Enclosure 1

Response to NRC RAI No. 101
Questions 02.04.12-9, 02.04.12-10 and 02.04.12-11,

Calvert Cliffs Nuclear Power Plant Unit 3

RAI No. 101

Question 02.04.12-9

The DCD requirement on subsurface hydrostatic loading states that the maximum groundwater level is 1.0 m below grade. The results of the groundwater modeling described in FSAR Section 2.4.12.5 and Calculation No. 25237-103-KOC-HMMG-00001, Groundwater Flow Model of Surficial Aquifer, show that the DCD requirement is not satisfied at several locations and that the predicted groundwater level is very close to the DCD requirement (within one meter) over a relatively large area. Provide a discussion of the degree of conservatism of the model results and the reliability of meeting the DCD requirement on maximum groundwater level considering the following issues:

The observed average fluctuation in the surficial aquifer was 1.2 m over the year of observation;

The calibration errors reported in Calculation No. 25237-103-KOC-HMMG-00001: root mean squared residual of 0.8 m, correlation coefficient of 0.525;

The use of the pre-construction, calibrated recharge value of 8.7 in/yr for post-construction conditions;

Other model errors, such as not accounting for the presence of building foundations and the surface of cut areas prior to filling;

Clarify the locations of and other names for the buildings identified in Calculation No. 25237-103-KOC-HMMG-00001, Groundwater Flow Model of Surficial Aquifer, as having a depth to groundwater of less than 1.0 m: buildings 1UQB, 1URB, 1UBP, and 2UBP. A figure was provided as Attachment 3 to the Calculation that was indicated to identify these buildings. However, only 1URB could be identified on this figure, the easternmost building in the nuclear island.

Response

Question 02.04.12-9 refers to the results of Revision 0 of the Surficial aquifer numerical model (Calculation No. 25237-103-KOC-HMMG-00001, Revision 0) completed in July 2007. Revision 1 of this model was completed in December 2008 which:

- expanded the model domain,
- incorporated the effect on groundwater flow resulting from deep foundations in the power block area,
- modeled the size and depth of the excavation for the deep foundations in the power block to account for the different hydraulic conductivity of the backfill in the excavation,
- revised the groundwater recharge rate; and,
- estimated the impact to stream flow in Johns Creek.

An electronic copy of the input files for Revision 1 of model was provided in response[1] to Question 2.4.12-8.

A new multi-layer model to allow evaluation of alternative flow paths from the Surficial aquifer to the underlying Upper Chesapeake unit has been developed. This model and the conservatism of the model results are discussed in detail in the response to Question 02.04.12-11.

COLA Impact

The COLA has been updated to incorporate the results of the new groundwater model. Markups are provided in Enclosures 2, 3 and 4. The Groundwater model is provided in Enclosure 5.

[1] UniStar Nuclear Energy Letter UN#09-243, from Greg Gibson to Document Control Desk, U.S. NRC, Response to Request for Additional Information for RAI No.101, Groundwater; dated May 20, 2009

RAI No. 101

Question 02.04.12-10

Calculation No. 25237-103-KOC-HMMG-00001, Groundwater Flow Model of Surficial Aquifer, concludes with the following statement: "To explain the area around the power block where the saturated thickness of the surficial aquifer is zero, detailed modeling should be conducted. This should account for the building foundations, which will act as barriers to groundwater flow, potentially raising the water-table. The other feature that should be incorporated is the surface of the cut areas prior to filling. This will provide a more accurate representation of the base of the fill/top of the surficial aquifer." Provide a discussion describing how the issues raised in these conclusions are being addressed. If additional modeling has been conducted, describe this modeling and provide electronic versions of the model input files used.

Response

Question 02.04.12-10 refers to the results of Revision 0 of the Surficial aquifer numerical model (Calculation No. 25237-103-KOC-HMMG-00001, Revision 0) completed in July 2007. Revision 1 of this model was completed in December 2008 which:

- expanded the model domain,
- incorporated the effect on groundwater flow resulting from deep foundations in the power block area,
- modeled the size and depth of the excavation for the deep foundations in the power block to account for the different hydraulic conductivity of the backfill in the excavation,
- revised the groundwater recharge rate; and,
- estimated the impact to stream flow in Johns Creek.

An electronic copy of the input files for Revision 1 of model was provided in response[2] to Question 2.4.12-8.

A new multi-layer model to allow evaluation of alternative flow paths from the Surficial aquifer to the underlying Upper Chesapeake unit has been developed. This model, including discussion of how the issues raised in the above conclusions are addressed, is discussed in the response to Question 02.04.12-11.

COLA Impact

The COLA has been updated to incorporate the results of the new groundwater model. Markups are provided in Enclosures 2, 3 and 4. The Groundwater model is provided in Enclosure 5.

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[2] UniStar Nuclear Energy Letter UN#09-243, from Greg Gibson to Document Control Desk, U.S. NRC, Response to Request for Additional Information for RAI No.101, Groundwater; dated May 20, 2009

RAI No. 101

Question 02.04.12-11

At the site hydrology audit the applicant stated that a new modeling effort will be looking at post-construction effects to the Upper Chesapeake unit. This was in reference to a question about alternative pathways considered and consistency between FSAR 2.4.12 and 2.4.13. If this new modeling has been conducted, describe this modeling and provide electronic versions of the model input files used

Response

The groundwater model for the site of Unit 3 has been revised twice. The model was first developed to simulate flow in the Surficial aquifer. The first model of the Surficial aquifer was a two-dimensional, single layer model. It was completed in July 2007 (Revision 0). In 2008, this model was revised to expand the model domain, incorporate the effect of deep foundations in the power block area on groundwater flow, account for the size and depth of the excavation in the power block, and account for the different hydraulic conductivity of the backfill in the excavation. In addition, the groundwater recharge rate was revised and the model was used to estimate the impact of the construction of Unit 3 on the base flow in Johns Creek. This revision of model (Revision 1) was completed in December 2008.

The model was further revised to account for the interaction between the Surficial aquifer and the underlying hydrostratigraphic units. For this purpose, the model was expanded to three dimensions by including five layers, each of which approximately describes one of the following hydrostratigraphic units:

Layer 1	Surficial aquifer
Layer 2	Upper Chesapeake aquitard
Layer 3	Upper Chesapeake unit
Layer 4	Middle Chesapeake aquitard
Layer 5	Lower Chesapeake unit

The two uppermost hydrostratigraphic units, the Surficial aquifer and the Upper Chesapeake aquitard, do not extend over the entire model domain. Because Visual Modflow requires that all layers extend over the entire model domain, cells within a particular layer, where the hydrostratigraphic unit generally corresponding to that layer is absent, were assigned the hydraulic properties of the unit that is present at that location.

