No. 53

Question 02.05.02-2

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

North Anna Unit 3

Dominion

Docket No. 52-017

RAI NO.: 5199 (RAI Letter 53)

SRP SECTION: 02.05.02 – VIBRATORY GROUND MOTION

QUESTIONS for Geosciences and Geotechnical Engineering Branch 2 (RGS2)

DATE OF RAI ISSUE: 12/21/2010

QUESTION NO.: 02.05.02-2

FSAR Section 2.5.2.5 Seismic Wave Transmission Characteristics of the Site and 2.5.4.2 Description of Subsurface Materials of the North Anna Site, Figures 2.5-209 & 210 and Figures 2.5-229 through 234 demonstrate significant variability in the elevation of the top of competent rock and layer thicknesses at the site under the reactor building complex and other category I structures. Figure 2.5-237 also shows large variations in the shear-wave velocity along the site. Methods of site response calculations including Approach 2 and Approach 3 (see NUREG/CR-6728) used to perform site response analyses are based on one-dimensional subsurface structure approximation, or in other word, flat layer structure.

a) Please justify the assumption of uniformity of layers based on available borings and shear-wave velocity profiles in relation to applicability of 1-D methods such as SHAKE and P-SHAKE to determine the North Anna site amplification.

b) Please describe how the site response analyses for the FIRS and GMRS will adequately capture the significant variability in the top of competent rock across not only the site, but also across the footprint of the Reactor Building and other seismic Category I structures.

Dominion Response

Dominion responded to this RAI question in a letter dated January 28, 2011 (ML110340012). That response was specific to the US-APWR technology and requires revision to reflect Dominion's change in its nuclear technology selection from the US-APWR to the ESBWR design. As such, the structures discussed in the original question are no longer valid. This RAI response supersedes the January 28, 2011 response in its

entirety as it is applicable to the ESBWR design (i.e., this response proceeds as if the question were asked based on the ESBWR design).

Please note that FSAR figure numbers have changed.

Old Figure	New Figure
2.5-209	2.5.4-201
2.5-210	2.5.4-202
2.5-229 to 234	2.5.4-225 to 234
2.5-237	2.5.4-237

Background

Zone IV and Zone III-IV Rock

Although the top of rock contours depicted in FSAR Figures 2.5.4-201 (Zone IV) and 2.5.4-202 (Zone III-IV) show distinct variation in elevation across the site, it is important to note that these zones consist of the same bedrock material, i.e., the site is not made up of layers of different rock types, nor are there dipping layers. The distinction between Zone IV (very strong rock) and Zone III-IV (strong rock) is in the degree of weathering, with Zone IV designated as slightly weathered to fresh and Zone III-IV designated as moderately to slightly weathered.

In the North Anna Unit 3 (NA3) borings, the decision to classify the rock core as Zone III-IV or Zone IV is based to some extent on the visual description of the core, but greater weight is placed on the rock quality designation (RQD) because it is a quantitative parameter. Rock core runs with a RQD between 50% and 90% are designated Zone III-IV and those with a RQD greater than 90% are designated Zone IV. In many borings, Zone III-IV cores alternate with Zone IV cores based on RQD, and thus designating a boundary between the zones is difficult.

In summary, although the top of rock contours in FSAR Figures 2.5.4-201 and 2.5.4-202 clearly show variation (and similarly the profiles in FSAR Figures 2.5.4-225 through 234, especially with the 2:1 vertical exaggeration within these figures), the variation is more random than the figures suggest, the rock material within each zone is the same, and both zones consist of high quality bedrock.

Zone III and Concrete Fill

Zone III is generally found above Zone III-IV in the rock profile and is classified as weathered rock with a RQD less than 50% and an average RQD of about 20%. Much of the variation in shear wave velocity (V_s) shown in FSAR Figure 2.5.4-237 is due to the varying degree of weathering in Zone III. V_s values below about 4,000 fps are generally from Zone III material. Below each building's footprint, all Zone III rock will be removed (by ripping) from beneath the reactor building and fuel building common foundation (RB/FB), the control building (CB) and the fire water service complex (FWSC), and replaced with concrete fill. As described in FSAR 3.7.2, the concrete fill has limited horizontal extent and will be explicitly included in the SSI structural model of

each building. The site response analysis and FIRS and GMRS calculations are performed using the in-situ soil and rock properties.

The site response analysis approach is described below in the response to Question (a). Figures 1, 2, and 3, which are referenced in the response, are provided in Attachment 1.

Response to Question (a)

Each 1-D analysis, by definition, assumes uniform soil profile layers in horizontal directions. The variation of the soil layer thicknesses and other dynamic properties are included in the site response analysis through the soil profile simulation (randomization) and repeated 1-D analyses using simulated profiles. Different base case soil columns are developed for the RB/FB, CB and FWSC locations. Each base case is simulated to produce 60 randomized profiles reflecting the variability observed at the footprint and in the close vicinity of each building. These randomized profiles consider both the variation in the soil and rock stratum properties (shear wave velocity, damping ratio, and soil strain-dependent nonlinearity relationships) and the observed range of variation in the stratum thicknesses across the footprint of the subject structure. The amplification factors and their corresponding uniform hazard response spectra (UHRS) at the foundation elevations for each seismic Category I building are calculated using their respective soil columns. The amplification factors and UHRS corresponding to the GMRS are calculated using the RB/FB soil column since this soil column is developed using the information obtained from the V_S measurements from all boreholes in the power block area and is considered applicable to this entire area. Furthermore, at each elevation, the design response spectra (DRS) obtained from RB/FB soil column and CB soil column are enveloped to calculate the RB/FB FIRS, CB FIRS as well as the GMRS and PBSRS. The effect of variability in material properties of the soil columns is included by randomizing over the range of low-strain dynamic properties and layer thicknesses extending from the finished ground surface to randomized hard rock depths, and randomizing over the range of shear modulus reduction and damping curves, where applicable. The base profiles and randomized profiles corresponding to the RB/FB are shown in Figure 1 and Figure 2, respectively, as an example. The RB/FB foundation is 161 ft x 230 ft in plan view, and has an embedment depth of 66 ft, resulting in the base of the mat foundation being at Elevation 224 ft (all elevations provided within are with respect to NAVD 88). Based on the top of competent rock (Zone III-IV) contours in FSAR Figure 2.5.4-202, the minimum contour below the structure is El. 220 ft, although there may be isolated areas that are lower (e.g., boring W-1 shows Zone III-IV hard rock as high as El. 229 ft, but RQD does not get consistently above 50% until El. 211 ft). Also, contours drop below El. 220 ft in the southeast corner of the FB.

The RB/FB shear wave velocity profile in Figure 1 was obtained from the three V_s borings within and close to the RB/FB footprint (B-901, B-907 and B-909 in FSAR Figure 2.5.4-242). This figure also shows the best estimate of the shear wave velocity used for the CB which is based on the V_s profile measured beneath the building (B-909).

The V_s profile was varied using a function of the estimated standard deviation for each soil/rock stratum. Figure 2 shows the V_s for the 60 simulated profiles for the RB/FB, including the input best estimate profile (from Figure 1) and the simulated median. These profiles were used as input to P-SHAKE to generate the FIRS and SSI input motion spectra for the RB/FB.

In summary, the assumption of uniformity of layers and the use of 1-D methods at the North Anna site, using the RB/FB as an example, is justified because:

- The variation of Zone III rock thickness from its average value at the RB/FB footprint (161 ft x 230 ft) structure is about 35 ft, i.e., the variation is not large compared to the plan dimensions. (See cross-section profile D-D in Figure 3).
- The soil and rock have not been deposited as distinct strata but are derived from the same parent rock weathered in-situ. Therefore the boundaries between the soil and rock zones are not distinct, and thus there are no distinct lateral impedance boundaries which could cause refraction, reflection, and trapping of the shear waves traveling in horizontal directions. As a result, the site can be characterized as undulating, but not dipping. Additionally, based on analysis of the subsurface characteristics, the site does not exhibit complex geotechnical or engineering geologic conditions. Therefore a 1-D site response analysis is adequate for this site.
- The demarcation between the Zone III-IV and Zone IV rock is relatively random, reflecting the weathering process. Both zones are high quality rock.
- The variation in the top of competent (Zone III-IV) rock is irregular due to the weathering process, i.e., the rock profile is not dipping in the classical sense. This irregular profile is best modeled by a profile simulation (randomization) process.
- The soil profile simulation process involving 60 simulated profiles appropriately represents the variation of layer thicknesses and top of rock elevations for the 1-D model input across the footprint of each seismic Category I building.
- The variation of layer thicknesses and top of rock elevations across the entire site is addressed by considering different best estimate shear wave velocity profiles and layer thicknesses as well as their corresponding variations (described in terms of standard deviation) using the applicable boring data within and at close vicinity to the foundation footprint for each seismic Category I building. For the purpose of sensitivity analyses with respect to considerations of the site subsurface variations, three additional sets of 60 simulated profiles are developed corresponding to each of the V_S measurements from boreholes B-901, B-907, and B-909 in the power block area. To ensure that the calculated FIRS and GMRS properly account for the variations noted in the differences between the data from the three boreholes, the weighted average results from these cases are compared to the GMRS and FIRS calculated for each building.

The sensitivity studies verified that this approach produces a sufficiently conservative FIRS for each building and GMRS for the site, given the V_S measurement borehole data in the power block area.

Further discussion on the applicability of the 1-D site response analysis as well as the results of relevant sensitivity analyses are provided in response to RAI number 5693, Question 02.05.02-3.

Response to Question (b)

For the FIRS calculation, as described in response to Question (a), the variation of rock stratum thicknesses (top of rock elevations) across the footprint of each building is addressed by the soil profile simulation process involving 60 simulated profiles, which characterize the variation of the layer thicknesses and top of rock elevations. Moreover, the variation of layer thicknesses and top of rock elevations across the entire site is addressed by considering different best estimate shear wave velocity profiles and layer thicknesses as well as their corresponding variations (described in terms of standard deviation) for each seismic Category I building using the applicable boring data in the close vicinity of its foundation footprint.

The GMRS for the NA3 site is defined at Elevation 224 ft corresponding to the deepest foundation elevation for seismic Category I structures (i.e., RB/FB). The amplification factors and UHRS corresponding to the GMRS are calculated using the RB/FB soil column since this soil column is developed using the information obtained from the V_S measurements from all boreholes in the power block area (B-901, B-907 and B-909 in FSAR Figure 2.5.4-237) and is considered applicable to the entire area. Furthermore, at the GMRS elevation, the DRS obtained from RB/FB soil column and CB soil column are enveloped. The envelope of the DRS calculated as geologic outcrop at GMRS elevation in soil columns corresponding to RB/FB and CB is used as the GMRS for the entire site. Thus, similar to the FIRS calculation, the characteristic site variations are addressed in the calculation of the GMRS.

Proposed COLA Revision

None.

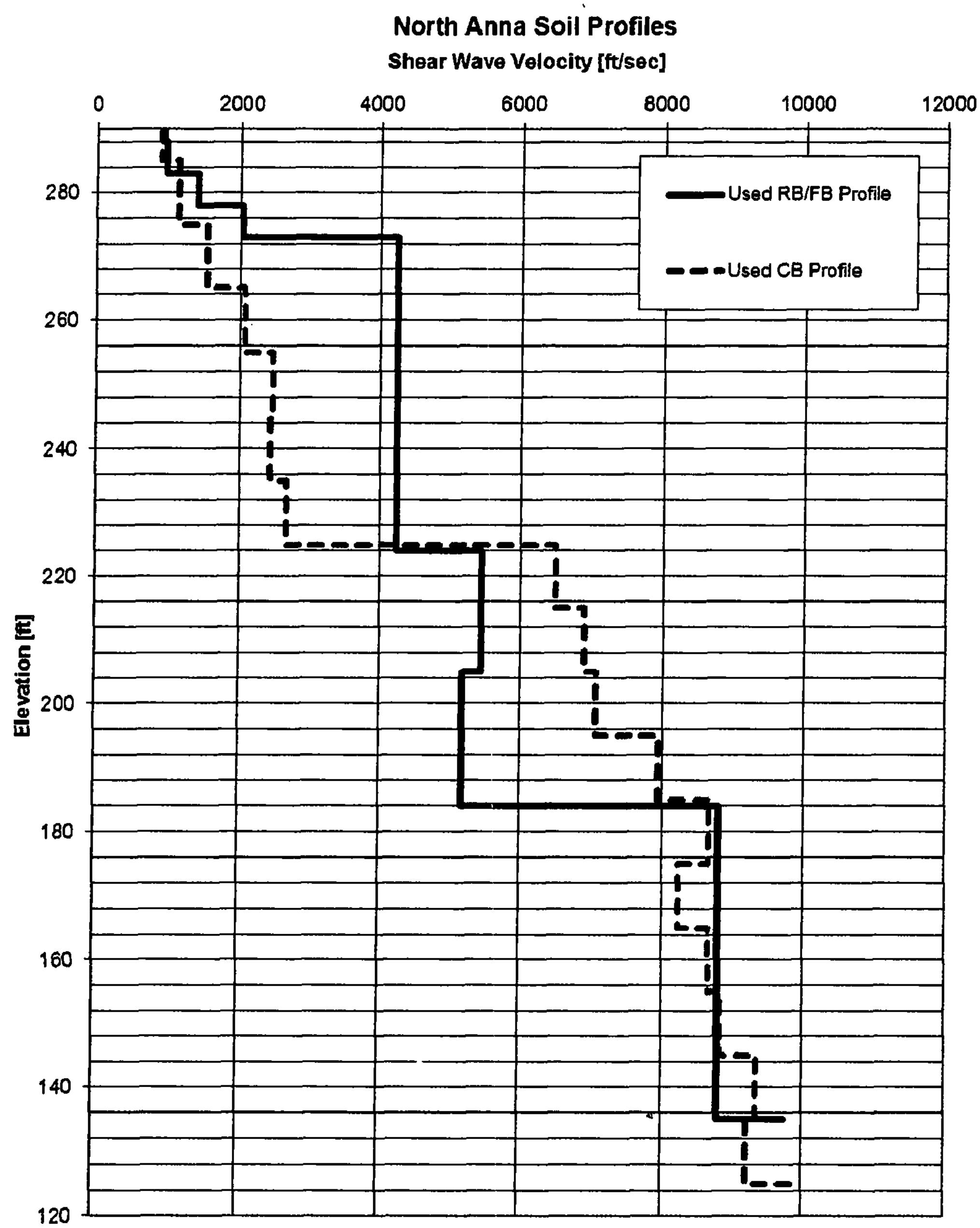


Figure 1 - Adopted Best Estimate Shear Wave Velocity Profile for RB/FB and CB

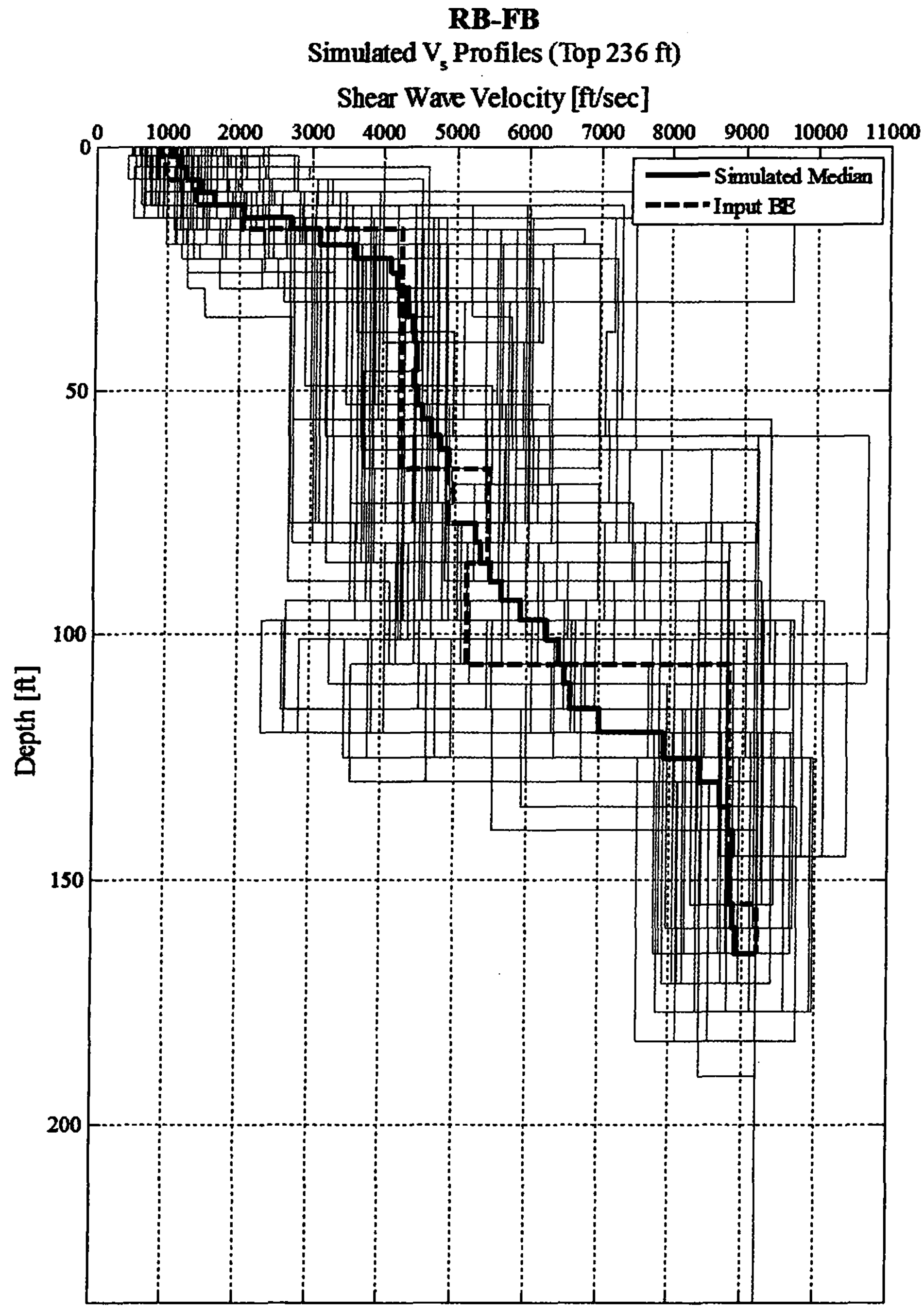
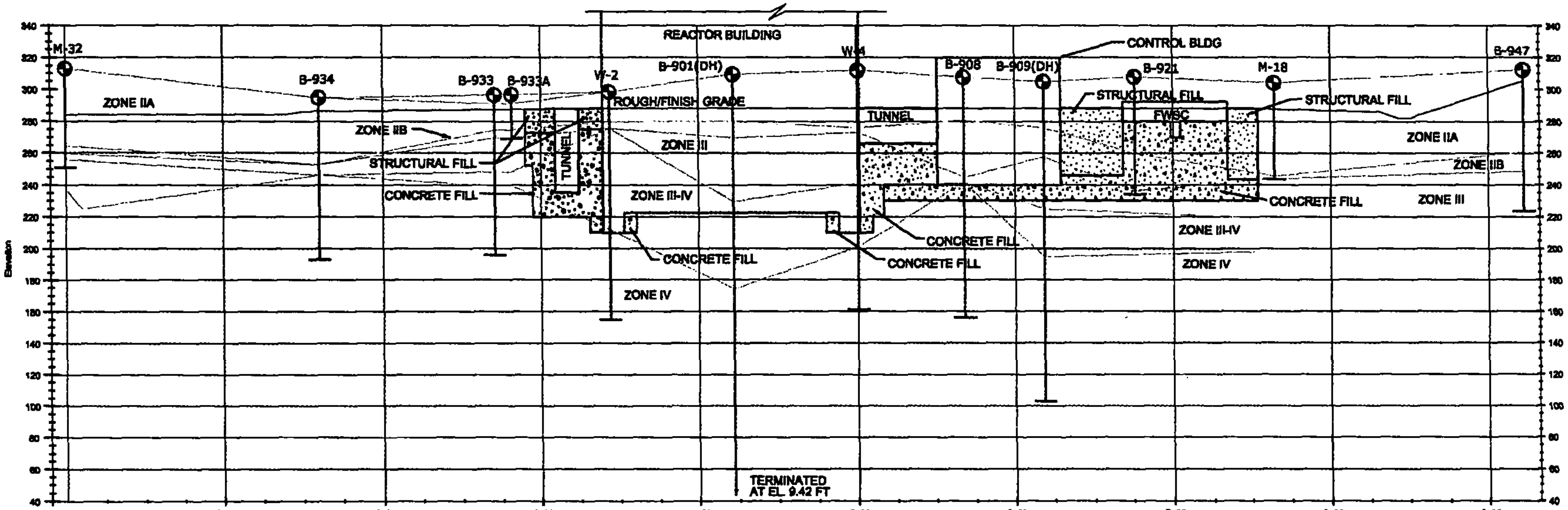


Figure 2 - Shear Wave Velocity for 60 Simulated Profiles for RB/FB

Figure 3 - Subsurface Cross-Section Profile D-D with Foundation Outline



REFERENCE FSAR FIGURE 2.5.4-228

NOTE:
THE CONVERSION FROM NAVD88 DATUM ELEVATIONS TO NGVD29 DATUM ELEVATIONS IS +0.86 FT

EXCAVATION PROFILE D-D

(VERTICAL AND HORIZONTAL SCALE EQUAL)

LEGEND

STRUCTURAL FILL
CONCRETE FILL
B-901 BORING NUMBER

ENCLOSURE 9

Revised Response to NRC RAI Letter No. 68

Question 02.05.02-3

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

North Anna Unit 3

Dominion

Docket No. 52-017

RAI NO.: 5693 (RAI Letter 68)

SRP SECTION: 02.05.02 – VIBRATORY GROUND MOTION

QUESTIONS for Geosciences and Geotechnical Engineering Branch 2 (RGS2)

DATE OF RAI ISSUE: 5/5/2011

QUESTION NO.: 02.05.02-3

The response to RAI 5199 (02.05.02-2) states that a 1-D analysis is justified for calculation of the GMRS due to the similarity of the bed rock and RQD values. However, shear wave velocity measurements show considerable variation at equivalent elevation levels, indicating that weathered rock zones III and III-IV are of variable thickness. For example, the BE profile shown on Figure 2.5-202b (Rev. 4) is a result of combining shear wave velocity measurements from borings B-901, B-907 and B-909, and represents the log mean of the Profiles 1 and 2 shown on Figure 2.5-241a (Rev. 3). Values shown on Figure 2.5-241a indicate that shear wave velocities vary up to 100% from approximately elevation 184 ft to 250 ft. These considerable horizontal variations in shear wave velocity impedance contrasts indicate that a 1-D analysis may not be sufficient to describe the multi-dimensionality of the subsurface, and the use of the BE profile instead of enveloping site amplifications from Profiles 1 and 2 may result in an underestimation of the site amplification functions, and, ultimately the GMRS.

In accordance with 10 CFR 100.23(c) and RG-1.208, the staff requests that the applicant justify that the 1-D site response analysis utilizing only vertically propagating shear waves is appropriate for the underlying complex velocity structure and the results of the 1-D analysis produce a GMRS that adequately characterizes the local subsurface conditions.

Please provide a table of layer thicknesses, shear-wave velocities, and densities, and identify the type of shear modulus and damping curves used for all site amplification calculations. Also explain how the average shear wave velocity Profiles 1 and 2 displayed in Figure 2.5-241a were developed.

Dominion Response

Dominion responded to this RAI question in a letter dated August 25, 2011 (ML11241A058) and provided two supplemental responses (December 5, 2011 (ML11342A080) and February 8, 2012 (ML12048A236)) as a result of conference calls with the NRC staff. Those responses were specific to the US-APWR technology and require revision to reflect Dominion's change in its nuclear technology selection from the US-APWR to the ESBWR design. As such, the structures discussed in the original question response are no longer valid except as described for the sensitivity analysis. This RAI response supersedes the previous three responses. Note: Figures 1 through 15, which are referenced in the response, are provided in Attachment 1.

1. Justification for 1-D Site Response Analysis Approach

Dominion concludes that the 1-D site response analysis (SRA) using only vertically propagating shear waves is appropriate for the North Anna site, and that the results of the 1-D analysis produce a ground motion response spectrum (GMRS) that is reasonable and adequately characterizes the local subsurface conditions, because:

a. The various soil and rock zones consist of the same parent rock material. Because of the weathering patterns, these zones can be described as undulating, but they are not dipping. The boundaries between the soil and rock zones and within the rock zones are not distinct, and thus there are no defined lateral impedance boundaries which could cause refraction, reflection, and trapping of the shear waves traveling in horizontal directions. In short, although there are variations in the thicknesses of the various zones, the velocity structure of the subsurface materials is not considered to be particularly complex.

b. The analysis considers different shear wave velocity profiles, layer thicknesses, and corresponding variations using applicable boring data.

The analysis was performed consistent with the guidance in NUREG-0800 and Regulatory Guide (RG) 1.208.

Composition of Various Soil and Rock Zones and Subsurface Conditions

The North Anna site subsurface characterization has been performed over several decades beginning with the licensing activities for Units 1 and 2, more recently during the Early Site Permit Application (ESPA), the NA3 ESBWR R-COLA, and the NA3 U.S. APWR S-COLA site investigations for the proposed North Anna Unit 3.

In support of more recent activities, there were five downhole geophysical borings taken to measure dynamic properties including shear wave velocity (V_S). Three of these borings (B-901, B-907, B-909) are located within or close to the Reactor

Building and Fuel Building (RB/FB) footprint, and two (M-10 and M-30) are outside the ESBWR power block area. The three B-series borings in the RB/FB set were conducted during the NA3 ESBWR R-COLA investigation and the two M-series supplemental borings were conducted during the NA3 US-APWR S-COLA investigation. These two additional borings showed no new geological features and re-confirmed the site variability characterized previously. These two new borings also indicated the same rock/soil zones defined previously (Zone III, Zone IV, etc.) and the geotechnical properties (including dynamic) of these zones were unchanged.

The data obtained from testing and analysis of site borings lead to the conclusion that the North Anna site is typical of the Piedmont geology. The various soil and rock zones are in different stages of the weathering process of the same parent rock material. The existing subsurface variability is the result of the different extent of localized effects of weathering on minerals comprising the parent rock (e.g., quartz is resistant to weathering and does not alter to clay materials). It is emphasized that the soil and rock have not been deposited as distinct strata but are derived from the same parent rock weathered in-situ. Therefore, the boundaries between the soil and rock zones are not distinct, and thus there are no distinct lateral impedance boundaries which could cause refraction, reflection, and trapping of the shear waves traveling in horizontal directions. As such, the velocity structure of the subsurface materials is not considered to be particularly complex. As noted earlier, although there are variations in the thicknesses of the various zones, these zones can be described as undulating, but they are not dipping.

For vertically traveling shear waves, significant horizontal impedance boundaries exist as observed in the borehole data. Such impedance boundaries appear at different depths depending on the penetration of the weathering process across the site. The soil profile simulation (randomization) process and the site response analysis take these impedance boundaries and their depth variation into account by analyzing 60 simulated soil profiles with appropriate impedance boundaries at various depths. As an example, the randomized soil profiles from the RB/FB soil column used in the development of GMRS (in addition to the CB soil column) are provided in Figure 1 through Figure 6 (10 profiles at a time for clarity). These figures show that the simulated profiles exhibit impedance boundaries similar to those observed in the borehole data. Consequently, the site response analysis accounts for the horizontal impedance boundary effects such as refraction, reflection and trapping of shear waves.

The applicable regulatory guidance for reviewing site response analysis is included in NUREG-0800 Standard Review Plan (SRP) 2.5.2, "Vibratory Ground Motion." Guidance on how to perform site response analysis is provided in RG 1.208, "A Performance-Based Approach to Define the Site-Specific Earthquake Ground Motion," March 2007, in particular Position C.4 and Appendix E. RG 1.208 guidance describes the site conditions for which a 1-D analysis may be appropriate.

Additional guidance is provided for an analysis accounting for inclined waves that may be required if dipping bedrock surfaces (rock strata inclined at an angle to the horizontal surface), topographic effects, or other similar impedance boundaries exist; regional characteristics (such as certain topographic effects) exist; or source characteristics (such as nearby dipping seismic sources) exist. The guidance further describes how multi-dimensional soil models may be needed if complex geologic and geotechnical conditions exist.

Neither a multi-dimensional analysis nor an analysis accounting for inclined waves is required for the North Anna site because the conditions requiring these more detailed analyses do not exist at the site. As previously described, the site does not have dipping bedrock or a nearby dipping seismic source nor does it contain vertical impedance boundaries, and thus the velocity structure of the subsurface materials is not considered to be particularly complex. Therefore, Dominion conducted a 1-D soil column analysis which included the modeling of vertically propagating waves as required by RG 1.208.

Considerations in the Site Response Analysis

Profile simulation (randomization) is used in the 1-D site response analysis to account for the variation of the shear wave velocities, strain-dependent property curves, and the thicknesses of the different layers by generation of a set of 60 simulated profiles for each best estimate (BE) profile considered. The GMRS for the NA3 site is defined at Elevation 224 ft (vertical datum is with reference to NAVD88 throughout this response) corresponding to the deepest foundation elevation for Seismic Category I structures (i.e., the RB/FB). The amplification factors and uniform hazard response spectra (UHRS) corresponding to the GMRS are calculated using the RB/FB soil column since this soil column is developed using the information obtained from the V_S measurements from all boreholes in the power block area (B-901, B-907 and B-909 in FSAR Figure 2.5.4-237). This soil column is considered applicable to the entire site since the ranges of soil/rock zone thicknesses encountered in these three borings envelope the thicknesses of the zones found in the majority of the site borings. The BE of the RB/FB V_S profile is determined from the log-mean of Profiles 1 and 2, which are developed as bounding profiles for the rock V_S values observed in boreholes B-901, B-907, and B-909 in the power block area. As shown in Figure 15, the log-mean V_S profile obtained from Profiles 1 and 2 ("Profile 1 & 2 Log-mean") closely follows the log-mean V_S profile from the three aforementioned boreholes ("Boring Log-Mean"). (The log-mean V_S profile obtained from Profiles 1 and 2 is also shown in Figure 2.5.4-242 of the current ESBWR FSAR (Rev. 7).) Note that while Profile 1 and Profile 2 each include data from more than one borehole and do not represent any single borehole rock V_S measurements, they do provide a useful range of variation of the rock V_S values. The variation range defined by the difference between the shear wave velocity of Profiles 1 and 2 and the BE (log-mean) profile is taken as the shear wave velocity standard deviation used in the profile simulation. Given the BE (log-mean) and

standard deviations obtained for the V_S values and the range of thickness variations for each rock layer, 60 simulated profiles corresponding to the RB/FB are developed which represent the different shear wave velocity conditions across the power block area. These 60 simulated profiles are presented in FSAR Figure 2.5.2-265.

Furthermore, at the GMRS elevation, the design response spectra (DRS) obtained from RB/FB soil column and Control Building (CB) soil column are enveloped. The CB BE profile is determined using the V_S data from Borehole B-909 which is within the footprint of this building and is more consistent with the RQD information obtained from the other boreholes within its footprint. The envelope of the DRS calculated as a geologic outcrop at the GMRS elevation in soil columns corresponding to the RB/FB and CB is used as the GMRS for the entire site. More details for the development of the BE soil profiles corresponding to each Seismic Category I structure are presented in FSAR Section 2.5.4.7.

To address site variability, RG 1.208 states that a Monte Carlo simulation (or equivalent procedure) should be used to accommodate the variability in soil depth, shear wave velocities, layer thicknesses, and strain-dependent dynamic nonlinear material properties. Using this method, a sufficient number of convolution analyses are required to adequately capture the effect of site subsurface variability and soil properties uncertainty. Performance of at least 60 convolutions (one for each simulated (randomized) profile) is recommended in RG 1.208 in order to define the site response mean and standard deviation. The Unit 3 site rock zone thicknesses and V_S variability (due to rock formation weathering) were recognized and incorporated in the analyses by performing the required convolutions for the 60 simulated profiles. These capture the variability in depth/thickness of each rock formation and the measured variation in the subsurface dynamic properties.

The methodology used to incorporate site subsurface variability in the SRA for Unit 3 is consistent with the guidance contained in SRP 2.5.2 and RG 1.208. The non-systematic variations in the subsurface properties result in site conditions that are well suited for a Monte Carlo simulation as described by RG 1.208.

The methodology described above was reviewed by the NRC for the NA3 ESBWR R-COLA. The method and results were described in the North Anna Unit 3 draft Safety Evaluation Report (SER) and discussed during the ACRS review meeting. At that time, there were no open items associated with this approach. The NRC documented acceptance of the results presented in the NA3 ESBWR R-COLA in the draft SER and used the same methodology for the performance of a confirmatory analysis. The best estimate of the V_S profile and the methodology to consider the velocity and thickness variations were not changed for use for the current GMRS development.

In order to show the adequacy of the approach described above (combining V_S data from different boreholes into a single BE profile which is used in the calculation of

GMRS and various FIRS), a sensitivity study was performed which compared the FIRS calculated for the NA3 US-APWR S-COLA Reactor Building (R/B) Complex and East Power Source Building (PS/B) with the log-mean of the amplified acceleration response spectra (ARS) obtained from each borehole individually. Note that this sensitivity study was performed in response to this RAI in reference to the GMRS and FIRS associated with the US-APWR technology (at Elevation 250 ft) being considered at the time. The current ESBWR reactor centerline location is the same as that of the previously analyzed US-APWR design and the design plant grade has been maintained at Elevation 290 ft. Since the approach of combining V_S data remains the same for the GMRS and FIRS calculations of the current ESBWR technology, the conclusions of this sensitivity study remain valid. Three boreholes B-901, B-907, and B-909 were included in the study since these boreholes were used in developing the BE profile for R/B Complex and East PS/B. The study is summarized in the following steps:

a. The V_S profiles for boreholes B-901, B-907, and B-909 below Elevation 250 ft are idealized as shown in Figure 7.

b. The depth of Zone III weathered rock is estimated in each borehole profile and replaced with concrete fill (best estimate shear wave velocity of V_S = 7000 ft/sec). This is performed consistent with the FIRS calculation for the NA3 US-APWR R/B Complex and the East PS/B, where Zone III rock was replaced by concrete fill. The resulting profiles with concrete fill (henceforth referred to as idealized profiles) are provided in Figure 8.

c. The hard rock SSE motion was propagated through the idealized profiles (single run per profile) and the ARS at Elevation 250 ft were calculated consistent with the methodology used in calculation of Truncated Soil Column Response (TSCR) FIRS and GMRS.

d. The log-mean (equal weight) ARS from the response of the idealized profiles were calculated and compared with the TSCR FIRS for R/B Complex and East PS/B as presented in Figure 9 and Figure 10, respectively.

Note that the application of equal weight to the results from each borehole is justified since the weathering process across the footprint of each building is random in nature and does not exhibit sloping or dipping in the subsurface rock. Therefore, all three boreholes are reasonably equally applicable to the footprint of each building. Nevertheless, given that borehole B-901 is located directly under the R/B Complex, a 50%-25%-25% scheme of weight factors was examined for the comparison with R/B Complex TSCR FIRS as presented in Figure 11. It is observed that both averaging schemes lead to results which are less than R/B Complex FIRS at all frequencies except for a negligible exceedance of less than 4% at frequencies of around 60 Hz.

The sensitivity study confirms that the FIRS that were provided for the NA3 US-APWR R/B Complex and East PS/B were conservative and that the soil column

simulation (randomization) process used in the FIRS development for these buildings adequately considers the sublayer variation observed in the borehole data.

For the current ESBWR technology at NA3, a new sensitivity study with respect to considerations of the site subsurface variations is carried out in which three additional sets of 60 simulated profiles are developed corresponding to each idealized profile to the design plant grade at Elevation 290 ft based on the V_S measurements from boreholes B-901, B-907, and B-909 in the power block area. To ensure that the calculated ESBWR FIRS and GMRS (at elevation 224 ft) properly account for the variations noted in the differences between the data from the three boreholes, the weighted average DRS from these cases are compared to the FIRS calculated for each building and the site GMRS as shown in Figures 12, 13, and 14. This sensitivity study further verified that the approach employed in combining the data from the three boreholes produces a sufficiently conservative FIRS for each building and the GMRS for the site.

2. Requested Data Input to Site Amplification Analysis

The zone thicknesses in each boring are summarized in FSAR Table 2.5.4-204.

The values in Table 2.5.4-204 are based mainly on SPT N-values for the soil, and on rock recovery and rock quality designation (RQD) for the rock. The table below shows these values.

Material	SPT	Coring
Zone IIA Saprolite	N ≤50 bpf	n/a
Zone IIB Saprolite	N > 50 bpf	Recovery <20%, RQD = 0
Zone III Weathered Rock	N = Ref/0.1 ft*	Recovery >20%, RQD< 50%
Zone III/IV Rock	n/a	RQD between 50 & 90%
Zone IV Sound Rock	n/a	RQD>90%

* N = Ref/0.1 ft means that the SPT sampler reaches refusal within 0.1 ft after 50 blows. This is different from N = 50/0.1 ft, since N = 50/0.1 ft implies that the sampler has already advanced through the initial 6 in. of seating. "Ref" indicates 50 blows within the seating interval.

The choice of RQD values for the various rock zones are based in part on the values in Table 5.2 of Peck et al (1974). In that table, RQD of 90% to 100% corresponds to excellent rock quality, RQD of 50% to 90% corresponds to fair to good rock quality, and RQD of 0 to 50% corresponds to very poor to poor quality.

A second method of determining zone thickness of the rock is by V_S values. The following ranges were adopted.

Material	V_S, ft/sec
Zone III Weathered Rock	2000-4000
Zone III/IV Rock	4000-8000
Zone IV Sound Rock	>8000

The correlation between RQD and V_S in a rock zone can only be approximate since RQD is a reflection of the number of fractures in the rock, which does not correlate directly with shear wave velocity. Nevertheless, the correlation has worked relatively well at the Unit 3 site. The RQD criteria are used exclusively for estimating zone thicknesses in Table 2.5.4-204 in the 88 borings where V_S was not measured. In the 5 V_S borings, V_S was also considered in selecting zone thickness in Table 2.5.4-204. This can be demonstrated by looking at the rock zone thickness values selected for two of the borings where V_S measurements were made, namely borings B-907 and B-909.

In the B-907 boring log, the sample at El. 285.2 ft meets the Zone IIB N-value criterion while the sample at El. 280.2 ft meets the Zone III N-value criterion. The V_S measurements exceed 2000 ft/sec at around El. 283 ft. From these data, an elevation of 283.7 ft was selected for the top of Zone III. The boring log shows RQD increasing from 46% in the core above El. 207.2 ft to 80% in the core below El. 207.2 ft and remaining at or above 80% in the succeeding cores. The V_S measurements exceed 4000 ft/sec at around El. 210 ft. An elevation of 207.2 ft was selected for the top of Zone III-IV. The boring log shows RQD increasing from 86% in the core above El. 177.2 ft to 92% in the core below El. 177.2 ft and staying above 90% in the succeeding cores. The V_S measurements exceed 8000 ft/sec at around El. 185 ft. An elevation of 177.2 ft was selected for the top of Zone IV. To sum up, for the top of Zone III and Zone III-IV, the RQD and V_S criteria are in almost exact agreement. For Zone IV, the two criteria indicate the elevation of the top of the zone within 8 ft of each other. The values based on RQD were selected for those two zones to be in line with the criteria used in all the borings that do not have V_S measurements.

In the B-909 boring log, the material below El. 259.9 ft is classified as weathered rock. The V_S measurements increase above 2,000 ft/sec between El. 258 ft and El. 257 ft and continue to increase with depth. Based on the above, El. 258 ft was selected as the top of Zone III. The boring log shows RQD increasing from 22% in the core above El. 223 ft to 98% in the core below El. 223 ft. The V_S measurements show a similar very steep rise at around El. 223 ft, going from 3150 ft/sec at El. 224.5 ft to 7530 ft/sec at El. 221.2 ft. Examination of the core log above El. 223 ft shows an increase in the drill rate for the final 2 ft of the core. Thus, El. 225 ft was chosen as the top of Zone III-IV. The cores below El. 223 ft continue to exceed RQD of 90% in almost all cases, indicating that the top of Zone III-IV at El. 223 ft is

also the top of Zone IV. However, the V_S values stay below 8000 ft/sec and sometimes below 7000 ft/sec in these lower elevations. The V_S first exceeds 8000 ft/sec at El. 200 ft but then drops below 8000 ft/sec again, and finally exceeds 8000 ft/sec consistently starting at about El. 187.5 ft. Based on all of these data, an elevation of 195 ft was selected for the top of Zone IV. To sum up, for the top of Zone III, the N-value criterion was not quite met but the V_S criterion had already been exceeded. For Zone III-IV, the RQD and V_S criteria were in excellent agreement. For Zone IV, the RQD criterion was met but the V_S values were significantly below the threshold. In that case, more weight was given to the V_S values.

The MACTEC boring logs do not classify the rock as Zone III, Zone III-IV, etc. The material is classified as weathered rock, hard rock, and, on occasions, hard rock – weathered rock. It appears that these classifications are based mainly on visual inspection and the frequency of joints in the rock. It is not expected that there will be consistent correlation between Zone III and MACTEC's weathered rock, Zone IV and MACTEC's hard rock, and Zone III-IV and MACTEC's hard rock – weathered rock.

Subsurface material density information is provided in FSAR Table 2.5.4-208 in the row labeled "Total unit weight." The best estimate shear wave velocity values for each zone can also be found in Table 2.5.4-208. Shear wave velocity data are plotted on FSAR Figure 2.5.4-237. The Zone III-IV and Zone IV rock has non-strain dependent shear modulus values, and damping ratio is taken as 1%. The shear modulus reduction curve for the Zone III weathered rock is shown on FSAR Figure 2.5.4-247 and the damping ratio versus shear strain relationship is shown on FSAR Figure 2.5.4-249.

3. GMRS Site Response Analysis (Accounting for the Five Versus Three Borings)

During the NRC Public Meeting on May 19, 2011, the NRC requested that the development of the site GMRS includes the two supplemental geotechnical borings (M-10 and M-30) in light of their proximity to the NA3 US-APWR UHSRS locations. Since there are no Seismic Category I structures in the NA3 ESBWR design close to those boring locations, the NRC request does not apply to the current NA3 ESBWR COLA. Nevertheless, the argument provided below clarifies that the adopted methodology encompasses the variation observed in those supplemental borings.

The data from these supplemental borings, although not explicitly used as input to the development of GMRS, are implicitly accounted for by the profile simulation and SRA methodology and have no effect on the final GMRS results as discussed below.

The comparison between the simulated profiles below Elevation 224 ft and the five measured boreholes across the site shows that the shear wave velocity values for in-situ rock measured in all geophysical borings are well represented within the randomized profiles with the exception of borehole M-30, which has very high V_S

values (~9500 ft/sec and higher) at shallow depths. Since the hard rock spectrum is defined at rock with shear wave velocity above 9200 ft/sec (per RG 1.208), for the M-30 borehole, the ground motion at Elevation 224 ft is the hard rock spectrum which is completely enveloped by the GMRS defined at this elevation. Because the GMRS is calculated as the log-mean of the response from the 60 simulated profiles, inclusion of profiles similar to boring M-30 with very high shear wave velocity in the simulation process would reduce the overall log-mean response closer to the hard rock spectrum. Therefore, the exclusion of borehole M-30 from the rock profile simulation is conservative and justified. Note that the rock profiles considered for the GMRS calculation consist entirely of linear rock materials which are supported on the hard rock with shear wave velocity of 9200 ft/sec. Due to the linear characteristics of the rock profiles, there are no confining effects from the soils above, and the calculation of the GMRS as a free field geologic outcrop is carried out by removing the top layers above Elevation 224 ft which is consistent with the requirements of DC/COL-ISG-17, "Ensuring Hazard-Consistent Seismic Input for Site Response and Soil Structure Interaction Analyses, Final Issue."

4. **Development of Profiles 1 and 2**

Profiles 1 and 2 are developed as bounding profiles with lower shear wave velocity values corresponding to the more fractured and weathered rock and higher values corresponding to essentially unfractured and unweathered rock observed in boreholes B-901, B-907, and B-909. Profiles 1 and 2 and the V_S values measured in the three boreholes are shown in FSAR Figure 2.5.4-241. Note that these profiles do not represent any single boring data and are used to identify the range of variation of rock V_S values.