The thickness of each of the five units included in the model was defined from borehole data collected as part of the geotechnical investigation at the site. The Lower Chesapeake aquitard, which separates the Lower Chesapeake unit from the Piney Point/Nanjemoy aquifer, was not included explicitly in the three-dimensional model. The Lower Chesapeake aquitard is below the bottom of the model, which was treated as a no-flow boundary. A sensitivity analysis was conducted to assess the effect of this assumption. The sensitivity analysis indicated that the leakance to the Piney Point Aquifer, which can be estimated by the flux through a general head boundary at the bottom of Layer 5, is relatively negligible compared with the horizontal flux towards the Chesapeake Bay.

The model grid was rotated 90 degrees from the plant design grid so that the model north is equivalent to the plant east. All references to the signs of the compass are with respect to the model north, which is at 45-degree angle with the true north, pointing to the true northeast. The model domain for the five-layer model is larger than the model domain of the original Surficial aquifer model (Revision 1). The total areal extent of the revised model is about one and a quarter square miles (1.26 mi^2), covering an area of 5180 ft (1579 m) by 6790 ft (2070 m). The model domain extends southward approximately 0.25 mi (0.40 km) beyond the southern side of the Unit 3 switchyard into the Johns Creek watershed. To the model north, the domain extends into Chesapeake Bay about 50 ft (15 m) beyond the tip of the barge dock. In the model east-west direction, the domain extends about 0.35 mi (0.56 km) to the east of the eastern side of the Unit 3 power block and about 0.45 mi (0.72 km) to the west of the western side of the Unit 3 cooling tower.

Because the exact location of groundwater discharge from the Surficial aquifer and the Upper Chesapeake unit into nearby streams and other low-lying areas is not known, a drain condition was applied over the entire top layer of the model, except over the part of the model that is in Chesapeake Bay. The elevation of each drain was set at 0.1 ft (0.03 m) below the ground surface. A high value for the conductance of these drains was used to allow the discharge of groundwater out of the aquifer system when the water table reaches the ground surface.

In the top layer of the model, a constant head boundary condition was used to represent Chesapeake Bay, and no flow conditions were used along the other three sides of the model. In the layers of the model representing the Upper and the Lower Chesapeake units, a general head boundary condition was used on the southern and northern boundaries and a no-flow condition on the eastern and western sides. Layer 2 and layer 4 in the model represent the two aquitards, with the exception of the north side of layer 2 where the Upper Chesapeake unit is present. The northern boundary of layer 2 used a general head boundary while other boundaries in layers 2 and 4 were treated as no-flow boundaries.

Different zones of groundwater recharge were used in the model simulations. These zones include forested areas, open undeveloped areas (i.e., areas covered with grasses and low shrubs), and paved areas. Also, different recharge zones were defined for forested areas over the Surficial aquifer, over the outcrop of the Upper Chesapeake aquitard and over the outcrop of the Upper Chesapeake unit.

In most simulations, each of the five hydrostratigraphic units was represented with a single value of horizontal hydraulic conductivity and a single value of vertical hydraulic conductivity. One alternative, conceptual geologic scenario and corresponding model employed two zones of horizontal hydraulic conductivity for the Upper Chesapeake unit. The second value represented a zone of low horizontal hydraulic conductivity relative the major portion of the unit. The horizontal to vertical anisotropy of hydraulic conductivity for all aquifer units was assumed to be 10:1.

Calibration parameters included hydraulic conductivity values and the rate of recharge in all units. Piezometric level data from thirteen monitoring wells in the Surficial aquifer, twenty wells in the Upper Chesapeake unit and three wells in the Lower Chesapeake unit were used as calibration targets. The model was calibrated for steady-state conditions. For this purpose, the average value of the monthly or quarterly observations at each well in 2007 was used as a calibration target representing long-term average conditions. The calibrated hydraulic conductivity values were within the range of values obtained from slug tests conducted in each aquifer unit. The calibrated hydraulic conductivity values for the aquitards were within the range of values for the confining layers used by the Maryland Geological Survey in their regional model (Drummond, *Water-Supply Potential of the Coastal Plain Aquifers in Calvert, Charles, and St. Mary's Counties, Maryland, with Emphasis on the Upper Patapsco and Lower Patapsco Aquifers, Report of Investigations no. 76*, Maryland Geological Survey, 2007).

The calibrated model was used to predict groundwater levels and flow direction at the site under post-construction conditions. For this purpose, the model was modified by replacing the current topography with the post-construction topography. The post-construction model accounts for hydraulic properties of backfill and other fill material used to achieve the final grade plan, treats buildings within deep foundations as barriers to shallow groundwater flow, incorporates proposed surface sand filters, and considers changes in groundwater recharge resulting from the construction of Unit 3 and supporting facilities and structures.

The post-construction model was used to estimate piezometric levels in the power block area. In addition, the post-construction model was used to identify likely and plausible alternative pathways of postulated accidental effluent releases from the Nuclear Auxiliary Building (NAB). The post-construction model was also used to quantify the impact of the construction of Unit 3 on groundwater discharge in Johns Creek. A sensitivity analysis was conducted to assess the impact of different assumptions and input parameter values on the model predictions. The sensitivity analysis included simulations for different values of hydraulic conductivity of the fill material, different assumptions for the performance of the surface sand filters designed to enhance groundwater recharge, an alternative hydraulic conductivity distribution in the Upper Chesapeake unit, and an assumption of leakage through the bottom of the Lower Chesapeake unit.

The major conclusions from the post construction simulations are:

a) The water table in the power block area will be well below the site grade level. In all simulations, the water table in the power block area was more than 30 ft (9.1 m) below the site grade level of 85 ft (26 m) (NGVD 29).

b) The groundwater pathway for liquid effluent releases from the NAB depends on the hydraulic conductivity of the fill material.

    - If the hydraulic conductivity of the fill is equal to the lower end of the range of expected values (1×10^{-3} cm/s (2.8 ft/day)), then releases from the bottom of the NAB will move first downward to the Upper Chesapeake unit and then horizontally through this unit toward Chesapeake Bay where they eventually discharge. Even with a conservative assumption of 0.145 for the effective porosity for the Upper Chesapeake unit, the estimated travel time from the release point to Chesapeake Bay is over 22 years.

    - If the hydraulic conductivity of the fill is equal to the upper end of the range of expected values (1×10^{-2} cm/s (28 ft/day)), then releases from the bottom of the NAB will move horizontally though the fill material and discharge into Branch 2. The estimated travel time from the release point to discharge point is less than a year.

c) The impact of the construction of Unit 3 on groundwater discharge in Johns Creek will be negligible.

Details on the development of the groundwater model, the assumptions and input parameter values used as well as simulation results are presented in the Groundwater Model Study provided in Enclosure 5 of this letter. Electronic versions of the model input files are provided in Enclosure 6.

COLA Impact

The COLA has been updated to incorporate the results of the new groundwater model. Markups are provided in Enclosures 2, 3 and 4.

Enclosure 2

Update of COLA Part 2, FSAR to incorporate the new Groundwater Model

Calvert Cliffs Nuclear Power Plant, Unit 3

1.8 INTERFACES WITH STANDARD DESIGNS AND EARLY SITE PERMITS

This section of the U.S. EPR FSAR is incorporated by reference with the following departures and supplements.