Reference

Peck, R.B., Hanson, W.E. and Thornburn, T.H. (1974). *Foundation Engineering,* 2nd Edition, John Wiley & Sons, Inc., New York.

Proposed COLA Revision

None.

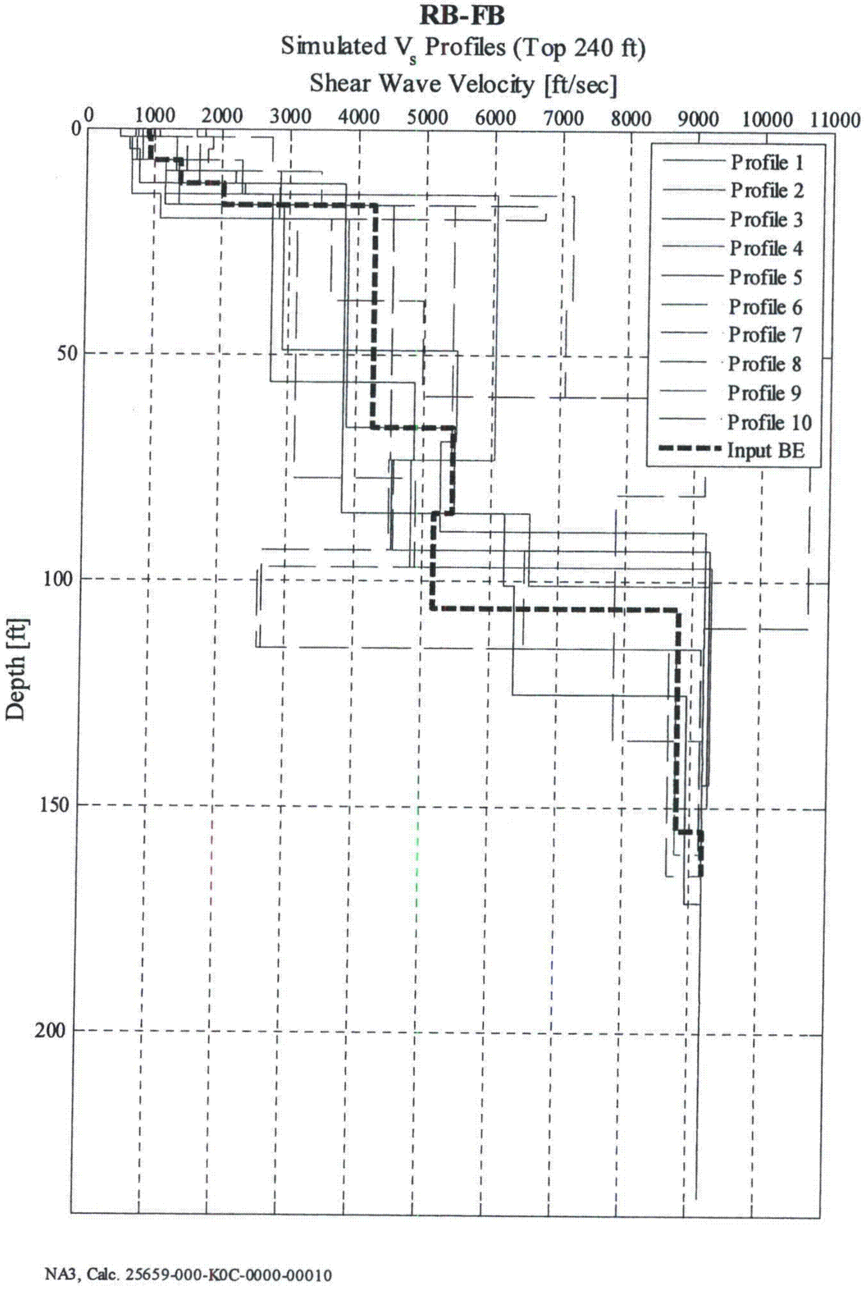


Figure 1: RB/FB Simulated Soil Profile Used for GMRS Calculation, Profiles 1 through 10. (Note that for the purpose of GMRS calculation the in-situ material at the top 66 ft of each profile is removed)

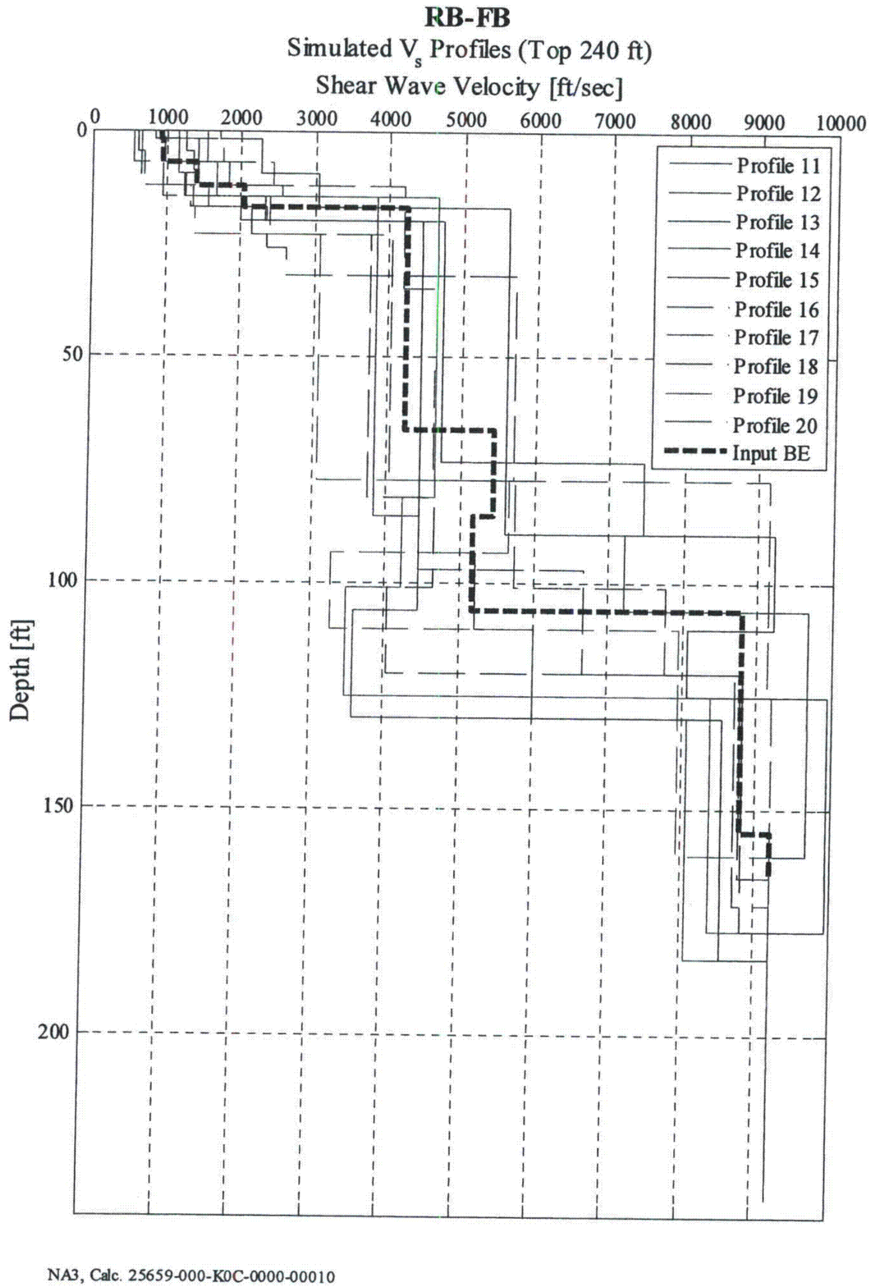
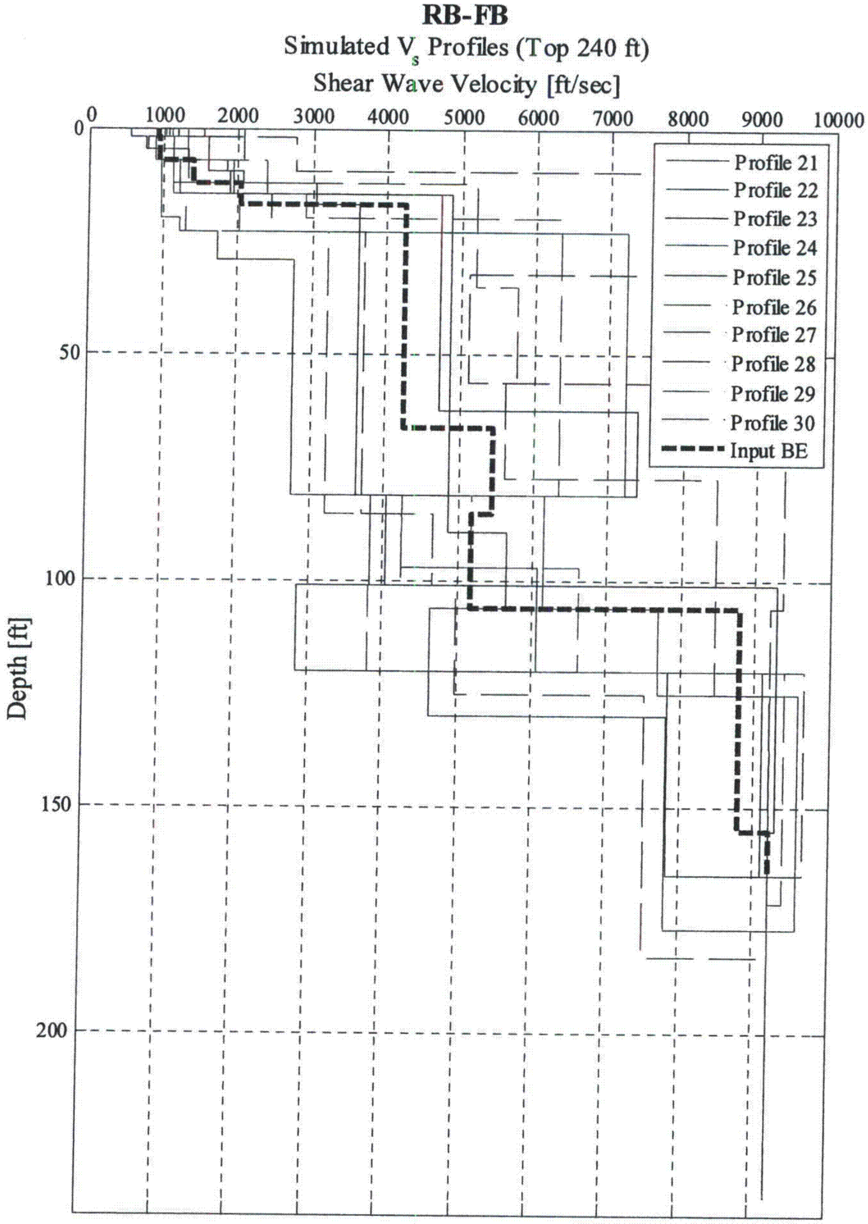
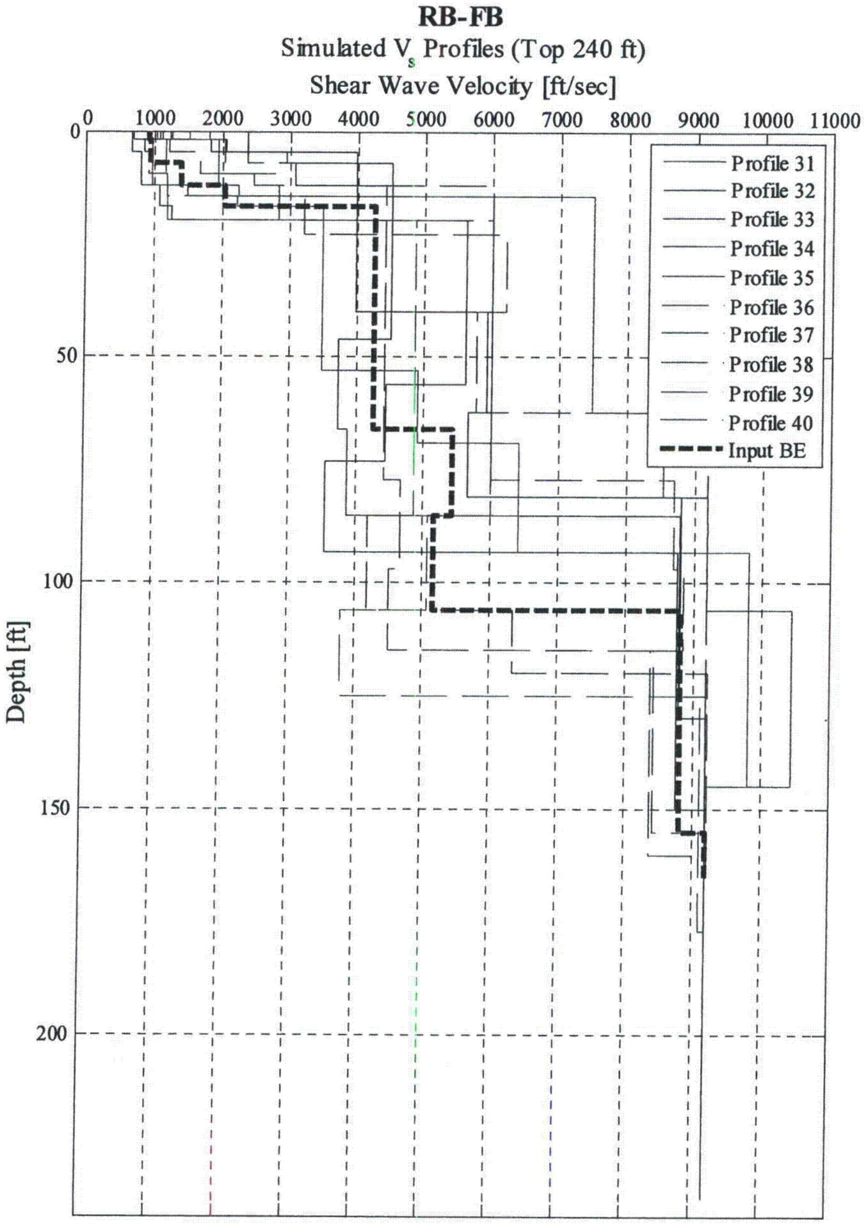


Figure 2: RB/FB Simulated Soil Profile Used for GMRS Calculation, Profiles 11 through 20. (Note that for the purpose of GMRS calculation the in-situ material at the top 66 ft of each profile is removed)



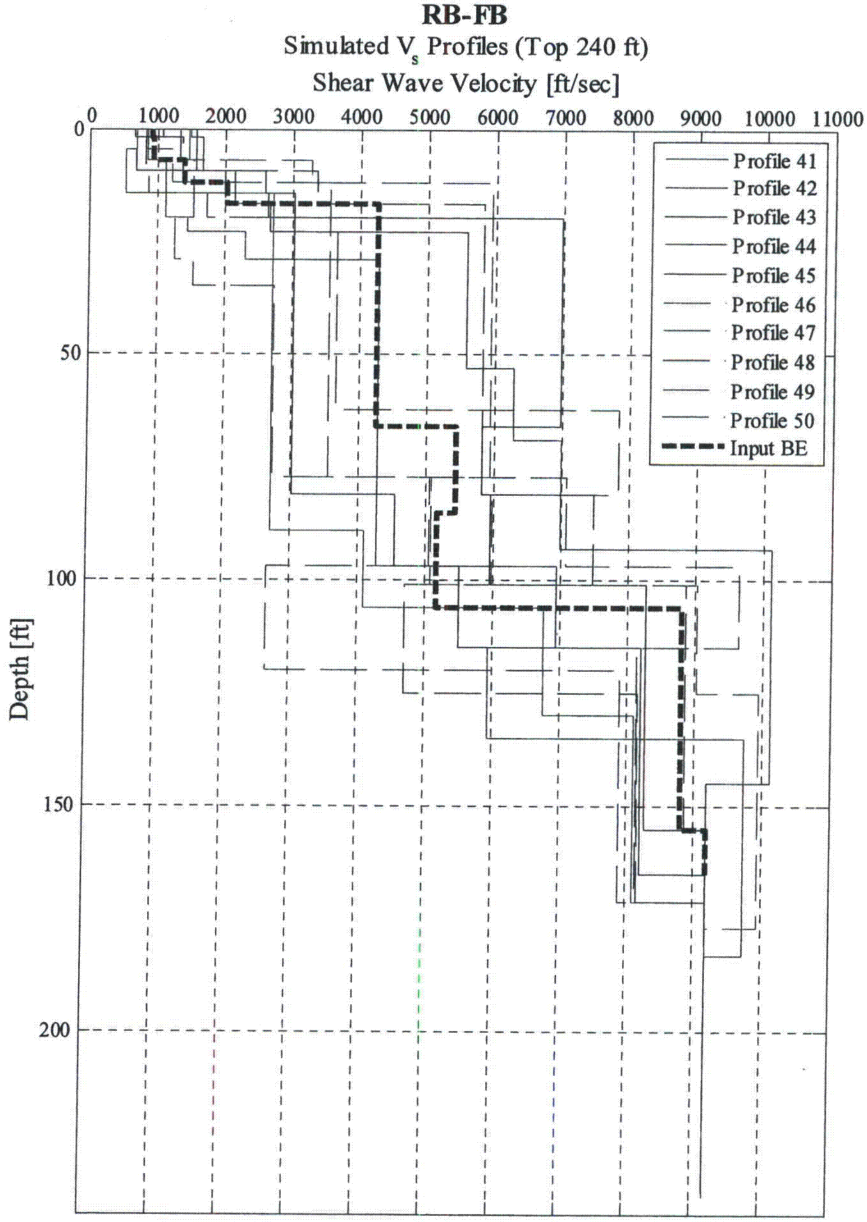
NA3, Calc. 25659-000-K0C-0000-00010

Figure 3: RB/FB Simulated Soil Profile Used for GMRS Calculation, Profiles 21 through 30. (Note that for the purpose of GMRS calculation the in-situ material at the top 66 ft of each profile is removed)



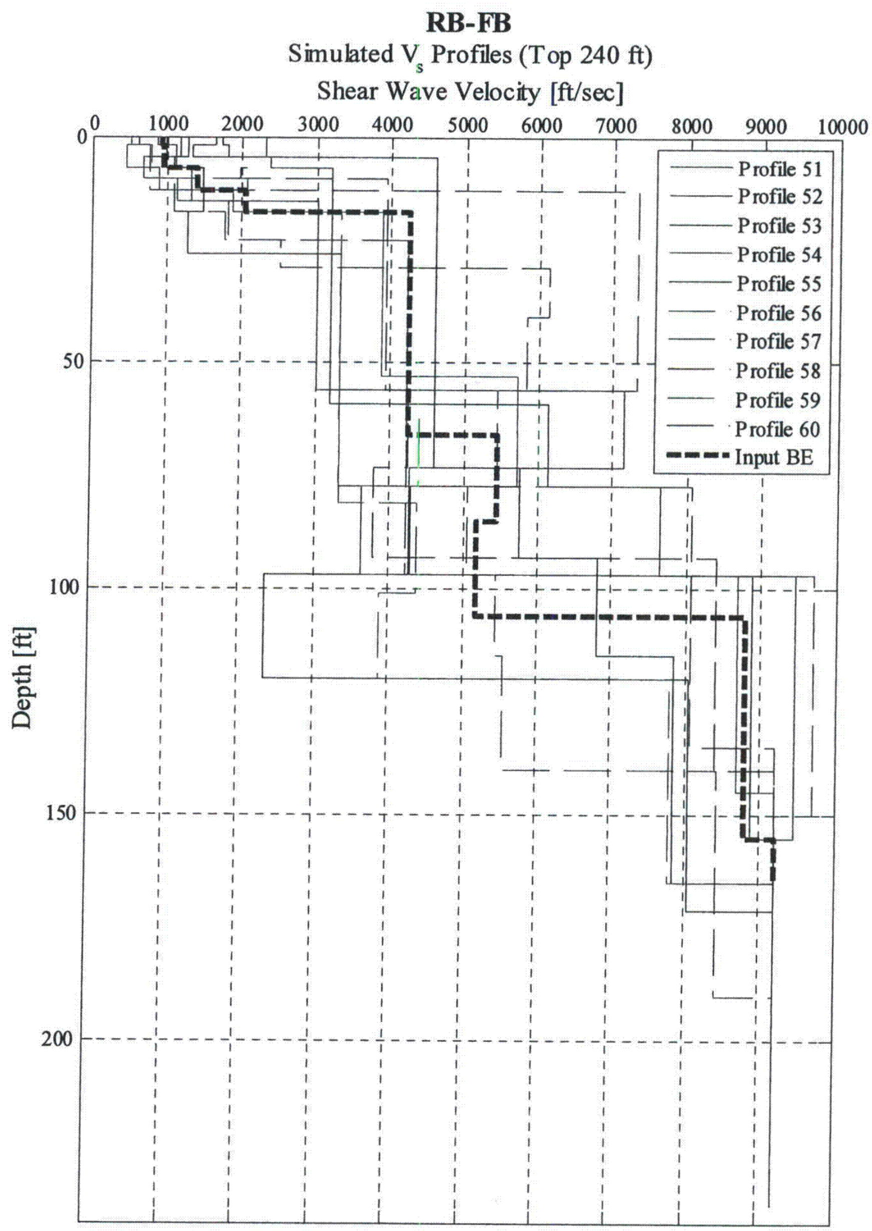
NA3, Calc. 25659-000-K0C-0000-00010

Figure 4: RB/FB Simulated Soil Profile Used for GMRS Calculation, Profiles 31 through 40. (Note that for the purpose of GMRS calculation the in-situ material at the top 66 ft of each profile is removed)



NA3, Calc. 25659-000-K0C-0000-00010

Figure 5: RB/FB Simulated Soil Profile Used for GMRS Calculation, Profiles 41 through 50. (Note that for the purpose of GMRS calculation the in-situ material at the top 66 ft of each profile is removed)



NA3, Calc. 25659-000-K0C-0000-00010

Figure 6: RB/FB Simulated Soil Profile Used for GMRS Calculation, Profiles 51 through 60. (Note that for the purpose of GMRS calculation the in-situ material at the top 66 ft of each profile is removed)