The U.S. EPR FSAR includes the following COL Item in Section 1.8:

> A COL applicant that references the U.S. EPR design certification will describe where the interface requirements are satisfied in the COL Final Safety Analysis (FSAR) to demonstrate compatibility with the U.S. EPR design.

This COL Item is addressed as follows:

Interface requirements for systems, structures, and components (SSCs) that relate to specific mechanical, electrical, nuclear, or structural systems are identified in appropriate sections of the FSAR. Table 1.8-1 provides a cross-reference to the description of these interfaces.

1.8.1 COL INFORMATION ITEMS

The U.S. EPR FSAR includes the following COL Item in Section 1.8.1:

> A COL applicant that references the U. S. EPR design certification will identify the FSAR section, or provide a list, that demonstrates how the COL information items have been addressed.

This COL Item is addressed as follows:

The text of the COL Items and COL No. identifier listed in Table 1.8-2 of the U.S. EPR FSAR are presented in Table 1.8-2. For each COL Item listed, the corresponding section of this FSAR that addresses the COL Item is identified. Additional explanatory comments are provided as necessary or appropriate.

1.8.2 DEPARTURES

The U.S. EPR FSAR includes the following COL Item in Section 1.8.2:

> A COL applicant that references the U. S. EPR design certification will provide a list of any departures from the FSAR in the COL FSAR.

This COL Item is addressed as follows:

{The list of departures from the U.S. EPR FSAR is as follows:

Maximum Differential Settlement	FSAR 2.5.4 and 3.8.5
Maximum Annual Average Atmospheric Dispersion Factor	FSAR 2.3.5
Accident Atmospheric Dispersion Factor from 0 - 2 Hours for the Low Population Zone	FSAR 2.3.4 and 15.0.3
~~Maximum Ground Water Elevation~~	~~FSAR 2.4.12, 3.4.2, and 3.8.5~~
Toxic Gas Detection and Isolation	FSAR 3.11, 6.4, 9.4.1 and 14.2.12
Technical Specifications Setpoint Control Program	FSAR 16.3.3, 16.5.5, and Bases 16.3.3

Justification for these departures is presented in Part 7 of the COL application.}

Table 2.0-1—{U.S. EPR Site Design Envelope Comparison}
(Page 2 of 5)

	U.S. EPR FSAR Design Parameter Value/Characteristic	CCNPP Unit 3 Design Parameter Value/Characteristic
Maximum Differential Settlement (across the basemat)	1/2 inch in 50 feet in any direction	½-1 inch in 50 ft for common Basemat. (note a) (See Sections 2.5.4 and 3.8.5.5.1) > ½ inch in 50 ft for both EPGB and ESWB (note a) (See Sections 2.5.4, 3.8.5.5.2, and 3.8.5.5.3)
Maximum Ground Water	3.3 ft below grade	~~Ranges between 4.0 ft and 10 ft below grade~~ ~~3.0 ft below grade for EPGB 1/2 (note b) (See Sections 2.4.12, 3.8.4, and 3.8.5.5.2)~~ ~~One corner of ESWB (See Sections 2.4.12 and 3.8.5.5.3)~~ Approximately 30 feet below grade (See Section 2.4.12.5)
Inventory of Radionuclides Which Could Potentially Seep Into the Groundwater		
Bounding Values for Component Radionuclide Inventory	See Table 2.0-2	See Table 2.0-2
Flood Level		
Maximum Flood (or Tsunami)	1 ft below grade	Approximately 3 ft below grade, except for the UHS Makeup Water Intake Structure and UHS Electrical Building which is designed to function under submerged conditions (See Sections 2.4.1 and 2.4.2, 2.4.10, 3.4.2, 3.4.3.10, 3.8.4.1.11, 3.8.4.3, and 9.2.5)
Wind		
Maximum Speed (Other than Tornado)	145 mph (Based on 3-sec gust at 33 ft above ground level and factored for 50-yr mean recurrence interval.)	95 mph (parameter referred to as Wind Gust in this FSAR) (based on 3 second gust at 33 feet for 50 year recurrence interval) (See Section 2.3.1)
Importance Factor	1.15 (Safety-related structures for 100-year mean recurrence interval.)	1.15 (safety related structures for 100 year mean recurrence interval) (See Section 2.3.1)
Tornado		
Maximum Pressure and rate of Drop	1.2 psi at 0.5 psi/sec	0.9 psi at 0.4 psi/sec (See Section 2.3.1)
Maximum Rotational Speed	184 mph	160 mph (See Section 2.3.1)
Maximum Translational Speed	46 mph	40 mph (See Section 2.3.1)
Maximum Wind Speed	230 mph	200 mph (See Section 2.3.1)
Radius of Maximum Rotational Speed	150 ft	150 feet (See Section 2.3.1)

Notes:

a. Value is a departure from a design parameter and is listed in Part 7 of the COL Application. Justification is provided in Chapter 3.

b. ~~Value is a departure from a design parameter and is listed in Part 7 of the COL Application. Justification is provided Chapter 3.~~ Not used.

c. Value is a departure from a design parameter and is listed in Part 7 of the COL Application. Justification is provided in Section 2.3.5.

d. Value is a departure listed in Part 7 of the COL Application. Justification is provided in Chapter 15.

e. The maximum 48-hour PMWP liquid of 32 inches is based on data obtained from NOAA Hydrometeorological Report No. 53 "Seasonal Variation of 10-square-mile Probable Maximum Precipitation estimates, United States East of the 105^{th} Meridian" for the three winter months - December through February. However, the effect of rainfall events on U.S. EPR roof loads is negligible, due to lack of parapets.

f. First value is U.S. EPR Design Parameter/Second value is CCNPP3 Site Specific Parameter.

g. The same meteorological data are used to calculate unfiltered χ/Q values. Since the site-specific control room χ/Q values were demonstrated to be bounded by the U.S. EPR χ/Q values, the calculation of the site-specific atmosphere dispersion factors for unfiltered inleakage was not necessary. CCNPP Unit 3 incorporates by reference the doses for the main control room presented in the U.S. EPR FSAR.

elevation of approximately -610 ft (-186 m) msl and the aquifer appears to attain a thickness of less than 25 ft (7.6 m) (MGS, 1996).

Transmissivities of 450 ft^2/day to 4570 ft^2/day (41.8 m^2/day to 424.6 m^2/day) have been reported for the Magothy aquifer in southern Anne Arundel County (MGS, 2002). Reported transmissivity values for southern Maryland counties range from 1000 ft^2/day to 12,000 ft^2/day (92.9 m^2/day to 1114.8 m^2/day. The primary use of this aquifer occurs in Anne Arundel, Prince George's, and Charles counties (Wolman, 2004).

Recharge to the Magothy aquifer is from direct infiltration of precipitation in northern Anne Arundel County where the Magothy Formation is exposed at the surface. In central Calvert County, flow is east-southeast, towards the Atlantic Coast. Other discharge occurs at local pumping locations (MGS, 1997 and USGS, 2005b).