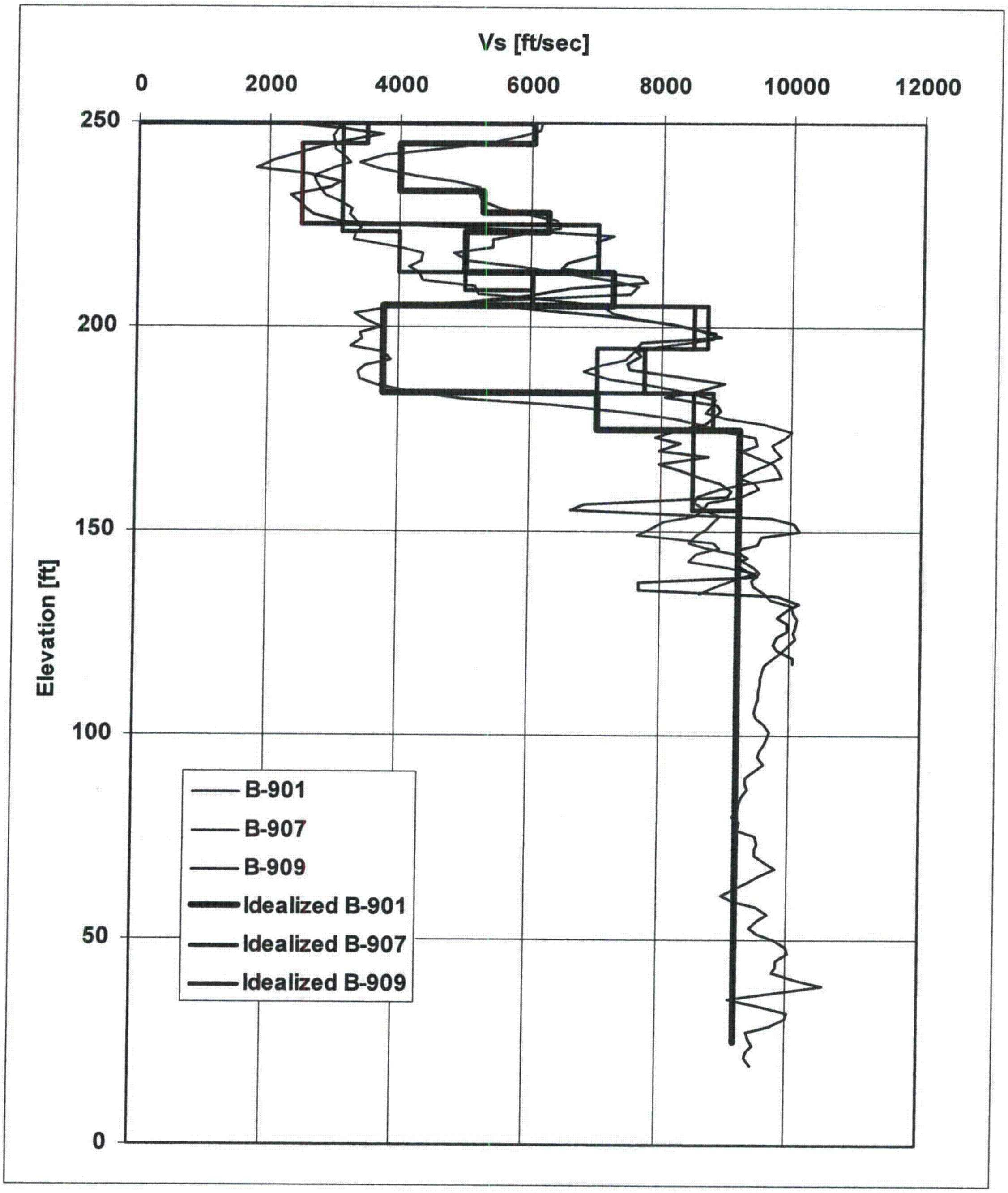


Figure 7: Idealized Shear Wave Velocity Profiles for Considered Boreholes (without concrete fill)

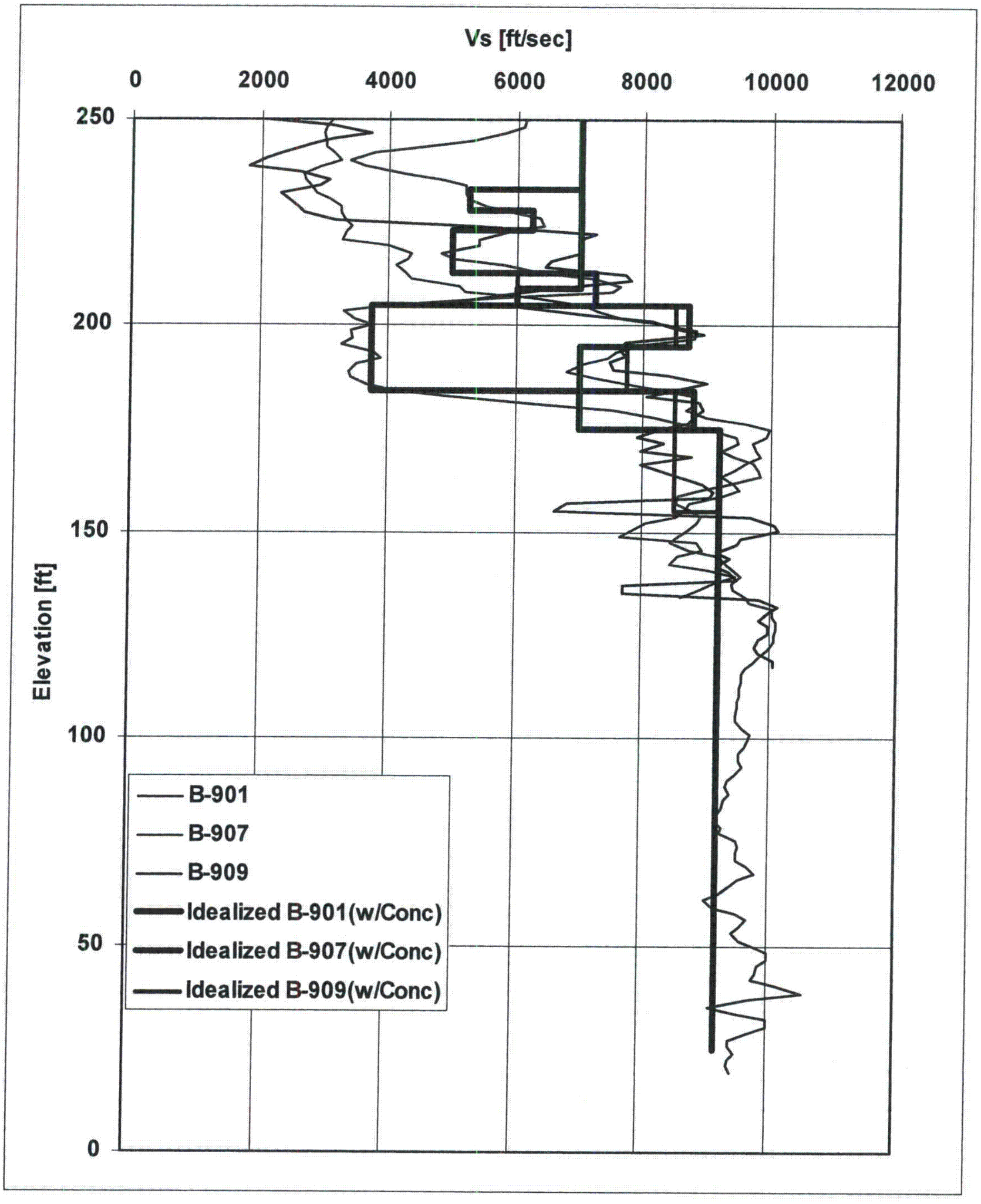


Figure 8: Idealized Shear Wave Velocity Profiles for Considered Boreholes (with concrete fill for the US-APWR technology)

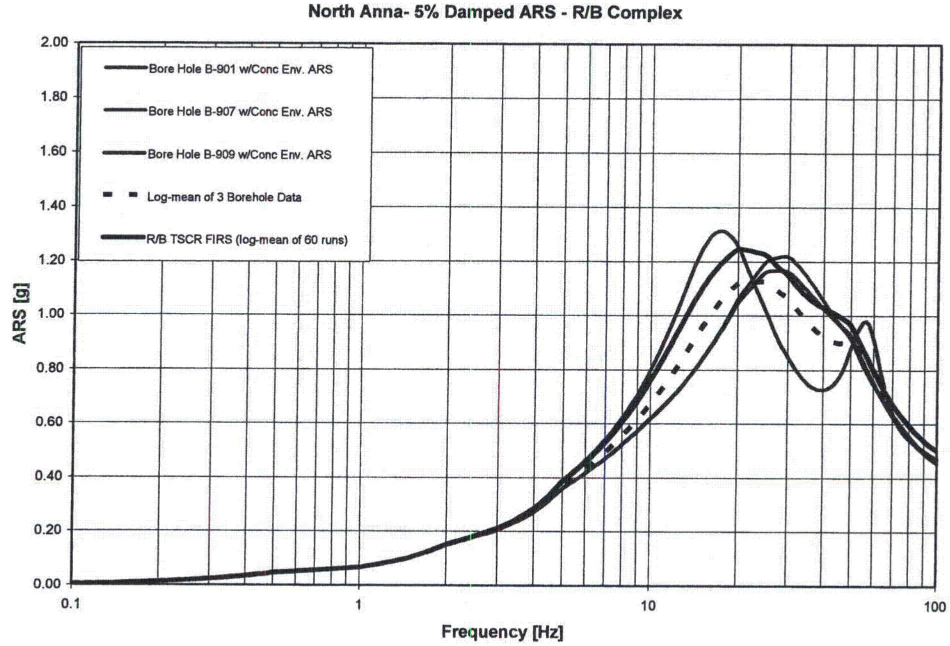


Figure 9: Comparison of Log-mean Response Obtained from Boreholes B-901, B-907, and B-909 with the US-APWR R/B Complex TSCR FIRS

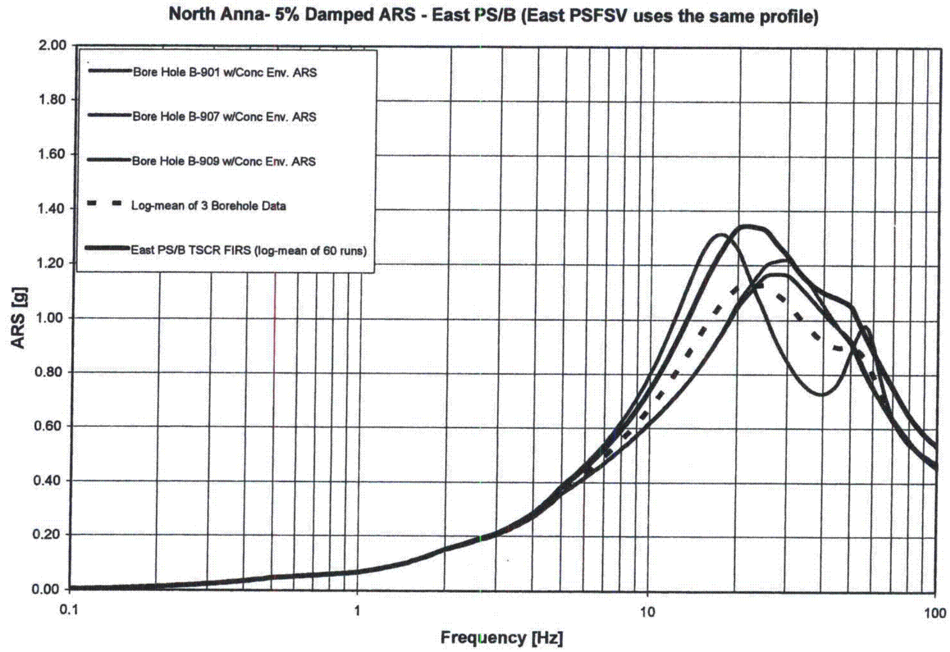


Figure 10: Comparison of Log-mean Response Obtained from Boreholes B-901, B-907, and B-909 with the US-APWR East PS/B TSCR FIRS

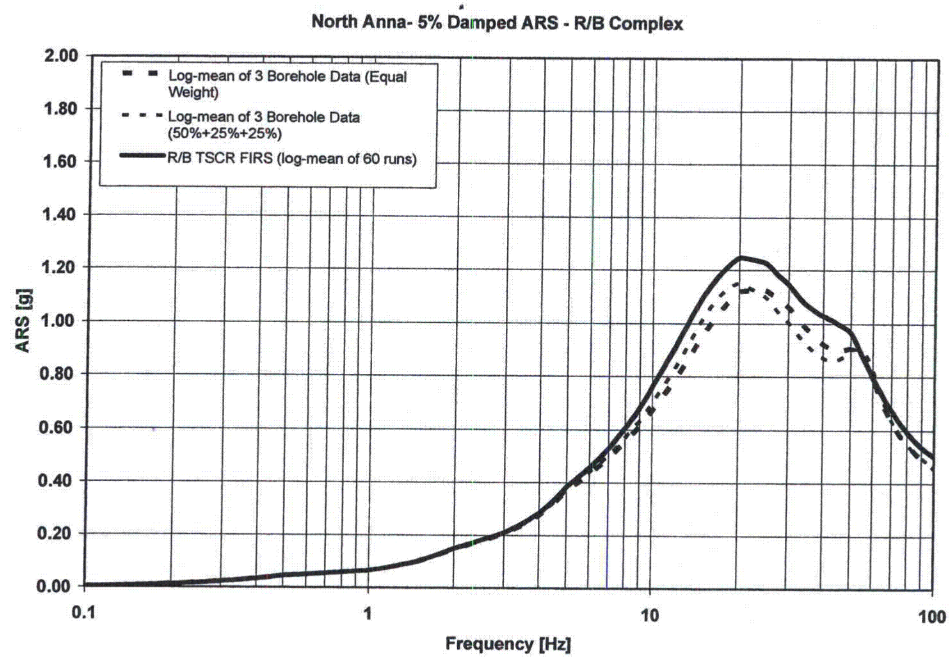


Figure 11: Comparison of Equally Weighted and 50%, 25%, 25% Weighted Log-mean Response Obtained from Boreholes B-901, B-907, and B-909 with the US-APWR R/B Complex TSCR FIRS

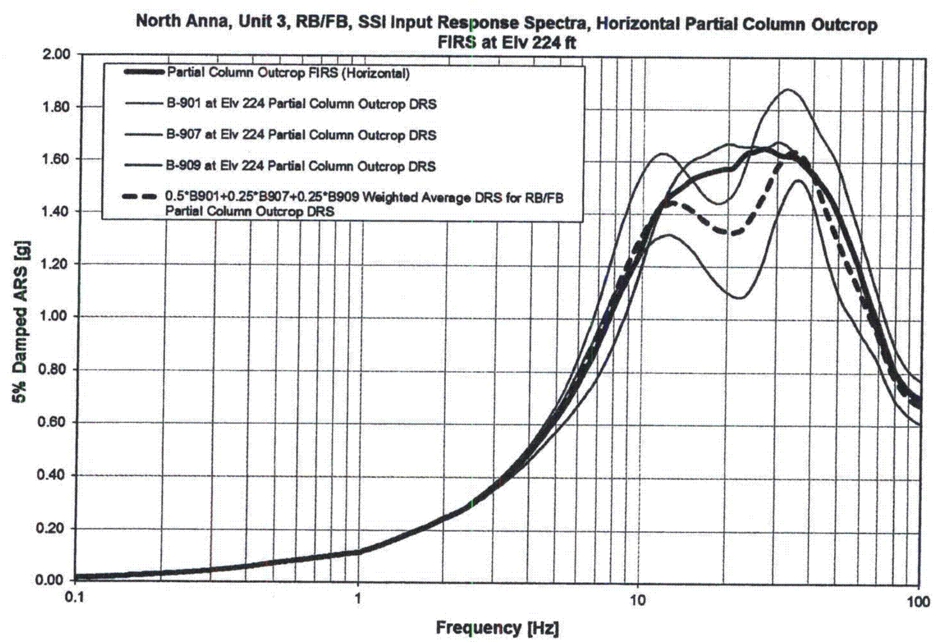


Figure 12: Comparison of the Combined Partial Column Outcrop DRS Using B901, B907, and B909 Soil Column Sets at Elevation 224 ft with the FIRS Calculated for the ESBWR RB/FB

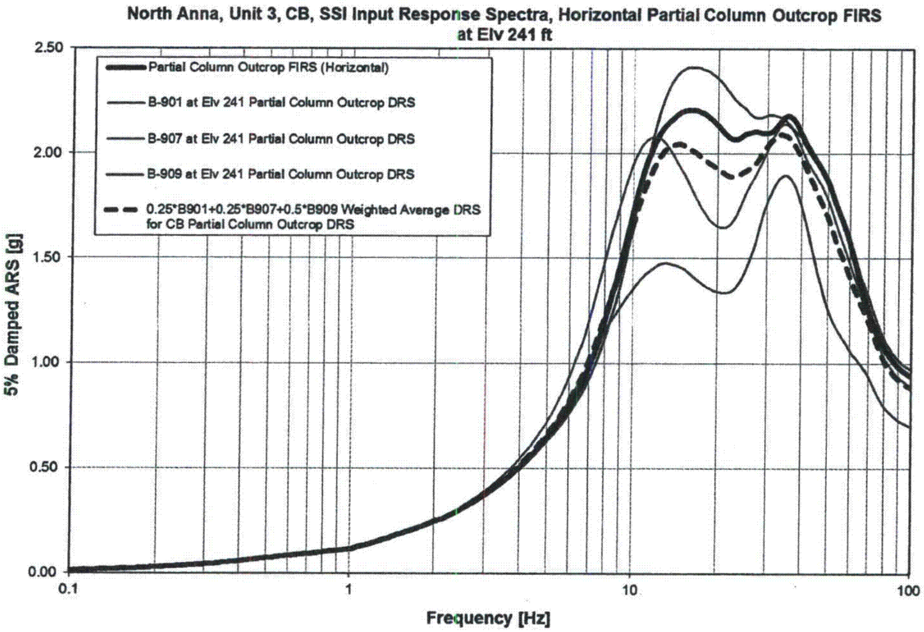


Figure 13: Comparison of the Combined Partial Column Outcrop DRS Using B901, B907, and B909 Soil Column Sets at Elevation 241 ft with the FIRS Calculated for the ESBWR CB

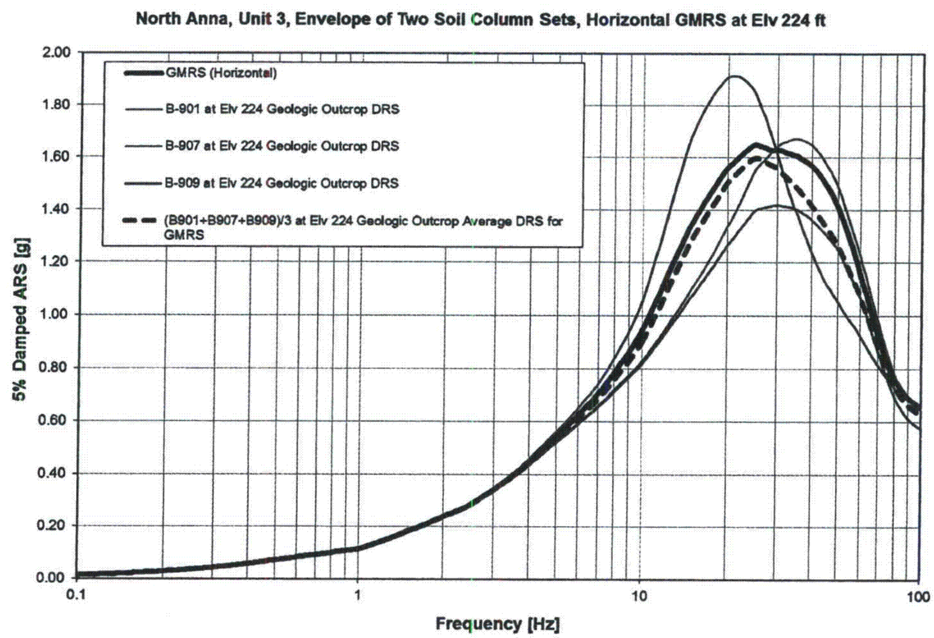


Figure 14: Comparison of the Combined Geologic Outcrop DRS Using B901, B907, and B909 Soil Column Sets at Elevation 224 ft with the ESBWR GMRS

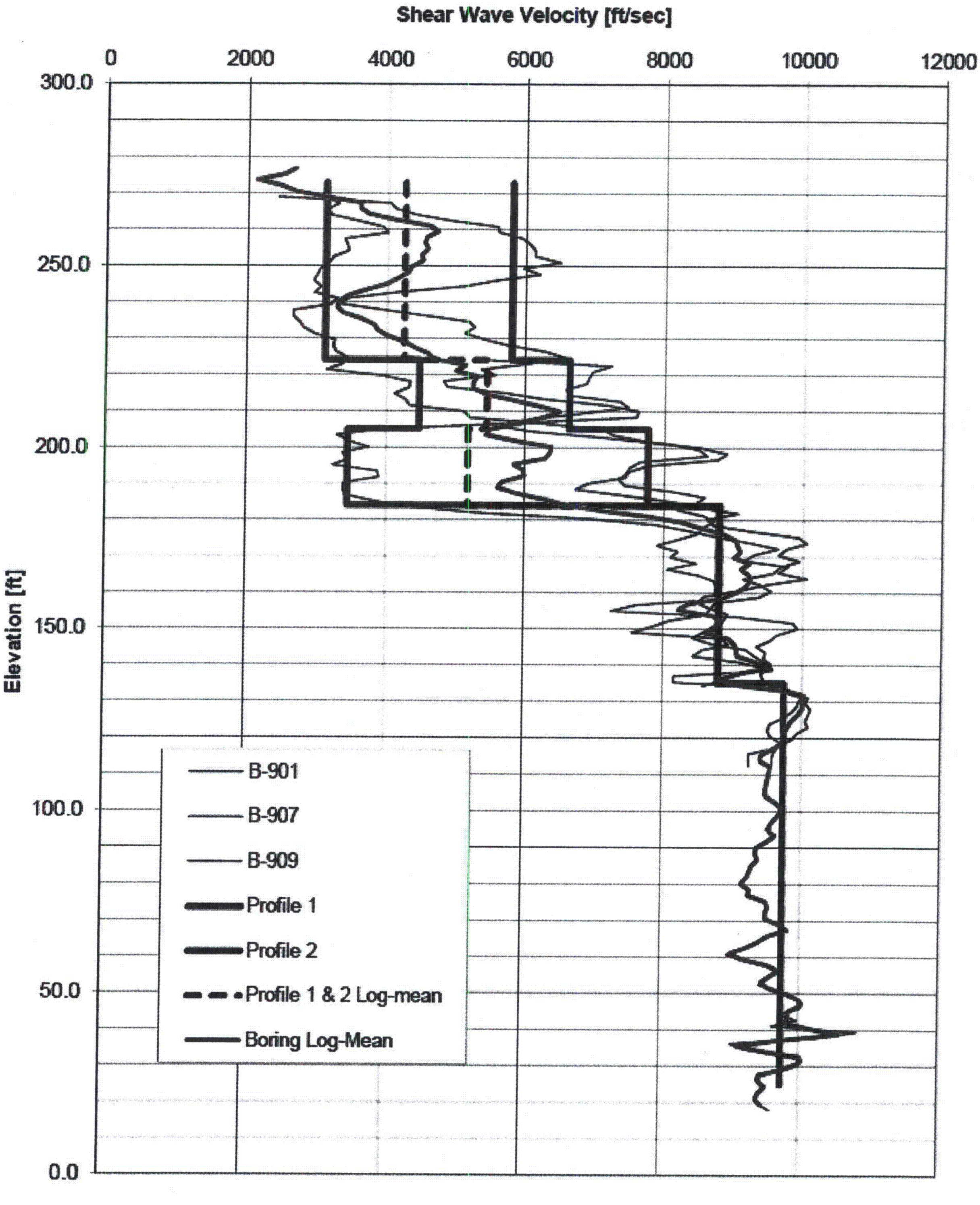


Figure 15: Bedrock Shear Wave Velocity Profiles

ENCLOSURE 10

Revised Response to NRC RAI Letter No. 64

Question 03.07.01-3

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

North Anna Unit 3

Dominion

Docket No. 52-017

RAI NO.: 5544 (RAI Letter 64)

SRP SECTION: 03-07-01 – SEISMIC DESIGN PARAMETERS

QUESTIONS for Structural Engineering Branch 1 (SEB1)

DATE OF RAI ISSUE: 04/07/2011

QUESTION NO.: 03.07.01-3

A basic assumption in a SASSI (computer code) based seismic soil structure interaction (SSI) analysis is that the subsurface layers involved are horizontally infinite and uniform. However, the North Anna Unit 3 (NA3) FSAR site is characterized by significant horizontal variability in subsurface condition and use of fill concrete beneath the proposed Category I structures and across the site, in general; see Figures 2.5.229 – 2.5.234 of the NA3 FSAR. The staff concern is that the presence and non-uniformity of the concrete fill layer may amplify seismic demands. To address this concern, the staff requests the COL applicant to identify the results of any sensitivity studies conducted to demonstrate that the lateral uniformity assumption is applicable to the site-specific seismic SSI analyses of all Category I structures at the NA3 site.