A 2003 potentiometric surface map of the Magothy aquifer is presented in Figure 2.4-61 (USGS, 2005b) to establish the elevation and horizontal direction of ground water flow.

2.4.12.1.2.8 Potomac Group

The lower Cretaceous Potomac Group consists of the following (in descending order): the Patapsco, Arundel, and Patuxent Formations. These units form a thick (greater than 1500 ft (457 m)) series of unconsolidated sediments, which locally contain three confining units and three aquifers. Because of the significant depth of these formations, and the abundance of exploitable supplies of ground water in shallower aquifers, these units are not currently used as a significant source of ground water in the vicinity of the CCNPP site. Consequently, available hydrogeologic information for the Potomac Group of aquifers and confining units is limited.

The Upper Patapsco aquifer underlies the Magothy aquifer and is separated from it by clayey units in the top of the Patapsco Formation and bottom of the Magothy Formation. These clayey units are collectively referred to as the Upper Patapsco confining unit. The Upper Patapsco aquifer includes sand units in the upper part of the Patapsco Formation. This aquifer is not continuous and comprises complexly stratified sandy units separated locally by silts and clays. Individual sand units in the Upper Patapsco aquifer are difficult to correlate laterally, but they appear to be sufficiently interconnected at the regional scale to form a single aquifer (MGS, 1995). The aquifer extends to the northeast through Prince George's and Anne Arundel counties, and beneath Chesapeake Bay to the eastern shore of Maryland. The aquifer is recharged by precipitation at outcrops in western and northern Charles, Prince George's and Anne Arundel counties. It subcrops beneath the tidal part of the Potomac River, where river water intrusion has been documented in the Indian Head area (USGS, 1997b). MGS, 2007a

The Upper Patapsco aquifer is extensively used for public supply in central Charles County, where a cone of depression has formed as deep as elevation -136 ft (-41.5 m) msl. It is also pumped heavily by major users in Prince George's and Anne Arundel counties (Wolman, 2004). A few major users pump the Upper Patapsco aquifer in northern St. Mary's and Calvert counties (MGS, 1995). Pump tests performed in the Upper Patapsco aquifer in east-central Charles County yielded a transmissivity of 1110 ft^2/day (103 m^2/day) (~~MGS, 2007~~). Upper Patapsco transmissivities reported for Charles and Anne Arundel counties range from 1000 ft^2/day to 10,000 ft^2/day (92.9 to 929 m^2/day) (Wolman, 2004).

The Lower Patapsco aquifer underlies the Upper Patapsco aquifer. The two aquifers are separated by clayey units forming the Middle Patapsco confining unit in the middle part of the Patapsco Formation. The Lower Patapsco aquifer comprises sandy units in the lower part of the Patapsco Formation. The aquifer extends northeast to northern Anne Arundel County, but its of approximately 84.78 ft (25.8 m) msl at well OW-423 to a low of approximately 68.1 ft (20.8 m) msl at well OW-743.

The ground water surface contour maps indicate that horizontal ground water flow in the Surficial aquifer is generally bi-modal. A northwest trending ground water divide roughly following a line extending through the southwestern boundary of the proposed power block area is present at the CCNPP site. Northeast of this divide, horizontal ground water flow is northeast toward Chesapeake Bay. Because the Surficial aquifer is not present below elevations of approximately 65 ft (19.8 m) msl to 70 ft (21.3 m) msl, ground water flowing in the northeastern direction likely discharges to small seeps and springs before reaching the Chesapeake Bay or CCNPP site streams. Ground water southwest of this divide flows to the southwest. ~~Ground water southwest of this divide flows to the southwest.~~ Ground water flowing from the divide toward the hydraulic boundary created by John's Creek and Branch 3 presumably discharges from seeps and springs above the 65 to 70 ft (19.8 to 21.3 m) msl elevation level along these stream valleys.

In general, the horizontal hydraulic gradient for the Surficial aquifer decreases from north to south across the CCNPP site. In the northern portion of the CCNPP site, the hydraulic gradients associated with the southwesterly and northeasterly flow components are similar with values ranging from 0.0110 ft/ft and 0.0124 ft/ft, respectively. In the southern portion of the CCNPP site~~ where northeasterly flow predominates~~, the hydraulic gradient is lower (approximately 0.0086 ft/ft). In the northwest portion of the CCNPP site where a small portion of the site's ground water flow emanating from the ground water divide is to the north and west, the hydraulic gradient is approximately 0.0150 ft/ft.

Ground water elevations measured in the four well clusters that monitor head differences between the Surficial aquifer and the Upper Chesapeake unit indicated a downward vertical gradient between the Surficial aquifer and the Upper Chesapeake unit. Water table elevations in the Surficial aquifer range from approximately 36.0 to 42.0 ft (11.0 to 12.8 m) higher than the potentiometric surface of the Upper Chesapeake unit (Table 2.4-36) indicative of less-permeable material separating the two water-bearing units.

2.4.12.3.1.2 Upper Chesapeake Unit

Ground water elevation data for the Upper Chesapeake unit in 2006 and 2007 are shown in Figure 2.4-74. These data exhibit slightly more variability in ground water elevations during the observation period (July 2006 to June 2007) than those for the Surficial aquifer. Seasonal trends for the Upper Chesapeake are very similar to those in the Surficial aquifer; they are slightly more pronounced. A slight seasonal influence during the monitoring period was indicated by ground water elevation lows in August 2006, followed by gradually increasing levels through March/April 2007, followed by decreasing levels generally approaching water levels observed in July 2006. One well (OW-759B) exhibited steadily increasing water levels throughout most of the 12-month observation period, with a maximum in June 2007. Although they exhibit the same general water level trends during the 12-month observation period, three wells (OW-708A, OW-711, and OW-769) exhibit noticeably higher ranges (amplitude) of elevation changes. On average, ground water elevations fluctuated approximately 4.0 ft (1.2 m), and the maximum observed fluctuation of 8.3 ft (2.5 m) was observed in OW-708A.

The ground water potentiometric data summarized in Table 2.4-36 were used to develop ground water surface elevation contour maps for the Upper Chesapeake unit on a quarterly basis. These maps are presented in Figure 2.4-75 through Figure 2.4-78 for July 2006, September 2006, December 2006, and March 2007, and Figure 2.4-100 for June 2007. For each quarter, the spatial trends of the potentiometric surface and the horizontal hydraulic gradients flowing in this direction likely discharges directly to the Chesapeake Bay because the silty sand unit containing the Lower Chesapeake unit is below sea level. Very little change in horizontal hydraulic gradient was observed during the monitoring period with values averaging approximately 0.0140 ft/ft.

Ground water elevations measured in the three well clusters that monitored head differences between the Upper Chesapeake unit and the Lower Chesapeake unit indicated a slight downward vertical gradient. Potentiometric surface elevations in the Upper Chesapeake unit range approximately 3.9 to 4.9 ft (1.2 to 1.5 m) higher than the ranges in the Lower Chesapeake unit at well cluster locations OW-313 and OW-418, respectively. Potentiometric surface elevations in the two units are basically identical at the well cluster closest to the Chesapeake Bay, location OW-703.

2.4.12.3.2 Hydrogeologic Properties

The 40 ground water observation wells installed in connection with the CCNPP Unit 3 site subsurface evaluation were slug tested to determine in situ hydraulic conductivity values for the Surficial aquifer and Upper and Lower Chesapeake units. Table 2.4-37 summarizes the test results.

Ten of the 17 Surficial aquifer wells tested were used to calculate hydraulic conductivity values. Three wells screened in the Surficial aquifer had measurable water but at or below the bottom of the well screen (OW-413A, OW-729, and OW-770); therefore, the slug test results from these wells are not included in this analysis. The slug test data from three additional Surficial aquifer wells (OW-714, OW-718, and OW-766) were not used in this evaluation because the static water levels were below the top of the solid slugs inserted into the well to displace the water level. Additionally, observation well OW-744 appears to have been screened in a discontinuous sand unit between the water bearing sand units of the Surficial aquifer and the Upper Chesapeake unit. Because the following slug test analyses are categorized by the three distinct water bearing units encountered onsite, the hydraulic conductivity evaluations presented below do not consider slug test data from this well. Slug test data from all the Upper and Lower Chesapeake unit wells were used in the hydraulic conductivity evaluations.

~~Soil samples collected from the Surficial aquifer, Upper Chesapeake, and Lower Chesapeake units during the geotechnical investigation were submitted for laboratory testing to determine moist unit weight, moisture content, and specific gravity. Testing results are included in Table 2.4-38. The results of these laboratory analyses were used to calculate mean void ratio and porosity values for the three water bearing units cited above.~~ The following discussions on hydrogeological properties are derived from the CCNPP Unit 3 data evaluations for the Surficial aquifer, Upper Chesapeake unit, and Lower Chesapeake unit. Hydrogeological property discussions for the Chesapeake Group aquitards comprising the Chesapeake Confining Unit and all deeper units described in Section 2.4.12.1.2 were summarized from the literature, where available. A detailed description of the geotechnical subsurface site investigation, including the hydrogeologic field program is described in Section 2.5.

2.4.12.3.2.1 Surficial Aquifer

Hydraulic conductivity values were determined from slug test results for the Surficial aquifer range from 0.040 ft/day to 17.4 ft/day (0.01 to 5.3 m/day), with a geometric mean of 0.910 ft/day (0.28 m/day) as detailed in Table 2.4-37. The range in values is considered to be indicative of the variability of the subsurface material composition (see Section 2.5). A transmissivity of 10.9 ft^2/day (1.01 m^2/day) for the Surficial aquifer was calculated using the mean hydraulic conductivity value cited above and an average saturated thickness of 12 ft (3.7 m).

~~Table 2.4-38 summarizes the laboratory test results for the three geotechnical samples collected from the Surficial aquifer sediments, which were at elevations ranging from 66.3 to 75.3 ft (20.2 m to 23 m) msl. These samples were collected from geotechnical borings B-320, B-722, and B-732. Sand and clayey sand make up the majority of the samples. Measured moist unit weight ranges from 120 to 124 pounds/cubic ft (pcf) (1922 to 1986 kg/m^3). Measured moisture contents, by weight, range from 23.1% to 29.4%. Specific gravity values range between 2.63 and 2.76. Using these values, the mean void ratio was estimated to be about 0.75. A mean total porosity of 42.7%t was calculated from this void ratio, and mean effective porosity of about 34.1% (Table 2.4-38) was estimated based on 80 percent of the total porosity (de Marsily, 1986).~~

Information on the vadose zone above the Surficial aquifer is limited. From the geotechnical data listed in Section 2.5.4, measured moisture contents by weight range from approximately 2.5% to 19.1%. The majority of the values ranged between 5% and 15%. Hydraulic conductivity for the Upland Deposits was estimated from grain size analyses as part of the CCNPP Units 1 and 2 FSAR investigation. A maximum hydraulic conductivity of 400 gpd/ft^2 (16,299 lpd/m) (53.6 ft/day (16.3 m/day)) was reported.

2.4.12.3.2.2 Chesapeake Group

The following discussion presents the evaluations of the hydrogeologic properties of the two water bearing units in the upper Chesapeake Group informally named the Upper Chesapeake and Lower Chesapeake units. This is followed by a description of the intervening and underlying Chesapeake Clay and Silt units comprising the remainder of the Chesapeake Group.

Upper Chesapeake Unit

The top of the silty sand unit comprising the informally named Upper Chesapeake unit lies approximately 50 ft (15 m) below the base of the Surficial aquifer. Hydraulic conductivities determined from the slug test results for the Upper Chesapeake unit range from 0.12 to 13.7 ft/day (0.04 m/day to 4.2 m/day), with a geometric mean of 0.740 ft/day (0.23 m/day) as detailed in Table 2.4-37. The range in values is indicative of the variability of the grain size and clay content of the material. A transmissivity of 15.8 ft^2/day (1.5 m^2/day) for the Upper Chesapeake unit is calculated using the mean hydraulic conductivity value cited above and an average saturated thickness of 21.4 ft (6.5 m/day).

~~Table 2.4-38 summarizes the laboratory test results for the five geotechnical samples collected from the Upper Chesapeake Unit sediments. Measured moist unit weights range from 116 lbs/ft^3 to 121 lbs/ft^3 (1859 to 1939 kg/m^3). Measured moisture contents, by weight, range from 23.1% to 44.2%. Specific gravity values range between 2.66 and 2.75. Using these values, the mean void ratio is estimated to be about 0.86. A mean total porosity of 46.2% is calculated from this void ratio, and the mean effective porosity of about 37.0% (Table 2.4-38) was estimated based on 80% of the total porosity (de Marsily, 1986).~~

Lower Chesapeake Unit

The top of the informally named Lower Chesapeake unit generally lies approximately 15 ft (4.6 m) below the base of the Upper Chesapeake unit. Hydraulic conductivities determined from the slug test results for the three wells screened in the Lower Chesapeake unit range from 0.019 to 0.093 ft/day (0.006 to 0.028 m/day), with an arithmetic mean of 0.045 ft/day (1.37 cm/day) (Table 2.4-37). The arithmetic mean for the hydraulic conductivity was used instead of the geometric mean due to the very small sample size. These values are lower than those observed in the Surficial aquifer and the Upper Chesapeake unit by more than one order of magnitude. A transmissivity of 1.6 ft^2/day (0.15 m^2/day) for the Lower Chesapeake unit is calculated using the mean hydraulic conductivity value cited above and an average saturated thickness of 36.1 ft (11 m).