Dominion Response

Dominion responded to RAI Letter 64 in a letter dated August 22, 2011 (ML11236A130). The response to RAI 03.07.01-3 was deferred to a future submittal. This RAI question was developed based on US-APWR technology. Dominion has changed its nuclear technology selection from the US-APWR to the ESBWR design. The response is provided below.

Note that FSAR Figures 2.5.229 to -234 referenced in the RAI (see above) are now Figures 2.5.4-225 to 2.5.4-230 in the revised NA3 FSAR. Also note that Figures 1 through 8, which are referenced in the response, are provided in Attachment 1.

Soil-Structure Interaction (SSI) Analyses Approach

The site-specific SSI analyses of each of the ESBWR NA Unit 3 Seismic Category I structures are performed using separate input ground motion time histories and soil profiles representative of the dynamic subgrade properties under each individual building. Dominion responses to RAI 5199 (RAI Letter 53; ML110340012) and RAI 5693 (RAI Letter 68; ML11241A058; ML11342A080; and ML12048A236) demonstrate that the approach used for development of site-specific Foundation Input Response Spectra (FIRS) adequately captures the effect of soil variability under each building. The results of the sensitivity studies presented in the Response to RAI No 5199 and the results of the site-specific SSI analyses of best estimate (BE), lower bound (LB) and upper bound (UB) subgrade profiles indicate that the considered range of dynamic subgrade properties adequately captures the variation of the overall dynamic characteristics of the subgrade. The comparisons of the SSI responses obtained from the analyses of BE, LB and UB profiles show that the effects of the interaction of the buildings with the stiff rock subgrade are small. Therefore, it can be concluded without performing sensitivity SSI analysis studies that the possible effects due to variations of the rock subgrade properties are small and are adequately addressed.

The site-specific SSI analyses of Unit 3 use separate sets of input ground motion time histories and strain-compatible soil profiles representative of the dynamic subgrade properties under the foundations of the ESBWR Seismic Category I structures, which are the Reactor Building / Fuel Building (RB/FB), Control Building (CB) and Firewater Service Complex (FWSC). In order to account for the uncertainties related to subgrade properties including their variability in the horizontal direction, the site-specific seismic design basis is developed as an envelope of the responses obtained from SSI analyses of three subgrade profiles representing BE, LB and UB strain-compatible properties of the subgrade. These BE, LB and UB profiles are developed following the "Specific Guidelines for SSI Analysis" section of NRC SRP 3.7.2, Revision 4 (Reference 1), based on the results of the site response analyses of the three sets of randomized soil profiles used for development of the site-specific FIRS for the RB/FB, CB and FWSC. The BE profiles for each structure represent the log-mean of the randomized strain-compatible soil profiles. The LB and UB soil properties for each structure are calculated as ± one log-standard deviation from the log-average values and are adjusted to ensure that the value of the coefficient of variability (COV) of the soil shear modulus is at least 0.5 corresponding to variation of the subgrade shear wave and compression wave velocities of at least $^{+}$/- 22.5%.

The site characteristics and the methodology used for development of the randomized soil profiles for the site response analyses based on data obtained from the site investigations are described in Dominion responses to RAI 5199 (RAI Letter 53) and RAI 5693 (RAI Letter 68). As described in the response to RAI 5693 Question 02.05.02-3, the randomized profiles used for site response analyses for RB/FB FIRS are developed based on the measurements of rock shear wave velocities observed in boreholes B-901, B-907, and B-909 in the power block area. The randomized profiles used for the CB and FWSC site response analyses are developed based on the measurement obtained from Borehole B-909.

The justification of the assumption of horizontal uniformity of the soil layers in relation to the applicability of 1-D wave propagation methods implemented in the P-SHAKE computer program for calculation of site amplification factors is provided in the Dominion Response to RAI No 5199. The sensitivity analyses performed to evaluate the effects of the site subsurface properties variations on the FIRS are presented in Dominion's response to RAI No 5693 (RAI Letter 68). These sensitivity studies verified that the approach implemented for development of the randomized soil profiles and site response analyses adequately captures the variability of subsurface properties and produces sufficiently conservative FIRS that serve as the basis for development of input control motion for the site-specific SSI analyses.

Results of the site-specific SSI analyses for BE, LB and UB subgrade profiles indicate that the effects of the interaction of the buildings with the stiff rock subgrade are small and that the dynamic properties of the structures govern the SSI. Figures 1 and 2 of this response provide comparison of transfer function results obtained from the SSI analyses of RB/FB for BE, LB and UB subgrade profiles. Responses are presented on these figures at two locations of the RB/FB model, the center of the basemat bottom and the top of the structural model. The figures show peaks of the horizontal response transfer functions at a frequency of 16.5 Hz for LB soil case, 22.2 Hz for the BE soil case and 30.0 Hz for the UB soil case representative of the shear column dynamic characteristics of the in-situ rock above the base of the building. The plots of the vertical acceleration transfer functions show peaks only for the LB case at a frequency of 40.5 Hz, thus indicating that the compression column dynamic properties of the site are characterized by frequencies higher than the highest frequency of interest of 50 Hz. The transfer function results presented in Figure 1 below indicate that the SSI analyses of the three different soil cases all yielded peak responses at frequencies that are close to the natural frequencies of the structure.

The sensitivity studies in the response to RAI No 5693 are based on comparison of the partial column outcrop design response spectra (DRS) obtained from site response analyses of three profiles representative of the shear wave velocity measurements from the three boreholes in the power block area, B-901, B-907, and B-909. Figure 3 below presents the site amplifications factors obtained from the results of these site response analyses. The peak frequencies in the presented site amplification factors reflect the column frequencies of the measured shear wave velocity profiles and are indicators of the variation of the overall dynamic properties of the subgrade. Figure 3 shows that the peak frequencies in the site amplification factors are in the range of 18 Hz to about 50 Hz, thus indicating that the variation of the overall dynamic properties of the subgrade in the power block area are adequately captured by the variance used in development of the BE, LB and UB profiles used for the site-specific SSI analyses.

Figures 4 and 5 below provide the 5% damping acceleration response spectra (ARS) results for the responses of RB/FB at the top of the structure and at the center of the basemat bottom, respectively. The comparisons in these figures show that the differences between the ARS obtained from the analyses of the BE, LB and UB soil profiles are small. The variation in subgrade properties affects mainly the amplitude of the spectral peak responses due to the difference in the rock damping. The ARS

comparisons in Figures 4 and 5 show negligible frequency shifts of the peak spectral responses, thus confirming that the effects of the interaction of the RB/FB with the stiff rock subgrade are small. The SSI effects, including effects of variability of the subgrade properties, on the response of the RB/FB as the heaviest building with the largest footprint dimensions are the most pronounced. Therefore, conclusions based on the comparisons of results obtained from the SSI analyses of RB/FB are also applicable for the CB and FWSC.

Modeling Approach used to Address the Presence and Non-uniformity of the Concrete Fill

The impact of the presence and non-uniformity of the concrete fill layer on the seismic demands is addressed in the SASSI modeling approach for the site-specific SSI analyses. The SASSI site model represents the in-situ properties of the subgrade as horizontally infinite layers. The limited extent of the concrete fill is included in the SASSI structural (house) models for the RB/FB, CB and FWSC, as shown in Figures 6, 7 and 8 below, by using solid brick elements. The concrete fill under the basemat is included in the structural model to reach the top elevation of the Zone III-IV rock. The SASSI structural (house) models of RB/FB and CB also include the concrete fill placed between the structures and adjacent to excavated Zone III rock by using solid brick elements placed around the perimeter of the shell elements modeling the basements of these two buildings. The width of the side concrete fill in the SASSI structural models is taken to be constant for all 4 sides of the building and equal to one-half of the fill width between buildings or the fill width on the side without adjacent buildings, whichever is smaller. Since the side concrete fill is stiffer than the excavated Zone III rock, it minimizes the effects of SSI.

The concrete fill is to have a minimum compressive strength of 2500 psi, which corresponds to a shear wave velocity of 7000 feet per second (fps) and which is similar to the shear wave velocity of the Zone III-IV rock. Since the in-situ soil properties of the supporting Zone III-IV rock are close to the properties of the concrete fill, the variability of the concrete fill thickness will have negligible effect on the SSI response. The 28-day compressive strength of the concrete fill is verified by a site-specific ITAAC, which is included in Part 10 of the Unit 3 COLA.

Reference

NUREG-0800,"Standard Review Plan for Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition- Design of Structures, Components, Equipment, and Systems," Section 3.7.2, "Seismic System Analysis," Revision 4 (09/2013).

Proposed COLA Revision

None.

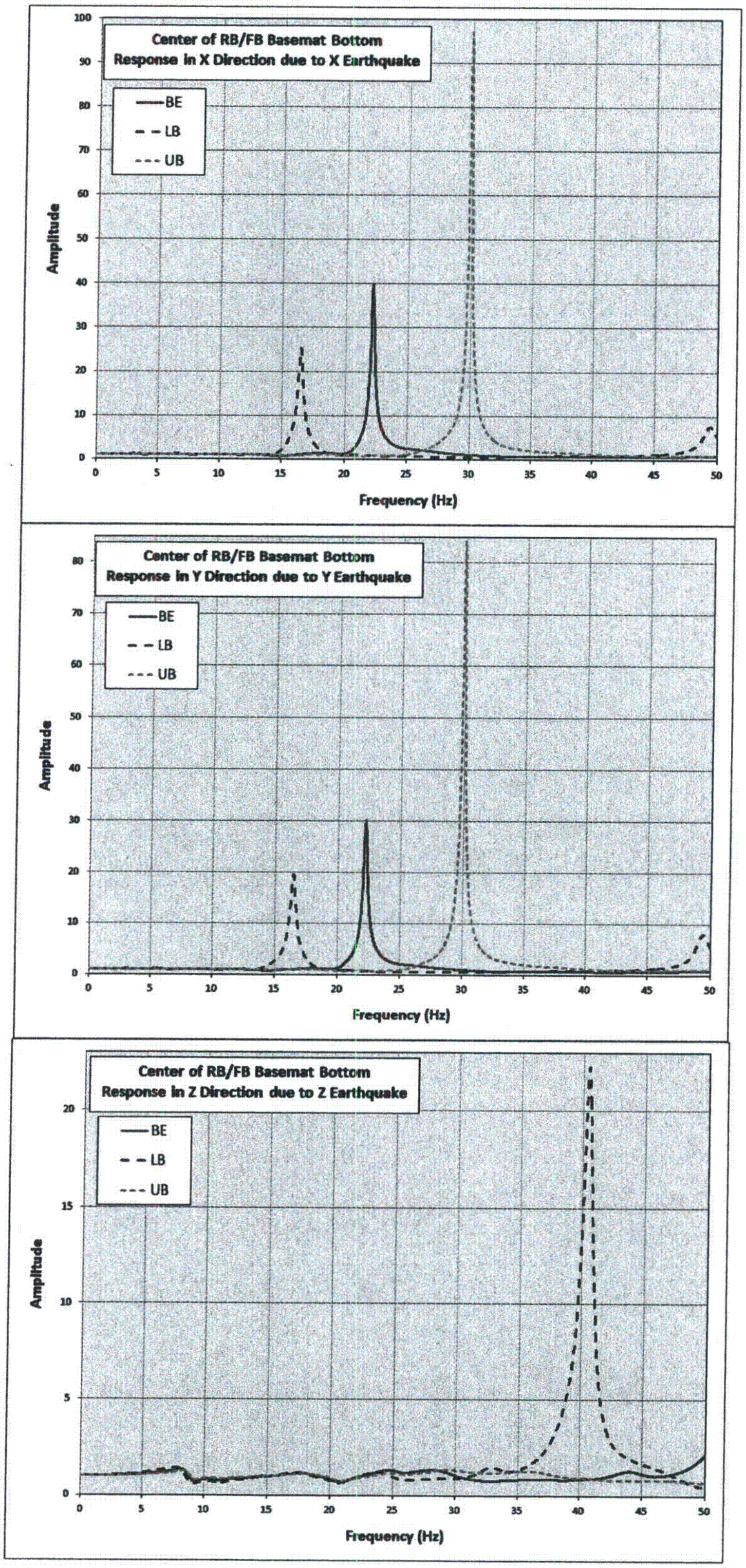


Figure 1: Acceleration Transfer Function for Response at the Center RB/FB Basemat Bottom

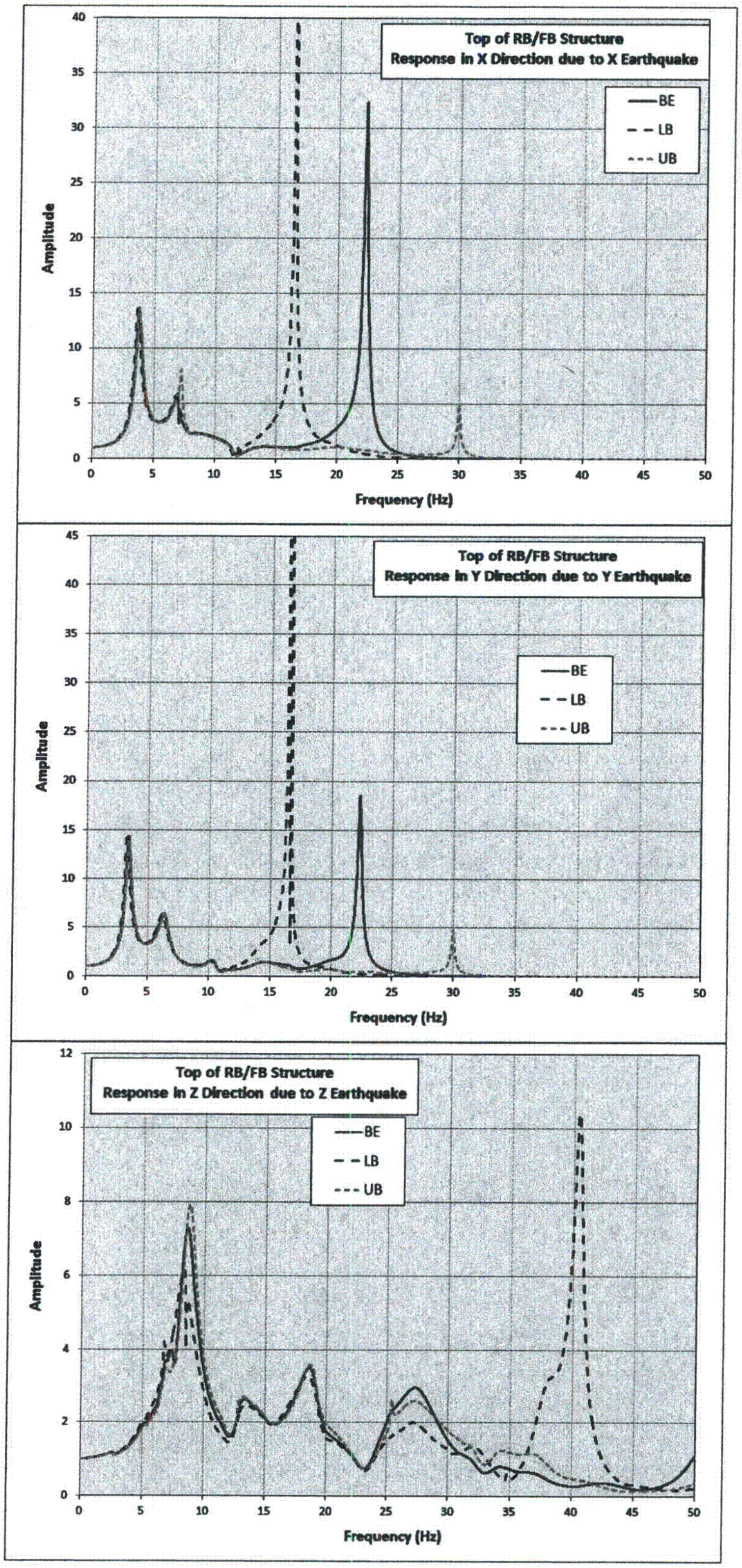


Figure 2: Acceleration Transfer Function for Response at the Top of RB/FB Structure

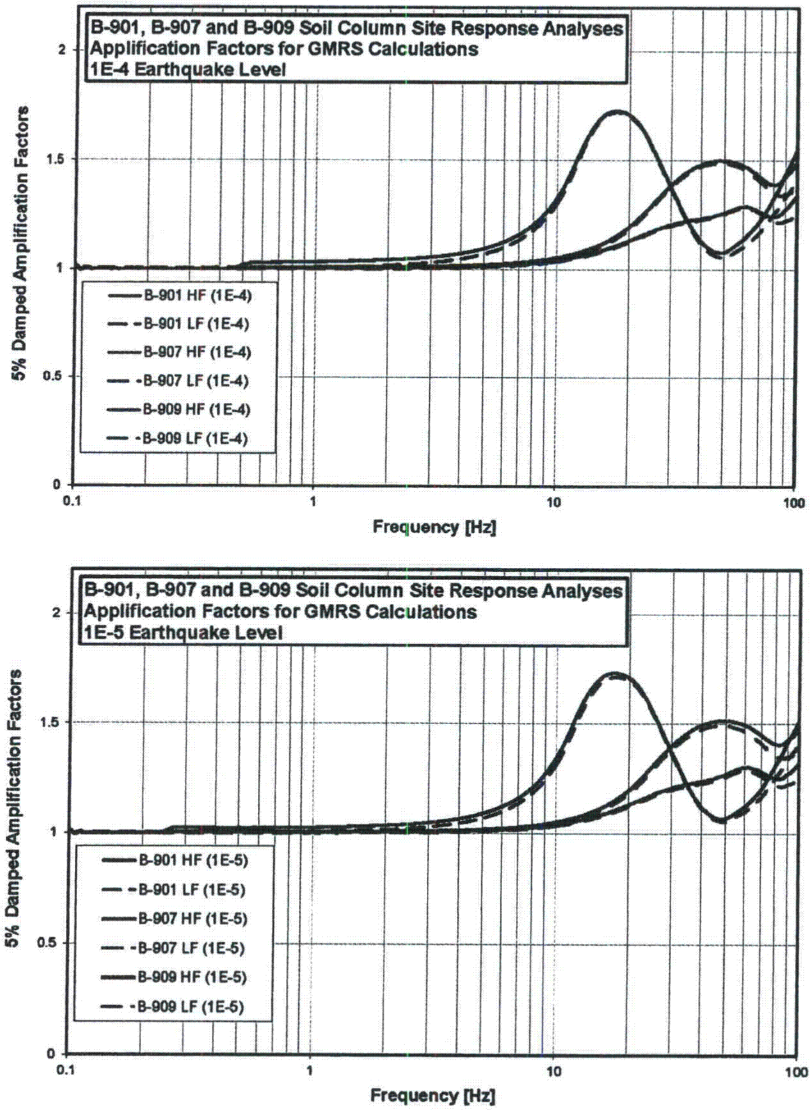


Figure 3: Site Amplification Factors from Analyses of B-901, B-907 and B-909 Soil Columns

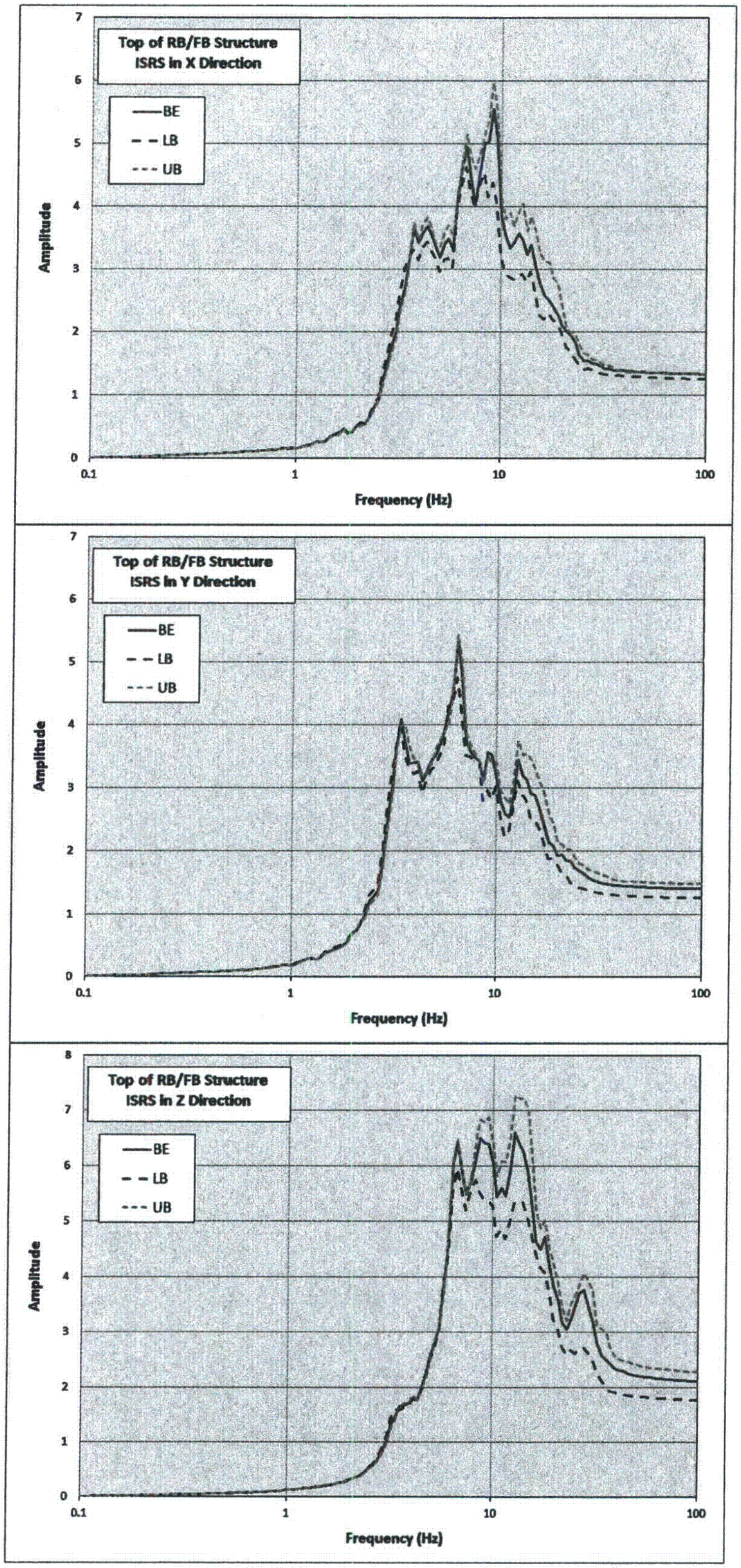


Figure 4: 5% Damping ARS for Response at the Top of RB/FB Structure

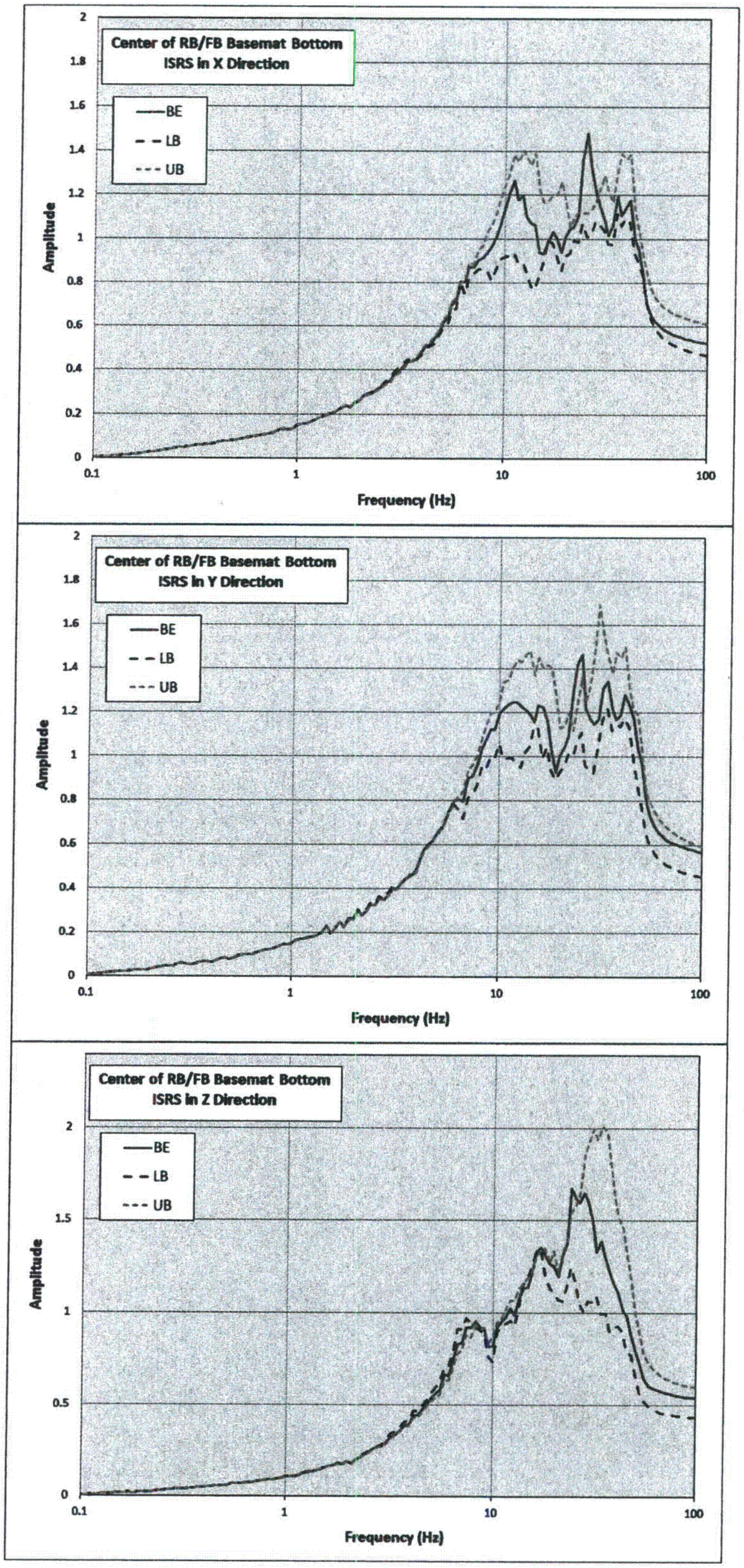


Figure 5: 5% Damping ARS for Response at the at the Center RB/FB Basemat Bottom

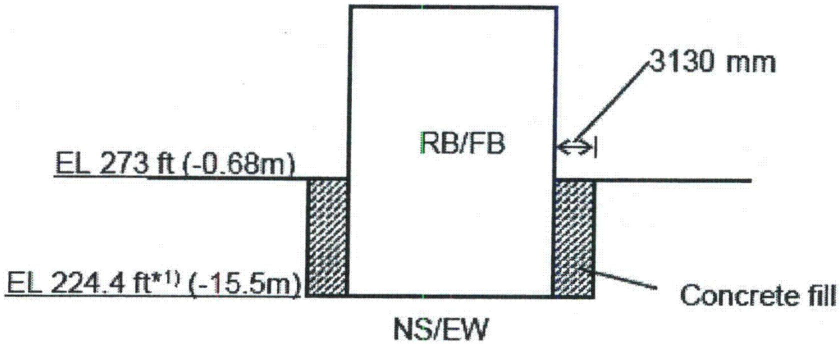


Figure 6: RB/FB SASSI Structural (House) Model

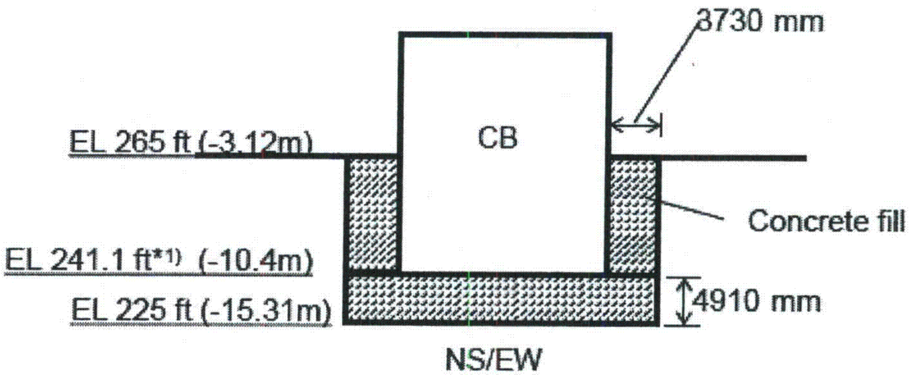


Figure 7: CB SASSI Structural (House) Model

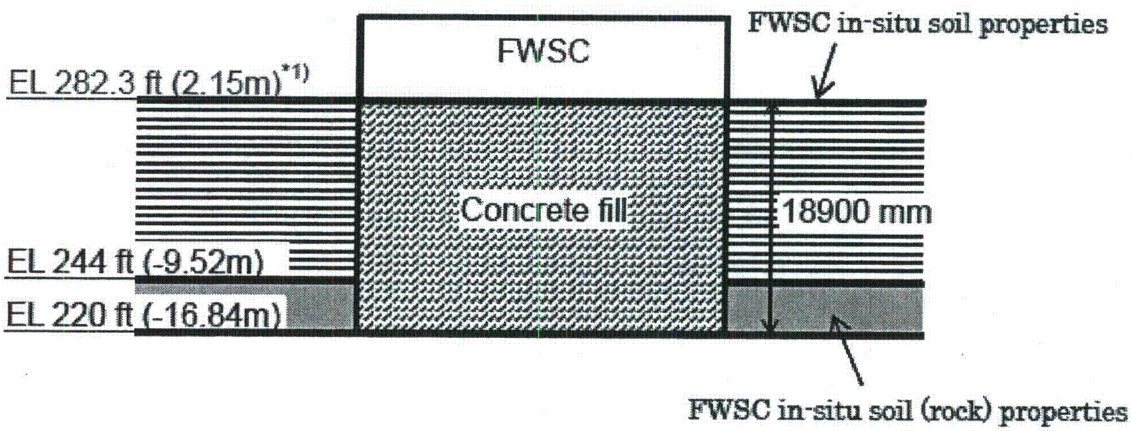


Figure 8: FWSC SASSI Model

ENCLOSURE 11

Revised Response to NRC RAI Letter No. 14

Question 03.07.02-1

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

North Anna Unit 3

Dominion

Docket No. 52-017

RAI LETTER NO.: 014

SRP SECTION: 03.07.02 – SEISMIC SYSTEM ANALYSIS

DATE OF RAI ISSUE: 06/27/2008

QUESTION NO.: 03.07.02-1

FSAR Section 3.7.2.8, Interaction of Non-Category I Structures with Seismic Category I Structures, incorporates by reference the ESBWR DCD with supplement NAPS SUP 3.7-5. NAPS SUP 3.7-5 references Figure 2.1-201 for the locations of structures. Staff review identified that neither Section 3.7.2.8 nor Figure 2.1-201 include all the information identified in Regulatory Guide (RG) 1.206 (C.1.3.7.2.8) to verify protection of seismic Category I structures from failure of non-Category I structures as a result of seismic effects. Please provide identification and locations of each Category I, II, and nonseismic structures, including the distance between structures and the height of each structure.

Dominion Response

Dominion responded to this RAI question in a letter dated October 8, 2008 (ML082840763). That response was submitted when North Anna Unit 3 was the original reference COLA (R-COLA) for the ESBWR design. This RAI response supersedes the October 8, 2008 response in its entirety.

A revised table, Table 1: North Anna ESBWR Unit 3 Plant Specific Structure Heights and Separation Distances, is provided in Attachment 1 to this enclosure to address question 03.07.02-1. The table has been revised to reflect changes to the site layout for an Economic Simplified Boiling Water Reactor (ESBWR) unit.

Proposed COLA Revision

None.

Table 1: North Anna ESBWR Unit 3 Plant Specific Structure Heights and Separation Distances

Plant Specific Structure	*Height Above Grade (feet)	Closest Seismic Category I (SCI) Structure	Distance Between Plant-Specific Structure and Closest SCI Structure (feet)
Electrical Building (main)	<90	Fire Water Service Complex	>100
Hybrid Cooling Tower Electrical Building	<40	Fuel Building	>1600
Dry Cooling Tower Electrical Building	<100	Fuel Building	>1350
Main Transformers	<50	Reactor Building	>400
Aux Transformers	<50	Fire Water Service Complex	>400
Ancillary Diesel Building	<40	Fuel Building	>45
Diesel Fuel Oil Storage Tank A	<50	Fire Water Service Complex	>280
Diesel Fuel Oil Storage Tank B	<50	Fire Water Service Complex	>360
Diesel Fuel Oil Transfer/Foam House	<40	Fire Water Service Complex	>250
Makeup Water Building	<40	Reactor Building	>850
Hybrid Cooling Tower	<240	Fuel Building	>1350
Dry Cooling Tower	<120	Fuel Building	>1300
Service Water Cooling Tower	<100	Fire Water Service Complex	>450
Circulating Water Pump House	<40	Fuel Building	>1300
Station Water Intake Building	<40	Reactor Building	>950
Demineralized Water Storage Tank	<50	Reactor Building	>800
Station Water Storage Tank	<50	Reactor Building	>800
Service Water Building	<40	Fire Water Service Complex	>570
Condensate Storage Tank	<40	Reactor Building	>220
Administration Building	<120	Fuel Building	>190
Cooling Tower Maintenance Building	<40	Fuel Building	>1400
Hot Machine Shop and Maintenance Building	<40	Fuel Building	>45
Sewage Treatment Plant	<40	Reactor Building	>850
Hydrogen Storage Area	<40	Fuel Building	>700
Nitrogen Storage Area	<40	Fuel Building	>550
Oxygen Storage Area	<40	Fuel Building	>750
CO2 Storage Area	<40	Fuel Building	>650
Electrical Building (small)	<40	Reactor Building	>100
Site Support Structure	<40	Fire Water Service Complex	>700
Vehicle Access Facility	<40	Fuel Building	>250

* Structure height includes relative elevation difference where plant specific-structure base elevation is higher than closest SCI structure plant finish grade.

ENCLOSURE 12

Revised Response to NRC RAI Letter No. 9

Question 08.02-14

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

North Anna Unit 3

Dominion

Docket No. 52-017

RAI LETTER NO.: 009

SRP SECTION: 08.02 – OFFSITE POWER SYSTEM

DATE OF RAI ISSUE: 06/13/2008

QUESTION NO.: 08.02-14

FSAR Section 8.2.2.1 states that the system impact study was prepared using 2011 summer light-load and 2014 summer base-case projections. Please provide the basis for using 2011 summer light-load and 2014 summer base-case projections rather than the summer heavy-load projections and clarify whether the summer loads bound winter peak loads.

Dominion Response

Dominion responded to this RAI question in a letter dated July 28, 2008 (ML082170400). That response was submitted when North Anna Unit 3 was the original reference COLA (R-COLA) for the ESBWR design. This RAI response supersedes the July 28, 2008 response in its entirety.

Both the original 2006 and the revised September 2013 System Impact Studies (SIS) were performed by PJM Interconnection, the Regional Transmission Organization (RTO), to study the interconnection of Unit 3 to the North Anna switchyard and each consists of a loadflow analysis, an import/export study, and a stability study.

The RTO determines network impacts from generation projects on a five year out transmission system model. Because Dominion submitted the original SIS to the RTO in 2006, North Anna Unit 3 network upgrade requirements were originally based on a 2011 system model. The RTO annually updates base models to perform Regional Transmission Expansion Plan analyses and identify potential reliability problems. Therefore, for the September 2013 Revised System Impact Study and Facilities Study Report, the RTO used the 2013 system model as its most accurate model for the study of the revised North Anna Unit 3 proposal. The current 2013 summer model, consisting of both peak load and light load cases, is based on the as-built transmission system

including proposed load additions and projects evaluated by the RTO in addition to North Anna Unit 3. The peak load case for the 2013 summer model envelopes the peak winter load and is used for the loadflow and import/export studies. Both the peak load and light load cases are used in the stability studies.

The original SIS was additionally reviewed by the RTO against a 2014 projected system model since the original interconnection date was 2014. This review was not required to establish interconnection rights as the rights were established using the original 2011 system model. Once interconnection rights have been established, the RTO reviews revised studies against the most current model (updated annually). Therefore, the RTO reviewed the Revised System Impact Study and Facilities Study Report against the current 2013 summer model only and did not consider any projected model.

FSAR Section 8.2.2.1 reflects the change in cases used to prepare the SIS.

Proposed COLA Revision

None.

ENCLOSURE 13

Revised Response to NRC RAI Letter No. 9

Question 08.02-15

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

North Anna Unit 3

Dominion

Docket No. 52-017

RAI LETTER NO.: 009

SRP SECTION: 08.02 – OFFSITE POWER SYSTEM

DATE OF RAI ISSUE: 06/13/2008

QUESTION NO.: 08.02-15

Staff review of FSAR Section 8.2.2.1 indicates this section does not address the grid frequency variation. Please identify the maximum and minimum grid frequency. In addition, please discuss how the auxiliary power system studies consider the combined effect of frequency and voltage variation on the operation of safety-related loads (safety-related battery chargers and safety-related UPS) and other running motor loads.

Dominion Response

Dominion responded to this RAI question in a letter dated July 28, 2008 (ML082170400). That response was submitted when North Anna Unit 3 was the original reference COLA (R-COLA) for the ESBWR design. This RAI response supersedes the July 28, 2008 response in its entirety.

Dominion is a member of PJM Interconnection, the Regional Transmission Organization, and is subject to the operational requirements of PJM Manual 14D, "Generator Operational Requirements." As stated in Section 7.1.1, page 46 of Manual 14D, Rev. 24, PJM expects generation to be delivered to the point of interconnection at 60 Hz. Section 7.1.1 of Manual 14D also provides the following guidance for generator capability when interconnected with the transmission system:

> "Generators and their protective systems (relaying, V/Hz, etc.), larger than 20 MW, should meet the frequency guidelines listed in Manual M36, System Restoration, Section 2.3, to coordinate with system preservation under-frequency load shedding. Additionally, generators and their protective systems should be capable of operation at over-frequency up to 62 Hz for a limited duration."

The following guidelines for underfrequency operation of generators in response to abnormal conditions are provided in PJM Manual M36, Rev. 19, Section 2.3 – PJM South Zone:

"There is no standard requirement for the Dominion Transmission Zone, however, a number of generator have underfrequency set point that range between 56.5 Hz – 58.2 Hz ranging from 0.5 – 120 seconds."

FSAR Section 8.2.2.1 describes the revised system impact study that was performed as part of the grid reliability and stability analysis. The study was revised by the regional transmission organization (PJM Interconnection) to incorporate the updated generator characteristics and unit auxiliary loads associated with an ESBWR for North Anna Unit 3. The revised study is included in a new report, PJM Generator Interconnection Q65 North Anna 500 kV (1570 MW Capacity/1594 MW Energy) Revised System Impact Study & Facilities Study Report Resulting from Necessary Studies Agreement, dated September 2013, which is a publicly available document.

The system was studied under cases including loss of the largest generating unit, loss of the most critical transmission line, and multiple contingencies. Results of the study show all cases are stable, with a maximum frequency for all cases studied of 60.383 Hz (Summer Light Load case Q14a –3 phase fault on the 500 kV side of the Ladysmith 500/230 kV transformer #1 cleared in primary time with the 500 kV North Anna to Morrisville 500 kV line out of service) and a minimum frequency for all cases studied of 59.769 Hz (Summer Light Load case 02b2 – breaker failure at the North Anna 500 kV switchyard with delayed clearing for a 3 phase fault on North Anna to Morrisville 500 kV line).

Analyses of the as-built onsite power system will be performed to determine the power system requirements during design basis operating modes. These analyses will, in part, specify interface requirements of power, voltage, frequency, and interrupting capability necessary for the offsite power system to support safety-related load operation during design basis operating modes. These analyses will be accomplished as part of a site specific ITAAC developed to address Section 4.2 of the ESBWR DCD, Tier 1. The ITAAC will verify that the frequency and voltage variations of the transmission system, in response to events studied, meet the interface requirements of the as-built onsite power system.

Proposed COLA Revision

None.

ENCLOSURE 14

Revised Response to NRC RAI Letter No. 54

Question 08.02-54

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

North Anna Unit 3

Dominion

Docket No. 52-017

RAI NO.: 5181 (RAI Letter 54)

SRP SECTION: 08.02 – OFFSITE POWER SYSTEM

QUESTIONS for Electrical Engineering Branch (EEB)

DATE OF RAI ISSUE: 02/03/2011

QUESTION NO.: 08.02-54

FSAR Subsection 8.2.2.2 states that maximum and minimum switchyard voltage limits have been established for the 500 kV switchyard at 534 kV and 505 kV respectively. Please confirm that these voltage limits have been established based on the loss of the largest generating units or loss of the most critical transmission line and multiple contingencies. Also, specify the maximum and minimum voltage limits for the 230 kV switchyard in the FSAR.

Dominion Response

Dominion responded to this RAI question in a letter dated May 12, 2011 (ML11133A334). That response was specific to the US-APWR technology and requires revision to reflect Dominion's change in its nuclear technology selection from the US-APWR to the ESBWR design. This RAI response supersedes the May 12, 2011 response in its entirety.

FSAR Section 8.2.2.1 describes the revised system impact study that was performed as part of the grid reliability and stability analysis. The study was revised by the regional transmission organization (PJM Interconnection) to incorporate the updated generator characteristics and unit auxiliary loads associated with an ESBWR for North Anna Unit 3. The revised study is included in a new report, PJM Generator Interconnection Q65 North Anna 500 kV (1570 MW Capacity/1594 MW Energy) Revised System Impact Study & Facilities Study Report Resulting from Necessary Studies Agreement, dated September 2013, which is a publicly available document.