~~Table 2.4-38 summarizes the laboratory test results for the three geotechnical samples collected from the Lower Chesapeake unit sediments. Measured moist unit weights range from 113 pcf to 117 pcf (1811 to 1875 kg/m^3). Measured moisture contents, by weight, range from 37.3% to 50.5%. Specific gravity values range between 2.64 and 2.70. Using these values, the mean void ratio is estimated to be about 1.06. A mean total porosity of 51.5% is calculated from this void ratio, and mean effective porosity of about 41.2% was estimated based on 80% of the total porosity (de Marsily, 1986).~~

Chesapeake Clay and Silts

Clay and silt comprising the Upper Chesapeakeaquitard separates the Surficial aquifer from the underlying Upper Chesapeake unit. The aquitard immediately underlies the Surficial aquifer below an elevation of approximately 65 ft (19.8 m) msl. Laboratory tests performed on core samples in support of southern Maryland hydrogeologic studies reported vertical hydraulic conductivities ranging between 5.9×10^{-5} ft/day to 2.5×10^{-2} ft/day (1.8×10^{-5} m/day to 7.6×10^{-3} m/day (MGS, 1997). Vertical hydraulic conductivities established for ground water model calibrations associated with these studies, range from 8.6×10^{-6} ft/day to 8.6×10^{-5} ft/day (2.6×10^{-6} m/day to 2.6×10^{-5} ft/day), except for channeled areas where higher values were assigned to accommodate infilled deposits of sand and gravel (MGS, 1997). These sand units presumably correlate to the Upper and Lower Chesapeake units described herein. Assigned specific storage values ranged between 6.0×10^{-6} ft^{-1} and 1×10^{-5} ft^{-1} (2.0×10^{-5} m^{-1} and 3.3×10^{-5} m^{-1} for the Chesapeake Group aquitards in the Chesapeake Confining Unit (MGS, 1996).

2.4.12.3.3 Ground Water Flow and Transport

The following sections present the most probable ground water flow direction and travel time from the CCNPP Unit 3 power block area to nearby surface water features. Based on the evaluation summarized in the above sections, only the shallow water bearing units (Surficial aquifer and the Upper Chesapeake and Lower Chesapeake water-bearing units) would be affected by construction and operation of the CCNPP Unit 3. Ground water use associated with CCNPP Unit 3 operations is discussed in Section 2.4.12.1.4. Accidental release parameters and pathways for liquid effluents in ground water and surface water are presented in Section 2.4.13.

The ground water seepage velocity is defined as distance over time and is calculated as follows:

Velocity = [(hydraulic gradient) x (hydraulic conductivity)] / (effective porosity)

The travel time is defined as rate of ground water movement for a set distance and is calculated as follows:

Travel Time = (distance) / (velocity)

2.4.12.3.3.1 Surficial Aquifer

In the vicinity of the CCNPP site, the Surficial aquifer is capable of transmitting ground water but is of limited areal and vertical extent. The Surficial aquifer (Upland Deposits) is not a reliable source of ground water because of its relative thinness, limited saturated thickness, and dissected topography that causes local ground water to discharge as small seeps and springs.

The ground water travel time in the Surficial aquifer was calculated from the center of the ground water divide in the CCNPP Unit 3 power block area to the projected discharge point in the headwater area of Branch 3. An average horizontal ground water velocity of ~~0.029~~ 0.072 ft/day (~~0.009~~ 0.022 m/day) was calculated using a mean horizontal hydraulic gradient of 0.0110 ft/ft between the ground water divide and Branch 3 (Figure 2.4-70 through Figure 2.4-73 and Figure 2.4-99), a hydraulic conductivity of 0.910 ft/day (0.28 m/day), and an effective porosity of ~~34.1% (Section 2.4.12.3.2.1)~~ 13.9%. Using a mean travel distance of approximately 1315 ft (400.8 m) from the ground water divide in the CCNPP Unit 3 power block to the closest downgradient point above 65 ft (19.8 m) msl in Branch 3, the ground water travel time from the power block area to Branch 3 was estimated to be about ~~124~~ 50 years. East of the CCNPP Unit 3 reactor building, the flow paths to adjacent springs and seeps are presumed to be shorter, with shorter corresponding travel times for spring/seep discharge.

2.4.12.3.3.2 Upper Chesapeake Unit

Direct ground water discharge to surface water from the Upper Chesapeake unit likely occurs along the lower reaches of Branch 1 and Branch 2 at elevations below approximately 20 ft (6 m) msl where the Upper Chesapeake unit presumably outcrops. The ground water travel time in the Upper Chesapeake unit was calculated from the center of the CCNPP Unit 3 power block area northward to the projected discharge point at an elevation of 20 ft (6 m) msl in Branch 2. An average horizontal ground water velocity of ~~0.034~~ 0.087 ft/day (~~0.010~~ 0.026 m/day) was calculated using a mean horizontal hydraulic gradient of 0.017 ft/ft (Section 2.4.12.3.1.2) along the projected flowpaths between the center of the CCNPP Unit 3 power block and the discharge point in Branch 2 (Figure 2.4-75 through Figure 2.4-78 and Figure 2.4-100), a hydraulic conductivity of 0.740 ft/day (0.226 m/day), and an effective porosity of ~~37.0% (Section 2.4.12.3.2.2.1)~~ 14.5%. Using a mean travel distance of approximately 1425 ft (434 m) from the center of the CCNPP Unit 3 power block to the projected downgradient discharge point at 20 ft (6 m) msl in Branch 2, the ground water travel time from the power block area to Branch 2 was estimated to be about 115 years. Similarly, the ground water travel times in the Upper Chesapeake unit were calculated from a point south of the CCNPP Unit 3 power block area northeastward to the projected discharge point at an elevation of 20 ft (6 m) msl in Branch 1 and farther downgradient to Chesapeake Bay. Using the same average horizontal ground water velocity of 0.034 ft/day (0.010 m/day) and mean path distances of 1415 ft (431.3 m) and 1685 ft (513.6 m) to Branch 1 and the Chesapeake Bay, respectively, travel times of approximately ~~114~~ 45 years and ~~138~~ 53 years were calculated. It is possible that a ground water hydraulic divide exists along the southwestern boundary of the CCNPP Unit 3 power block area, resulting in a flow direction beneath the western switchyard area towards St. John's Creek and Branch 3.

2.4.12.3.3.3 Lower Chesapeake Unit

The ground water in the Lower Chesapeake unit likely discharges to the Chesapeake Bay, because this unit is entirely below sea level. The ground water travel time in the Lower Chesapeake unit was calculated from the center of the CCNPP Unit 3 power block area northeastward to the downgradient location of the Chesapeake Bay shoreline. An average horizontal ground water velocity of ~~0.0015~~ 0.0040 ft/day (~~0.00046~~ 0.0012 m/day) was calculated using a mean horizontal hydraulic gradient of 0.014 ft/ft (Section 2.4.12.3.1.3) along the projected flowpaths between the center of the CCNPP Unit 3 power block area and the shoreline (Figure 2.4-80 through Figure 2.4-83 and Figure 2.4-101), a hydraulic conductivity of 0.045 ft/day (0.014 m/day), and an effective porosity of ~~41.2% (Section 2.4.12.3.2.2.2)~~ 15.6%. The arithmetic mean for the hydraulic conductivity was used instead of the geometric mean due to the very small sample size. Using a distance of approximately 1540 ft (469 m) from the center of the CCNPP Unit 3 power block area to a downgradient point on the shoreline of Chesapeake Bay, the ground water travel time from the CCNPP Unit 3 power block area to the bay is estimated to be about 2810 years.