The system was studied under cases including loss of the largest generating unit, loss of the most critical transmission line, and multiple contingencies. Results of the study show that the maximum voltage for all cases studied is 536.15 kV (2.32% increase over

524 kV starting voltage for Summer Light Load case NP2) and the minimum voltage for all cases studied is 515.5 kV (1.64% decrease under 524 kV starting voltage for Summer Peak Load case NP2). This confirms that grid voltage variations resulting from studied events can be managed within the normal operating voltage range established for the switchyard at North Anna of 505 kV to 540 kV.

The voltage schedule for the North Anna switchyard is maintained for the 500 kV buses. The 230 kV switchyard is connected to the 500 kV switchyard by two 500/230 kV transformers with fixed taps currently set at -2.5%. This establishes the 230 kV switchyard per unit voltage at 97.5% of the 500 kV switchyard per unit voltage. Therefore, the 230 kV switchyard does not have maximum and minimum voltage limits independent from the 500 kV switchyard.

Proposed COLA Revision

None.

ENCLOSURE 15

Revised Response to NRC RAI Letter No. 66

Question 08.02-59

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

North Anna Unit 3

Dominion

Docket No. 52-017

RAI NO.: 5645 (RAI Letter 66)

SRP SECTION: 08.02 – OFFSITE POWER SYSTEM

QUESTIONS for Electrical Engineering Branch (EEB)

DATE OF RAI ISSUE: 04/14/2011

QUESTION NO.: 08.02-59

In response to RAI Question 08.02-10 (Letter 9, eRAI 178) regarding grid stability analysis for multiple contingencies (tripping of all three units), the applicant stated that NERC Category D is considered an extreme event analysis and exceeds N-2 evaluation. This includes a case for loss of all generating units at a single station. However, the applicant did not address the effect of grid stability during the loss of both existing units (Units 1 and 2). After review of commercial nuclear power plant event reports, the staff finds three dual units trip occurred since 2009: Sequoyah 1 and 2 (LER 327 and 328/2009003), Calvert Cliffs Units 1 and 2 (LER 3172010001 and 3182010001), Braidwood Units 1 and 2 (LER 4562010001 and 4572010003). In light of recent events, the possibility of dual unit trip exists at North Anna since reserve auxiliary transformers are shared between North Anna 1 and 2. Based on the operating experience identified in above LERs, address the effect of grid stability (maximum and minimum switchyard voltage) during the loss of both existing units.

Dominion Response

Dominion responded to this RAI question in a letter dated May 26, 2011 (ML11147A176). That response was specific to the US-APWR technology and requires revision to reflect Dominion's change in its nuclear technology selection from the US-APWR to the ESBWR design. This RAI response supersedes the May 26, 2011 response in its entirety.

FSAR Section 8.2.2.1 describes the revised system impact study that was performed as part of the grid reliability and stability analysis. The study was revised by the regional transmission organization (PJM Interconnection) to incorporate the updated generator characteristics and unit auxiliary loads associated with an ESBWR for North Anna Unit

3. The revised study is included in a new report, PJM Generator Interconnection Q65 North Anna 500 kV (1570 MW Capacity/1594 MW Energy) Revised System Impact Study & Facilities Study Report Resulting from Necessary Studies Agreement, dated September 2013, which is a publicly available document.

The specific case of a simultaneous trip of North Anna Units 1 and 2 was studied to determine the stability of the transmission system and the resulting maximum voltage increase and decrease. The study is case 4.4.c (NP5) in the report. Results stated in Tables Ia and Ib of the report show that the case is stable and that the resulting maximum voltage is 530.5 kV (1.21% increase over 524 kV starting voltage for Summer Light Load case NP5) and the resulting minimum voltage is 521.5 kV (0.46% decrease under 524 kV starting voltage for Summer Peak Load case NP5). This confirms that grid voltage variations resulting from a sudden loss of both Units 1 and 2 can be managed within the normal operating voltage range established for the switchyard at North Anna of 505 kV to 540 kV.

Proposed COLA Revision

None.

ENCLOSURE 16

Revised Response to NRC RAI Letter No. 36

Question 09.02.01-13

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

North Anna Unit 3

Dominion

Docket No. 52-017

RAI LETTER NO.: 036

SRP SECTION: 09.02.01 – STATION SERVICE WATER SYSTEM

QUESTIONS for Balance of Plant Branch 2 (ESBWR/ABWR) (SBPB)

DATE OF RAI ISSUE: 05/06/2009

QUESTION NO.: 09.02.01-13

The plant service water system (PSWS) design bases as described in Design Control Document (DCD) Tier 2, Section 9.2.1, "Plant Service Water System," indicates that performance of regulatory treatment of non-safety systems (RTNSS) functions is assured by applying the defense-in-depth (DID) principles of redundancy and physical separation to ensure adequate reliability and availability as discussed in DCD Tier 2 Appendix 19A, "Regulatory Treatment of Non-Safety Systems," Section 19A.8.3, "Augmented Design Standards." Tier 2 of the DCD, Table 3.2-1, "Classification Summary," (revised by the RAI 3.2-6 S02 response) defines the PSWS P41, as safety class non-safety, quality group D, and Quality Class S/N with a seismic category of NS. Quality Class "S" indicates that special quality assurance requirements are applied and "N" indicates the standard nonsafety-related quality assurance requirements are applied. DCD Table 3.2-3, "Quality Group Designation - Codes and Industry Standard," American Society of Mechanical Engineers (ASME) B31.1, "Power Piping" will be the code utilized for quality group D for piping and valves.

ESBWR DCD COL Item 9.2.1-1-A, "Material Selection," states that "the COL Applicant will determine material selection and provide provisions to preclude long term corrosion and fouling of the PSWS based on site water quality analysis (Subsection 9.2.1.2)." To address this COL item, FSAR Section 9.2.1.2, "System Description," states that fiberglass reinforced polyester (FRP) pipe is to be used for buried plant service water system piping to preclude long-term corrosion.

The information submitted is insufficient for staff to determine the acceptability of FRP for this application. For example, special treatment for RTNSS SSCs is not well defined in the application. If the applicant has performed an engineering evaluation to justify the

use of FRP in this application, technical information in that engineering evaluation should be submitted to the staff for review.

With respect to the selection of non-metallic material for the PSWS, describe the special treatment quality assurance provisions applicable to supplemental quality class S/N for the FRP used in PSWS for RTNSS systems. This special treatment should include the following considerations;

a) Describe how operating experiences (OE), where as buried fiberglass materials have been utilized in a similar application such as water service with similar piping size, pressure and temperatures, will be addressed in the selection of the buried fiberglass materials.
b) Describe if ASME B31.1 "Nonmandatory Appendix III, Rules for Nonmetallic Piping and Piping Lines with Nonmetals," will be utilized for the fiberglass design and installation. In addition, describe any material standard/classification, for example American Society for Testing and Materials or American Water Works Association that better defines the piping and fitting standards to be utilized.
c) Since PSWS has special quality assurance requirement in the RTNSS environment, provide details of the buried fiberglass application including:
    - piping size, wall thickness, and piping lengths
    - design and operating pressures and temperatures
    - location with respect to high traffic areas and if it will be necessary to sleeve the fiberglass for protection
    - fiberglass to carbon steel interface and location of interface
    - material handling and storage, installation, qualification and testing programs for the piping and fittings related to installation personnel
    - inservice inspection and accessibility
    - details of initial cyclic pressure testing plus hold times
    - information to support FRP seismic design acceptability as seismic category NS for RTNSS piping applications

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<u>Dominion Supplemental Response</u>

Dominion responded to this RAI question in a letter dated August 3, 2009 (ML092180975). That response was submitted when North Anna Unit 3 was the original reference COLA (R-COLA) for the ESBWR design and only addressed Parts a) and b) of the RAI question. This supplemental response addresses Part c). The original response to Parts a) and b) are unchanged and are included here for completeness.

a) Applicable operating experience (OE) with the use of fiberglass reinforced polyester (FRP) pipe (composite pipe) in industrial applications was reviewed in reaching the determination that this piping material is acceptable for use in the PSWS below-grade application. Applicable OE continues to be reviewed as the PSWS design

progresses in order to determine appropriate design, manufacturing and installation lessons-learned and best practices in the application of this material.

Based on review of recent applications of FRP pipe, it was concluded that this material has been successfully used in a variety of industrial applications, including:

- Cooling water for power and industrial plants
- Feed lines and penstock for hydroelectric plants
- Sanitary sewer projects (gravity and pressure systems)
- Pipeline rehabilitation (slip-lining)
- Drinking water projects (raw and potable)
- Irrigation systems

These applications included pipe sizes up to 160 inch diameter, operating pressures to 460 psi, and temperatures up to 150°F.

The review also identified that the composite pipe material industry experienced challenges in the 1970s stemming from excessive deflection and strain corrosion during installation and in-service, as well as problems with pipe joint effectiveness, that resulted in poor piping performance. To address these issues, the industry developed and/or improved design, manufacture, and installation standards. ASME B31.1, *Power Piping,* Non-Mandatory Appendix III, *Rules for Nonmetallic Piping and Piping Lines with Nonmetals* was developed to provide minimum requirements for the design, materials, fabrication, erection, testing, examination, and inspection of nonmetallic piping. Nonmetallic material and product standards related to FRP pipe, incorporated into the Code, include:

- AWWA C950: Standard for Glass-Fiber-Reinforced Thermosetting-Resin Pressure Pipe
- ASTM D1694: Standard Specification for Threads 60° (Stub) for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
- ASTM D2992: Obtaining Hydrostatic or Pressure Design Basis for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and Fittings
- ASTM D2996: Standard Specification for Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
- ASTM D3839: Standard Guide for Underground Installation of "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe

A review of industry literature indicates that long term reliability of FRP pipes has been proven for the last 30 years with more than 37,000 miles of pipe in operation internationally. In addition, the use of large diameter FRP pipe in industrial applications continues to expand worldwide. Due to its inherent corrosion resistant properties, FRP pipe has been established as an excellent low maintenance alternative to steel and concrete piping.

A review of OE related to U.S. nuclear power plant service identified two FRP pipe failures that occurred at Perry Nuclear Generation Plant (Perry) on December 22,

1991 and on March, 26, 1993. These failures resulted in long plant shutdowns on both occasions. Perry installed FRP for the underground portions of its Circulating Water System (CWS), Service Water System (SWS) and Fire Protection System (FPS).

Perry performed investigations of these FRP pipe failures and concluded that:

a. Large bore FRP for CWS and SWS suffered much damage/abuse during installation. Heavy equipment was used to install the piping. This caused impact and deflection damage.
b. Impact damage was repaired, if it was identified.
c. Deflection damage also occurred when soil was backfilled around/over the piping. The deflection damage resulted in bending the piping out-of-round into egg shape cross-section at certain locations.
d. The piping was of marginal design and was poorly manufactured.

The above deficiencies that jointly caused failures of the FRP at Perry can be readily attributed to the following:

a. Impact and deflection damage - Poor work practices and procedures
b. Impact damage identification/repair - Poor quality control
c. Damage during installation - Poor work practices/procedures - Lack of standards
d. Marginal design and poor manufacturing - Lack of adequate standards and poor quality control resulting in noncompliance with the existing standards.

Perry received its construction permit on May 3, 1977 and began commercial operation in 1987. The underground piping for the CWS and SWS is typically installed very early in the construction cycle. At Perry, the underground FRP was installed in the mid to late 1970s and the piping was manufactured and procured much earlier. At that time, FRP piping codes and standards were either not available or limited in scope and detail compared to steel piping standards. In addition, these early standards for FRP pipe did not have the benefit of the experience accumulated over time since then that the present day codes and standards incorporate.

The overall conclusion drawn from the review of industry operating experience and industrial application of FRP pipe is that the work practices and quality standards associated with this material have improved considerably since the 1970s. In consideration of the FRP pipe resistance to corrosion in the below-grade environment and the vast recent positive experience with its application in industrial pressurized water systems, including the incorporation of the material into the ASME B31.1 Power Piping Code and the promulgation of industry standards for design, manufacture, installation, and testing, Dominion concludes that FRP pipe is the optimal material for use in the RTNSS Category C PSWS below-grade application.

b) PSWS FRP pipe will meet the requirements of ASME B31.1 Nonmandatory Appendix III, *Rules for Nonmetallic Piping and Piping Lines with Nonmetals,* including the applicable ASTM and AWWA standards for FRP pipe that have been incorporated into the Code. FSAR Section 9.2.1 will be revised to commit to using this appendix.

c) See table below for additional quality requirements:

RAI Item	**Unit 3 Information**
Piping size, wall thickness, and piping lengths	The PSWS contains approximately 800 feet of nominal pipe size (NPS) 42" FRP pipe. Wall thickness is as specified by supplier for the design parameters, native soil properties and proposed backfill material. A typical representative NPS 42 inches product (NOV FiberGlass Systems Green Thread™) has a minimum wall thickness of 0.519 inches.
Design and operating pressures and temperatures	The design specification is 150 psig @ 120°F, with an operating pressure range of 80 psig to 150 psig and operating temperature range of 88°F to 120°F.
Location with respect to high traffic areas and if it will be necessary to sleeve the fiberglass for protection	High traffic areas will be identified during detailed design, and pipe sleeves will be specified for all high traffic areas.
Fiberglass to carbon steel interface and location of interface	Flanged interfaces are used between FRP and steel pipe. FRP flanges conform to manufacturing standards for fiberglass flanges (e.g., ASTM D5421 or D4024). The connections are approximately 24 inches above grade and are located in the Turbine Building and Service Water Buildings. Precise physical locations will be determined during detailed design.

RAI Item	Unit 3 Information
Material handling and storage, installation, qualification and testing programs for the piping and fittings related to installation personnel	Storage and handling of FRP materials are in accordance with applicable AWWA and ASTM standards: ASTM D3839, ASTM F1668, AWWA M45, and manufacturer's instructions. In reference to pipe failures and installation issues with past FRP systems at nuclear power plants (e.g., Perry), industry construction methods used previously did not provide adequate protection to the pipe. Damage and abuse to piping materials due to improper handling caused impact and deflection damage. Current manufacturing processes are much improved and more consistent as compared with standards that were in place at the time of previous installations. Use of current best practices for construction and installation will prevent recurrence of these issues. Specific actions that will be taken include: • Use of slings for lifting (to prevent surface damage) • Use of proper backfill materials and procedures to reduce ring deflection and eliminate contact of pipe with rocks and other hard objects that may cause mechanical damage • Use of trained craft personnel responsible for bonding pipe joints, including improved quality oversight
Inservice inspection and accessibility	The Dominion nuclear fleet has an existing Underground Piping and Tank Integrity Program, which was developed in accordance with NEI 09-14, *Guideline for the Management of Buried Piping Integrity*. The features of the program include: • Periodic inspections and tests based on risk significance and service conditions • Fitness for Service evaluations and assessments as part of a Life Cycle Management Plan • An Asset Management Plan which identifies preventive actions and mitigation strategies for leakage • Excavation controls and condition monitoring of backfill • Periodic program self-assessments Similar requirements will be developed for the PSWS using the guidance of NEI 09-14. Provisions for internal access and inspection will be included in the design.

RAI Item	Unit 3 Information
Initial cyclic pressure testing plus hold times	Initial system hydrostatic test will meet the requirements of ASME B31.1, including Non-mandatory Appendix III. Additional guidance of ASTM D3839, AWWA M45, and manufacturer's recommendations will be incorporated in written testing procedure.
FRP seismic design acceptability as seismic category NS for RTNSS Category C piping applications	PSWS is a nonsafety-related system and is classified as RTNSS Category C. RTNSS Category C systems and components (i.e., FRP) are designed to the seismic requirements of FSAR Section 19A.8.3, *Augmented Design Standards.* As stated in the eighth paragraph of DCD Section 19A.8.3, "RTNSS C systems and components are designed to the seismic requirements of IBC-2003 consistent with the above SSE ground motion." The Unit 3 SSE ground motion is defined in FSAR Section 3.7. Failure or interaction of the PSWS FRP would not degrade functioning of a SC-1 SSC to an unacceptable level. Current requirement of seismic analysis to IBC augmented by using the NA3-specific SSE ground input motion is appropriate and consistent with the safety significance of the system.

FSAR Section 9.2.1.2 reflects the use of ASME B31.1, Nonmandatory Appendix III, *Rules for Nonmetallic Piping and Piping Lines with Nonmetals*, including applicable ASTM and AWWA standards for FRP pipe.

Proposed COLA Revision

None.

ENCLOSURE 19

CD-ROM Containing SACTI Code Input and Output Files

Dominion submitted responses to RAIs 02.03.02-1 and 02.03.02-3 in letters dated April 25, 2008 (ML081260212) and January 10, 2011 (ML110140131), respectively. Both of these responses provided SACTI code input and output files. This enclosure provides updated SACTI code input and output files on CD-ROM to facilitate the staff's review.

ENCLOSURE 20

CD-ROM Containing ARCON96 Code Input and Output Files

Dominion submitted a response to RAI 02.03.04-2 in a letter dated January 10, 2011 (ML110140131). The response provided ARCON96 code input and output files. This enclosure provides updated ARCON96 code input and output files on CD-ROM to facilitate the staff's review.

ENCLOSURE 21

CD-ROM Containing XOQDOQ Code Input and Output Files

Dominion submitted a response to RAI 02.03.05-4 in a letter dated January 10, 2011 (ML110140131). The response provided XOQDOQ code input and output files. This enclosure provides updated XOQDOQ code input and output files on CD-ROM to facilitate the staff's review.

ENCLOSURE 22

CD-ROM Containing HEC-RAS Code Input and Output Files

Dominion submitted a response to RAI 02.04.02-2 in a letter dated April 3, 2009 (ML090990451). The response provided HEC-RAS code input and output files. This enclosure provides updated HEC-RAS code input and output files on CD-ROM to facilitate the staff's review.

ENCLOSURE 23

CD-ROM Containing LADTAP II Code Input and Output Files

Dominion submitted a response to RAI 11.02-5 in a letter dated June 9, 2011 (ML11167A149). The response referred to a previous letter dated March 14, 2011 (ML110760408) that provided LADTAP II code input and output files. This enclosure provides updated LADTAP II code input and output files on CD-ROM to facilitate the staff's review.

ENCLOSURE 24

CD-ROM Containing GASPAR II Code Input and Output Files

Dominion submitted a response to RAI 11.03-5 in a letter dated June 9, 2011 (ML11167A149). The response referred to a previous letter dated March 14, 2011 (ML110760408) that provided GASPAR II code input and output files. This enclosure provides updated GASPAR II code input and output files on CD-ROM to facilitate the staff's review.

ENCLOSURE 25

Review of Enrico Fermi Unit 3 Response to

NRC RAI Letter No. 61, Question 01-4

Enrico Fermi Unit 3 RAI Letter No. 61, Question 01-4

The NRC issued RAI Letter No. 61, Question 01-4 for Enrico Fermi Unit 3 on June 21, 2011. The question states:

> "The Fermi combined license application includes license requests associated 10 CFR Parts 30, 40, and 70. The applicant is requested to complete the attached tables in order to provide a cross-reference of regulations and regulatory guidance in support of the staffs review."

DTE Energy submitted a response to this question in letter number NRC3-11-0021, dated July 15, 2011 (ML11200A042).

Dominion's Review Results

Dominion reviewed the RAI question and concluded that similar information, in the form of a completed table for North Anna Unit 3 (NA3) should be provided to support the NRC staff review of the NA3 COLA.

Completed tables that include a cross-reference of regulations and regulatory guidance applicable to 10 CFR Parts 30, 40, and 70 to specific chapters and sections in the NA3 COLA are provided in Attachments 1 and 2 to this enclosure.

Additionally, Dominion determined that the changes to the Fermi 3 COLA Part 2, FSAR Chapter 13.5, Appendix 13CC, and COLA Part 7, identified by DTE Energy as a result of completion of the RAI response, should be addressed in the NA3 COLA. COLA Part 2, *Final Safety Analysis Report* (FSAR) Chapter 13.5 and Appendix 13CC changes were provided in the NA3 COLA – Submissions 12 and 13, dated July 31, 2013 (ML13221A504). COLA Part 7 changes were included in the December 2013 COLA submittal, Submissions 14 and 15 (Letter No. NA3-13-019). Dominion also determined that NA3 specific changes were appropriate for COLA Part 2, FSAR Chapter 13.4 and COLA Part 8. These changes were also included in the December 2013 COLA submittal, Submissions 14 and 15.

Proposed COLA Revision

None.

CROSS-REFERENCE OF REGULATIONS AND REGULATORY GUIDANCE IN SUPPORT OF REVIEW OF PART 30/40 LICENSE APPLICATION VS. PART 52 COLA CONTENT

Review Area	Regulations	Regulatory Guidance	COLA Chapter
License Action Type	10 CFR Parts 30 and 40	Section 8.1 and Appendix D.1, Item No. 1 of NUREG-1556, Volume 7	The license action type for North Anna Unit 3 (Unit 3) is described in Part 1, Section 2(e), and Part 2 (FSAR), Section 1.1.2.2.
Legal Identity	10 CFR Parts 30.32, 30.34, 40.3, 40.21, and 40.31	Section 8.2 and Appendix D.2, Item No. 2 of NUREG-1556, Volume 7	The legal identity of the applicant is described in Part 1, Section 2(a-d).
Address	10 CFR Parts 30.32 and 40.31	Section 8.3 and Appendix D.3 Item Nos. 2 and 3 of NUREG-1556, Volume 7	Part 1, Section 2(a-d) provides the Dominion corporate address. FSAR, Section 1.1.2.4, provides the reactor location.
Person to be Contacted About this Application	10 CFR Parts 30.32 and 40.31	Section 8.4 and Appendix D.4, Item No. 4 of NUREG-1556, Volume 7	Regina A. Borsh, COLA Licensing Lead, Dominion (804) 205-0797
Materials to be Possessed and Proposed Uses	10 CFR Parts 30.4, 30.14, 30.15, 30.18, 30.19, 30.21, 30.32(g), 30.32(i), 30.33(a)(1), 30.33, 31.5, 31.8, 31.11, 32.210, 40.1, 40.3, 40.4, 40.34, 40.32, 40.35, 51.21, and 51.22	Section 8.5.1, 8.6, Appendix C, and Appendix D.5, Item Nos. 5 and 6 of NUREG-1556, Volume 7	The materials to be possessed and proposed uses are described in Part 1, Section 2(e), and FSAR, Chapter 12, including the portions ESBWR DCD Chapter 12 incorporated by reference. As described in FSAR Section 12.2.1.5, the request for a Part 30 and 40 license does not involve authorization to possess uranium hexafluoride in excess of 50 kilograms in a single container or 1000 kilograms total, or in excess of 2 curies of plutonium in unsealed form or on foils or plated surfaces. Also, no by-product will be received, possessed, or used in a physical form that is in unsealed form, on foils or plated surfaces, or sealed in glass, that exceeds the quantities in Schedule C in 10 CFR 30.72. COLA Part 10, Section 3.3, provides license conditions for byproduct, source and special nuclear material.

Review Area	Regulations	Regulatory Guidance	COLA Chapter
Financial Assurance and Recordkeeping for Decommissioning (if applicable)	10 CFR Parts 30.35, 30.32(h), 40.31(i), and 40.36	Section 8.5.2, Appendix C, and Appendix G of NUREG-1556, Volume 7; and Chapter 4 and Appendix A of NUREG-1757, Volume 3	Financial assurance and recordkeeping for decommissioning required for 10 CFR Parts 30 and 40 are not required. However, the financial assurance and recordkeeping for decommissioning of Unit 3 are described in the Decommissioning Funding Assurance Report provided in Part 1, Attachment E and in the Quality Assurance Program Description in FSAR Appendix 17AA.
Individual(s) Responsible for Radiation Safety Program and Their Training and Experience and Authorized User	10 CFR Parts 20.1101 30.33(a)(3), and 40.32(b)	Section 8.7.1, 8.7.2, Appendix C, and Appendix D.6, Item No. 7 of NUREG-1556, Volume 7	The radiation protection program for Unit 3 is described in FSAR Section 12.5, and Appendix 12AA and 12BB. Appendix 12AA and 12BB incorporate NEI 07-08A and 07-03A by reference. The job description and function for Functional Manager Radiation Protection and Chemistry, Supervisors Radiation Protection, and Radiation Protection Technicians are described in FSAR Sections 13.1.2.1.1.8, 13.1.2.1.1.9, and 13.1.2.1.1.10, respectively. Qualifications of the managers, supervisors, and technicians meet the requirements for education and experience described in ANSI/ANS-3.1, as endorsed and amended by Regulatory Guide 1.8 as clarified in Appendix 17AA, QAPD, Part IV. Training criteria for site personnel are consistent with the guidance in Regulatory Guide 1.8 as clarified in Appendix 17AA, QAPD, Part IV. Qualifications and training are described in FSAR Sections 13.1 and 13.2.
Training for Individuals Working in or Frequenting Restricted Areas (Occupationally Exposed Individuals and Ancillary Personnel)	10 CFR Parts 19.11, 19.12, 19.13, 20.1801, 20.1802, 30.7, 30.9, 30.10, 30.33(a)(3), 30.34(e), 40.32(b), and 40.41	Section 8.8, Appendix C, and Appendix D.6, Item No. 8 of NUREG-1556, Volume 7	The radiation protection program is described in FSAR Section 12.5, Appendix 12AA, and Appendix 12BB. Training criteria is discussed in FSAR Section 13.2.

Review Area	Regulations	Regulatory Guidance	COLA Chapter
Facilities and Equipment	10 CFR Parts 20.1101(b), 20.1406, 30.33(a)(2), 30.35(g), and 40.32(b)	Section 8.9, Appendix C, and Appendix D.6, Item No. 9 of NUREG-1556, Volume 7	Physical arrangement of the facility is described in FSAR Section 12.3. The radiation protection program is described in FSAR Section 12.5, Appendix 12AA, and Appendix 12BB, including the ALARA program. Appendix 12BB incorporates NEI 07-03A by reference. NEI 07-03A, Section 12.5.3, describes facilities, instrumentation, and equipment provided to support implementation of the radiation protection program. Radiation record retention requirements are contained in the QAPD, in FSAR Appendix 17AA.
Radiation Safety Program	10. CFR Parts 20.1101, 20.2102, 21.21(a), and 40.32(b)	Section 8.10, Appendix C, and Appendix D.6, Item No. 10 of NUREG-1556, Volume 7	FSAR Table 13.4-201 provides a commitment to implement the radiation protection program. The radiation protection program as described in NEI 07-03A, FSAR Section 12.5, describes the elements that need to be implemented. Qualifications of the managers, supervisors, and technicians meet the requirements for education and experience described in ANSI/ANS-3.1, as endorsed and amended by Regulatory Guide 1.8 as clarified in Appendix 17AA, QAPD, Part IV. Training criteria for site personnel are consistent with the guidance in Regulatory Guide 1.8 as clarified in Appendix 17AA, QAPD, Part IV. Qualifications and training are described in FSAR Sections 13.1 and 13.2. Radiation record retention requirements and 10 CFR 21 reporting information are contained in the QAPD, in FSAR Appendix 17AA.

Review Area	Regulations	Regulatory Guidance	COLA Chapter
Waste Management	10 CFR Parts 20.1904, 20.2001, 20.2002, 20.2003, 20.2004, 20.2005, 20.2006, 20.2007, 20.2108, 30.51, and 61.52	Section 8.11, Appendix C, and Appendix D.6, Item No. 11 of NUREG-1556, Volume 7	FSAR Sections 11.2 and 11.4, including the portions of ESBWR DCD Sections 11.2 and 11.4 incorporated by reference, discuss liquid and solid radwaste storage and processing systems, respectively. FSAR Section 12.2 discusses dose rates and limits for Unit 3. This addresses the liquid waste that is disposed of directly to the environment. The radiation protection program is discussed in FSAR Section 12.5.
Security of IAEA Category I and 2 Sources	10 CFR 20.2207 and Increased Controls Orders	Contact FSME/MSSA for information	The physical security program is described in FSAR Section 13.6.
Fees	10 CFR Part 170.31	Section 8.12 and Appendix B of NUREG-1556, Volume 7	Dominion will assume full cost of associated 30, 40, and 70 application fees in conjunction with review of COLA.
Certification	18 U.S.C. 1001	Section 8.13 and Appendix B of NUREG-1556, Volume 7	The form will be signed when submitted.
Amendments and Renewals	10 CFR Parts 2.109, 30.37, 30.38, 40.43, and 40.44	Section 9 of NUREG-1556, Volume 7	Not Applicable – The Unit 3 application is for a new license.
Applications for Exemptions	10 CFR Parts 19.31, 20.2301, and 30.11	Section 10 of NUREG-1556, Volume 7	Not Applicable – The Unit 3 application does not request any exemptions for 10 CFR Part 30 or Part 40.
Termination of Activities	10 CFR Parts 20.1402, 20.1403, 30.34(b), 30.35(g), 30.36(d), 30.36(g), 30.36(h), 30.36(j), 30.51(f), and 40.42	Section 11 of NUREG-1556, Volume 7	Not Applicable – The Unit 3 application is for a new license; therefore, termination of activities does not apply.

CROSS-REFERENCE OF REGULATIONS AND REGULATORY GUIDANCE IN SUPPORT OF REVIEW OF PART 70 LICENSE APPLICATION VS. PART 52 COLA CONTENT

Review Area	Regulations	Regulatory Guidance	Acceptance Criteria	COLA Chapter
General Information	10 CFR 70.22(a)(1) – (a)(4) 10 CFR 70.23(a)(5)	Chapter 1 of NUREG-1520	Sections 1.1.4, 1.2.4, and 1.3.4 of NUREG-1520	COLA Part 1 provides relevant corporate information, including identity, full name and physical address. Also, as described in COLA Part 1, the purpose of the application is to seek a class 103 license which will be used to generate electricity for commercial purposes. The application also seeks licenses to receive, possess and use source, special nuclear, and by-product material, in connection with the operation of North Anna Unit 3 (Unit 3). As described in FSAR Section 12.2.1.5, the request for a Part 70 license does not involve authorization to possess enriched uranium for which a criticality accident alarm system is required, uranium hexafluoride in excess of 50 kilograms in a single container or 1000 kilograms total, or in excess of 2 curies of plutonium in unsealed form or on foils or plated surfaces. COLA Part 1 also provides a description of the financial qualification of Dominion for construction, operation, and decommissioning of Unit 3. COLA Part 10, Section 3.3, provides license conditions for byproduct, source and special nuclear material. A request for an exemption from 10 CFR 70.22(b), 70.32(c), 74.31, 74.41, and 74.51, is included in COLA Part 7. 10 CFR 70.22(b), 70.32(c), 74.31, 74.41, and 74.51 contain exceptions for nuclear reactor licensed under 10 CFR Part 50 as related to the description of the Material Control & Accounting (MC&A) program and certain SNM programs and procedures. The request for exemption extends these exceptions to the Unit 3 facility which is being licensed under 10 CFR Part 52. A description of the facility location is provided in COLA, Part 2 (FSAR) Section 1.1.2.4. The facility layout is shown on Figure 2.1-201. Site geography and population information is provided in FSAR Section 2.1. The location of nearby industrial, transportation, and military facilities is described in FSAR Section 2.2. Meteorological description and data is provided in FSAR Section 2.3. Site hydrology data, including the design basis flood, is provided in FSAR Section 2.4. Site geology data, including seismicity, is provided in FSAR Section 2.5.

Review Area	Regulations	Regulatory Guidance	Acceptance Criteria	COLA Chapter
Organization and Administration	10 CFR 70.22(a)(6) and (a)(8) 10 CFR 70.23(a)(2) and (a)(4)	Chapter 2 of NUREG-1520 Reg Guide 1.8	Section 2.4.3 of NUREG-1520	The organizational structure, including organizational charts, is described in FSAR, Section 13.1, and Appendix 17AA. The description of the organization in FSAR Section 13.1 provides functional descriptions of specific organizational groups, including those responsible for managing the design, construction, operations, and modifications of the facility. Responsibilities and reporting hierarchy are clearly defined, providing for clear, unambiguous controls and communications among the organizational units. As described in FSAR Section 13.1.1.4, personnel of the technical support organization meet the education and experience qualifications for those described in ANSI/ANS-3.1 as endorsed and amended by Regulatory Guide 1.8 as clarified in Appendix 17AA, QAPD, Part IV. In addition, as described in FSAR 13.1.3, qualifications of managers, supervisors, and technicians of the operating organization meet the requirements for education and experience described in ANSI/ANS-3.1, as endorsed and amended by Regulatory Guide 1.8 as clarified in Appendix 17AA, QAPD, Part IV. FSAR, Appendix 13AA, Section 13AA.2.4, describes the activities required to transition the unit from the construction phase to the operational phase. These activities include turnover of systems from construction, preoperational testing, schedule management, test procedure development, fuel load, integrated startup testing, and turnover of systems to operating and technical support staff.
ISA	N/A pursuant to 10 CFR 70.60	N/A	N/A	N/A

Review Area	Regulations	Regulatory Guidance	Acceptance Criteria	COLA Chapter
Radiation Protection	10 CFR Part 19 10 CFR Part 20 10 CFR 70.22(a)(6) – (a)(8) 10 CFR 70.23(a)(2) – (a)(4) 10 CFR Part 70, Subpart G	Chapter 4 of NUREG-1520, Reg Guide 1.8, 8.8, 8.10, 8.15, etc.	Section 4.4 of NUREG-1520	The radiation protection program is described in FSAR Section 12.5, Appendix 12AA, and Appendix 12BB. As described in the FSAR, NEI 07-03A and 07-08A are incorporated by reference. NEI 07-03A describes the details of the radiation protection program and NEI 07-08A describes the details for the ALARA program. The radiation protection program describes the organization, facilities, instrumentation and equipment, and procedures. Qualification and training criteria for site personnel are consistent with the guidance in Regulatory Guide 1.8, as clarified in Appendix 17AA, QAPD, Part IV, and are described in FSAR Sections 13.1 and 13.2. As described in FSAR Table 13.4-201, the Unit 3 COLA includes a commitment to implement elements of the radiation protection program necessary to support receipt and storage of fuel onsite prior to fuel receipt. In addition, as described in FSAR Table 13.4-201, the Unit 3 COLA includes a commitment to implement elements of the radiation protection program applicable to radioactive material prior to initial receipt of byproduct source, or special nuclear materials (excluding exempt quantities as described in 10 CFR 30.18). The radiation protection program as described in NEI 07-03A, Section 12.5, describes the elements that need to be implemented.
Criticality Safety	70.22(a)(6) – (a)(8). 70.24(d)(1) includes an exemption from crit. alarms. 70.23(a)(2) – (a)(4) 10 CFR 70.52	Chapter 5 of NUREG-1520	Section 5.4.3 of NUREG-1520	As described in the radiation protection program (NEI 07-03A, Section 12.5), "prior to receiving fuel under this license, and thereafter, when reactor fuel is possessed under this license, plant procedures on criticality accident requirements will be established, implemented and maintained and radiation monitoring will be provided in accordance with 10 CFR 50.68." As described in FSAR Section 13.5.2.1.7, fuel handling operations are performed in accordance with written procedures; including procedures to prevent inadvertent criticality. DCD Section 9.1 is incorporated by reference in the FSAR. DCD Section 9.1.1.7 describes that new fuel storage racks criticality control meets the requirements of 10 CFR 50.68(b). DCD Section 9.1.2.8 describes that spent fuel storage racks criticality control meets the requirements of 10 CFR 50.68(b). Thus, as allowed by 10 CFR 70.24(d)(1) a criticality accident alarm system is not required. As described in FSAR Section 12.2.1.5, the request for a Part 70 license does not involve authorization to possess enriched uranium for which a criticality accident alarm system is required, uranium hexafluoride in excess of 50 kilograms in a single container or 1000 kilograms total, or in excess of 2 curies of plutonium in unsealed form or on foils or plated surfaces.

Review Area	Regulations	Regulatory Guidance	Acceptance Criteria	COLA Chapter
Chemical Safety	N/A since the Part 70 license does not involve the use of chemicals	N/A	N/A	N/A
Fire Safety	70.22(a)(6) – (a)(8) 70.23(a)(2) – (a)(4)	Chapter 7 of NUREG-1520	Section 7.4.3 of NUREG-1520	The fire protection program is addressed in FSAR Section 9.5.1.15, including incorporating DCD Section 9.5.1.15 by reference. The fire protection program identifies organization and responsibilities, staffing requirements, training requirements, control of combustible materials, and quality assurance requirements. As described in FSAR Table 13.4-201, the Unit 3 COLA includes a commitment to implement elements of the fire protection program necessary to support receipt and storage of fuel onsite prior to fuel receipt. As described in FSAR Table 13.4-201, the Unit 3 COLA includes a commitment to implement elements of the fire protection program applicable to radioactive material prior to initial receipt of byproduct source, or special nuclear materials (excluding exempt quantities as described in 10 CFR 30.18). In addition to the fire protection program, FSAR Section 9.5, including incorporating DCD Section 9.5 by reference, describes the fire protection systems, fire barrier requirements, and building ventilation requirements. DCD Table 9.5-1 and FSAR Table 9.5-201 identify the codes and standards (including NFPA Codes) that are applicable for fire protection for Unit 3. FSAR, Appendix 9A, including incorporating DCD Appendix 9A by reference, describes the fire hazards analysis for Unit 3.

Review Area	Regulations	Regulatory Guidance	Acceptance Criteria	COLA Chapter
Emergency Preparedness	10 CFR 70.22(i)(1)(i) or 70.22 (i)(1)(ii). 10 CFR 70.22(i)(3), if an emergency plan is required	Chapter 8 of NUREG-1520	Section 8.4.3 of NUREG-1520	Emergency planning is described in FSAR Section 13.3. The Emergency Plan, prepared in accordance with 10 CFR 50.79(d) is provided in COLA Part 5. Commitments for implementation of the Emergency Plan are provided in FSAR Table 13.4-201. As described in FSAR Section 12.2.1.5, the request for a Part 70 license does not involve authorization to possess enriched uranium for which a criticality accident alarm system is required, uranium hexafluoride in excess of 50 kilograms in a single container or 1000 kilograms total, or in excess of 2 curies of plutonium in unsealed form or on foils or plated surfaces. Because the above quantities are less than the values stipulated in 10 CFR 50.72(i) are not exceeded, consistent with 10 CFR 70.22(i)(1)(ii), an emergency plan that meets 10 CFR 70.22(i)(3) is not required. FSAR Section 12.2.1.5 specifies that these limitations be implemented prior to implementation of the Emergency Plan.
Environmental Protection	10 CFR Part 20 70.22(a)(7) – (a)(8) 70.23(a)(3) – (a)(4) Selected portions of Part 51, such as 10 CFR 51.52.	Chapter 9 of NUREG-1520 NUREG-1748 for preparing the EA + FONSI related to the possession, inspection, and handling of SNM, if needed. Otherwise, document the review of these activities as part of the EIS being prepared by the NRC staff under NUREG-1555.	Section 9.4.3 of NUREG-1520 (safety review only)	COLA Part 3, Environmental Report (ER), addresses environmental reviews and environmental protection including the assessment of environmental issues that were resolved in the NA3 Early Site Permit (ESP) proceeding as documented in NUREG-1811. The COLA ER was developed for the 10 CFR Part 52 COL application consistent with the guidance in NUREG-1555 to support NRC development of the Environmental Impact Statement (EIS).
Decommissioning	N/A pursuant to 10 CFR 70.25 (a)	N/A	N/A	N/A
Management Measures	N/A pursuant to 10 CFR 70.60	N/A	N/A	N/A

Review Area	Regulations	Regulatory Guidance	Acceptance Criteria	COLA Chapter
Material Control and Accounting (MC&A)	10 CFR 20.2201 70.22(b) includes an exemption from an FNMCP for SNM used at a Part 50 reactor site. 10 CFR 74, Subpart B	Currently, there is no regulatory guidance (i.e., NUREG or Reg Guide) to evaluate the possession, inspection, and handling of SNM at a reactor site. Regulations in 10 CFR 74, Subpart B are currently used as guidance to perform the review in this area.	Currently, there is no regulatory guidance (i.e., NUREG or Reg Guide) to evaluate the possession, inspection, and handling of SNM at a reactor site. Regulations in 10 CFR 74, Subpart B are currently used as guidance to perform the review in this area.	The description of the Material Control & Accounting (MC&A) Program for special nuclear material (SNM) is included in FSAR Appendix 13CC. The procedures for SNM MC&A are identified in FSAR Section 13.5.2.2.11. A request for an exemption from 10 CFR 70.22(b), 70.32(c), 74.31, 74.41, and 74.51, is included in COLA Part 7. 10 CFR 70.22(b), 70.32(c), 74.31, 74.41, and 74.51 contain exceptions for nuclear reactor licensed under 10 CFR Part 50 as related to the description of the MC&A program and certain SNM programs and procedures. The request for exemption extends these exceptions to the Unit 3 facility which is being licensed under 10 CFR Part 52.
Physical Security	10 CFR 73.1 and 73.55 and 73.67	Section 13.6.1 of NUREG-0800	Subsection II of Section 13.6.1 of NUREG-0800.	The physical security program is described in FSAR Section 13.6. As described in FSAR Table 13.4-201, the Special Nuclear Material Physical Protection Program, which is applicable to protection of special nuclear material prior to the protected area being declared operational, will be implemented prior to initial receipt of special nuclear materials of low strategic significance.

ENCLOSURE 26

Review of Enrico Fermi Unit 3 Response to

NRC RAI Letter No. 69, Question 01-7 Sup. 1

Enrico Fermi Unit 3 RAI Letter No. 69, Question 01-7 Sup. 1

The NRC issued RAI Letter No. 69, Question 01-7 for Enrico Fermi Unit 3 on November 9, 2011, and requested supplemental information during a teleconference. The Fermi Unit 3 supplemental information request states:

> "In a January 12, 2012, teleconference between the NRC and Detroit Edison, the NRC asked Detroit Edison to submit a docketed statement providing the strategic significance classification (Category I – strategic, Category II – moderate strategic significance, Category III – low strategic significance as defined in 10 CFR 70.4) of the fuel for the initial core load at Fermi 3."

DTE Energy submitted a response to this supplemental request in letter number NRC3-12-0004, dated February 1, 2012 (ML12034A064).

Dominion's Review Results

To address the supplemental information requested by the NRC staff, Dominion makes the following statement for North Anna Unit 3:

> The Special Nuclear Material (SNM) in the form of new reactor fuel for North Anna Unit 3 is Category III, SNM of low strategic significance, as defined in 10 CFR 70.4. The new reactor fuel at the facility will not exceed a U-235 isotope enrichment of 10 percent. ESBWR DCD Reference 4.3-10, Global Nuclear Fuel, "GE14E for ESBWR Initial Core Nuclear Design Report," NEDC-33326-P-A, Class III (Proprietary), Revision 1, September 2010, NEDO-33326-A, Class I (Non-proprietary), Revision 1, September 2010 provides detailed information on the reactor fuel.

Proposed COLA Revision

None.

ENCLOSURE 27

Revised Enrico Fermi Unit 3 RAI Numbers

In a letter dated August 30, 2013 (ML13247A394), Dominion submitted the results of its review of RAIs associated with COLA content that was updated in the July 2013 COLA submission. Enclosure 5 of that letter provided the results of the review of EF3 RAIs. In a letter to DTE Energy, dated November 14, 2013 (ML13297A191), the NRC identified RAI question numbers that had been mistakenly reused in EF3 RAI letters and assigned new numbers to correct the error. As a result, Dominion is revising certain EF3 RAI numbers listed in Enclosure 5 of Dominion's August 30, 2013 letter to be consistent with the new number assigned by the NRC (Note that only the RAI number is being revised). The revised RAI numbers are provided in the following table.

EF3 RAI Number listed in Enclosure 5 of Dominion letter dated August 30, 2013	Revised EF3 RAI Number
13.03-55	13.03-81
13.03-56	13.03-82
13.03-57	13.03-83
13.03-58	13.03-84
13.03-59	13.03-85
13.03-60	13.03-86
13.03-61	13.03-87
13.03-62	13.03-88
13.03-63	13.03-89
13.03-64	13.03-90
13.03-65 Dup	13.03-91
13.03-66 Dup	13.03-92
13.03-67 Dup	13.03-93
13.03-68 Dup	13.03-94
13.03-69 Dup	13.03-95
13.03-70 Dup	13.03-96
13.03-71 Dup	13.03-97
13.03-72 Dup	13.03-98
13.03-73 Dup	13.03-99
13.03-74 Dup	13.03-100
13.03-75 Dup	13.03-101
13.03-76 Dup	13.03-102
13.03-77 Dup	13.03-103
13.03-78 Dup	13.03-104