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2.4.12.4 Monitoring or Safeguard Requirements

The observation well network in the vicinity of CCNPP Unit 3 currently consists of 40 wells constructed in the summer of 2006. Groundwater levels in the observation well network were monitored monthly from July 2006 through October 2008 and have been monitored quarterly thereafter. Quarterly groundwater level monitoring will continue until the onset of CCNPP Unit 3 construction, at which time most of the existing observation wells will be properly sealed and abandoned in accordance with MDE Regulation 26.04.04.11. Most of the wells are within the CCNPP Unit 3 power block area and adjacent areas that will be re-graded during construction. For this reason, all but nine of the existing wells will be properly abandoned to allow for construction and to eliminate the potential for the wells to become damaged during construction and potentially provide a pathway for contaminants to enter the local groundwater system.

Groundwater levels will continue to be monitored quarterly during the construction of CCNPP Unit 3 in the nine observation wells outside of the construction footprint. The following wells will remain: OW-768A, -769, -703A, 703B, -718, -725, -743, -759A and -759B. The objective of continued monitoring of water levels is to determine the long-term range of seasonal water-level fluctuation. The range of fluctuation during the construction period will be compared to that identified during monitoring before construction, to determine if groundwater gradients, flow directions and flow velocities are significantly affected by construction activities.

As soon as practical after construction is complete, and before CCNPP Unit 3 begins operation, approximately 29 new observation wells will be installed in the vicinity of CCNPP Unit 3. The locations of the proposed observation wells are shown on FSAR Figure 2.4-108. These 29 wells, together with the 9 existing wells, are comparable to the number of wells in the original observation network and provide sufficient coverage to monitor groundwater levels in the three aquifers of primary interest beneath the site of CCNPP Unit 3. These are (in increasing depth) the Surficial aquifer, the Upper Chesapeake unit and the Lower Chesapeake unit. Other deeper regional aquifers exist beneath the CCNPP Unit 3 site, but the shallowest of these (the Piney Point-Nanjemoy aquifer) is separated from the overlying Lower Chesapeake unit by an aquitard approximately 170 ft thick and it is unlikely that there is a significant flow path from the Lower Chesapeake unit to the deeper aquifers.

The proposed new wells are arrayed in 13 pairs and one well triplet. Eleven of these new well pairs, plus one well pair from the original nine wells, will monitor the vertical hydraulic gradient between the Surficial aquifer and the underlying Upper Chesapeake unit. Two of the new well pairs, plus one well pair from the original nine wells, will monitor the vertical gradient between the Upper Chesapeake unit and the underlying Lower Chesapeake unit. The well triplet will monitor the vertical hydraulic gradient between all three aquifers. Two of the original nine wells are single wells monitoring the Surficial aquifer and three of the original nine wells are single wells monitoring the Upper Chesapeake unit.

Groundwater levels in each of the 38 observation wells (9 existing and 29 new) in the post-construction network will be measured quarterly. The data will be used to construct water table contour maps for the Surficial aquifer and potentiometric surface contour maps for both the Upper and Lower Chesapeake units. These maps will allow determination of groundwater flow gradients, flow directions and flow velocities after operation of CCNPP Unit 3 begins. In addition, some of these wells may be used during plant operation to monitor groundwater quality, including identifying the presence of plant-related radionuclides in the vicinity of CCNPP Unit 3.

Safeguards will be used to minimize the potential of adverse impacts to the ground water by construction and operation of CCNPP Unit 3. These safeguards would include the use of lined containment structures around storage tanks (where appropriate), hazardous materials storage areas, emergency cleanup procedures to capture and remove surface contaminants, and other measures deemed necessary to prevent or minimize adverse impacts to the ground water beneath the CCNPP Unit 3 site. No ground water wells are planned for safety-related purposes.

2.4.12.5 Site Characteristics for Subsurface Hydrostatic Loading and Dewatering

Ground water conditions relative to the foundation stability of safety-related facilities and plans for the analysis of seepage and piping conditions during construction are discussed in Section 2.5.4.6. The completed surface grade for CCNPP Unit 3 is expected to range between elevations of 72 to 85 ft (21.9 to 25.9 m) msl, requiring cut and fill across the site area. The proposed maximum grade elevation of the nuclear island is approximately 83 ft (25.3 m) msl. The design depth for foundations of structures within the nuclear island is estimated to be at an approximate elevation of 40 ft (12.2 m) msl for the reactor containment structure.

Ground water elevations within the Surficial aquifer range from approximately elevation 68 to 85.7 ft (20.7 to 26.1 m) msl with the highest observed elevations occurring in the CCNPP Unit 3 power block area. Since the current maximum observed Surficial aquifer ground water elevation is 85.7 ft (26.1 m) msl in the nuclear island area, the water table currently lies approximately 45.7 ft (13.9 m) above the lowest subsurface portion of safety-related structures.

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The U.S. EPR FSAR requires that the maximum ground water elevation be at least 3.3 ft (1.0 m) below grade for safety-related structures. As indicated above, existing data indicates that the maximum pre-construction ground water level is currently at or slightly above the proposed grade level in the nuclear island area, potentially outside of the U.S. EPR FSAR design envelope. ~~Because the CCNPP Unit 3 cut and fill operations, site grading, and construction activities will alter the existing Surficial aquifer ground water system, ground water modeling using a two-dimensional single layer numerical model was employed to evaluate these effects in the power block area and estimate post-construction ground water levels in the Surficial aquifer below the safety-related structures of the power block. The safety-related UHS makeup water intake structure (MWIS), shown in Figure 2.4-64, is located near the Chesapeake Bay at a nominal grade elevation of 10 ft. Because of its remote location, the UHS MWIS is not included in the numerical model. The ground water level at the UHS MWIS is conservatively estimated to be at grade elevation.~~

~~At the time of the preparation of the ground water model, Surficial aquifer ground water elevations were not yet available for the period from April to June 2007. Water levels in March 2007 were the highest observed values, and these observations were used to calibrate the model. Surficial aquifer observation wells OW-714, OW-718, OW-743, and OW-759A were not used in the calibration since they were outside of the model domain boundaries. To calibrate the numerical model, hydraulic conductivity values and recharge rates of the native soils were allowed to vary. Hydraulic conductivity values and the effects of anisotropy were evaluated, however, it was determined that the best fit to the observed ground water elevation data was obtained when a uniform hydraulic conductivity value (1.10×10^{-3} cm/s) approximately equal to the arithmetic mean (1.31×10^{-3}) of the slug test data was used. Due to the uncertainty in infiltration values at the site, recharge was varied, with a starting estimate of 10 to 20% of the mean annual rainfall of 44 inches. The best agreement with the observed water levels was obtained with a recharge value of 5 in/yr, or 11.4% of the mean annual rainfall. At the time~~

modeling was performed, precipitation data was not available for 2007 to compare the value used during calibration to the period used to calibrate the model. The simulated ground water levels were found to agree well with the observed values and reproduce the salient features of the flow patterns shown in Figures 2.4-70 through 2.4-73 and Figure 2.4-99 based on the interpretation of the measured water levels. Because of inherent spatial variability in aquifer hydraulic conductivity, and potential spatial variability in actual infiltration versus runoff, an exact match between observed and calibrated ground water elevations is not expected.

Post-construction modeling accounted for the elevations of areas to be cut, filled and graded. The fill areas effectively extend the boundaries of the pre-construction ground water domain. The hydraulic conductivity of the fill material used in the model was 5.00×10^{-3} cm/s. Increasing the hydraulic conductivity of drain cells was explored, but was found to have insignificant effect on the simulated water levels. Model cells in areas where building foundations extend to or near the bottom of the Surficial aquifer were designated as inactive and excluded from the model to indicate that the foundations are barriers to ground water flow. Recharge rates over the area of the proposed buildings in the Unit 3 power block area were reduced to 0, while in all other areas they were kept at 5 in/yr. In addition, the design calls for bio-retention ditches (French drains) to be installed along the perimeter of the power block. Drain cells were located in the model to represent the bio-retention ditches. The drain elevations were set at 76 and 74 ft msl, according to the current design. Post-construction modeling results indicate the following:

- Beneath the reactor building, the minimum depth to water will be about 13 ft (4.0 m) below grade. At this location, plant grade elevation is approximately 83 ft (25.3 m). Beneath the entire power block area, the depth to water ranges from approximately 6 ft to 16 ft (1.8 m to 4.9 m) below ground surface (Figure 2.4-97).
- The Surficial aquifer water table elevations ranges approximately 8 to 16 ft (2.4 to 4.9 m) below proposed grade at all safety-related structures (Figure 2.4-97).
- The depth below grade of the water table at safety-related structures is more than the 3.3 ft (1.0 m) required by the U.S. EPR FSAR.
- Horizontal ground water flow below the Unit 3 power block area will be predominantly to the north and east and toward the bio-retention ditches on the northwest, northeast, and southeast sides of the power block area.

Modeled post-construction water table elevations will average approximately 69 ft (21.0 m) msl at the nuclear island (Figure 2.4-98). The predicted maximum post-construction water table elevation at safety-related structures extending below grade is approximately 72 ft (22.0 m). This occurs in the southern portion of the CCNPP Unit 3 nuclear island at the Safeguards Building2 (Figure 2.4-98). The design depth for foundations of structures within the nuclear island is estimated to be at an elevation of approximately 40 ft (12.2 m) msl. Therefore, a maximum of approximately 32 ft (9.8 m) of hydrostatic head exists at the foundations.

Based on the results of the ground water model, a permanent ground water dewatering system is not anticipated to be a design feature for the CCNPP Unit 3 facility. Control of surface water (precipitation seepage and runoff) and temporary ground water dewatering are expected during construction activities.

The numerical model of the Surficial aquifer has been revised to evaluate construction impacts to ground water levels in the vicinity of the power block and stream flow in John's Creek adjacent to the Unit 3 site. Figure 2.5-129 shows the grading plan for the Unit 3 site and Figure 2.4-107 shows the post-construction topography of the model domain. Both stream flow and ground water levels after construction of Unit 3 are dependent upon several factors, including the hydraulic conductivity of the engineered fill material used and the rate of ground water recharge within the graded area of the site.

The hydraulic conductivity of the engineered fill must be estimated because it has not yet been placed and, therefore, cannot be measured. The rate of ground water recharge within the graded area of the site is difficult to predict because construction of structures, paving with impermeable surfaces, and installation of stormwater drains have the effect of reducing recharge while leveling of the topography, placement of relatively permeable engineered fill, removal of vegetation and its associated evapotranspiration and construction of stormwater retention ditches and basins have the effect of increasing recharge. These activities are undertaken during construction of Unit 3.

A sensitivity analysis to improve estimates of the hydraulic conductivity of the engineered fill and ground water recharge within the graded area of the site was completed using the numerical model. This analysis determined baseline values of 0.005 cm/sec and 5 in/yr, respectively, for these parameters.

Baseline values of hydraulic conductivity and ground water recharge for the native soils were determined to be 0.001 cm/sec and 5 in/yr, respectively. Model simulations using these values produce ground water levels that best satisfy the model calibration criteria. Assuming baseline conditions, where the rate of ground water recharge in areas to be graded does not differ significantly from that in undisturbed wooded areas of the site (i.e. 5 in/yr), model simulations show that the estimated average ground water discharge into John's Creek in the reach adjacent to the Unit 3 site is approximately 20 percent lower after construction than before construction.

The magnitude of this change is primarily dependent upon the rate of ground water recharge that occurs over the graded area of the site. Assuming baseline conditions, cutting, filling and grading of the site cause the position of the existing ground water divide to shift to the west and a greater proportion of ground water recharge from the site to flow toward the Chesapeake Bay rather than John's Creek. However, if the rate of ground water recharge over the graded area is actually twice as high as in the undisturbed wooded areas, the discharge to John's Creek in the reach adjacent to the Unit 3 site will increase after construction by up to about 20 percent.

On the other hand, the results of modeling show that if the rate of recharge over the graded area is equal to only half the rate over the undisturbed wooded areas, the discharge to John's Creek in the reach adjacent to the Unit 3 site is reduced by about 50 percent. Because only the access road and nuclear island of the Unit 3 site will be paved, evapotranspiration is substantially reduced by clearing approximately 274 acres of woodland across the Unit 3 site and several stormwater retention basins are used to promote infiltration of site drainage, it is likely that the rate of ground water recharge over the graded area of the site will be greater than the rate over the undisturbed wooded areas. Therefore, ground water discharge to John's Creek most likely will not decrease substantially and may slightly increase after construction of Unit 3.

Cutting, filling and grading will locally affect the location and flow of springs and seeps on the Unit 3 site. These springs and seeps occur where the base of the Surficial aquifer is exposed within erosion channels and at the face of embankments. Downward flow of ground water

~~within the aquifer is restricted by the underlying aquitard and discharge occurs laterally at these locations, forming a spring or seep. Springs and seeps that currently exist in areas to be filled by site grading will be buried. However, they will be buried with fill whose hydraulic conductivity will likely be greater than that of the Surficial aquifer from which the springs and seeps currently flow. (Calibration of the Surficial aquifer numerical model produced an estimate for the hydraulic conductivity of the engineered fill of 0.005 cm/sec and 0.001 cm/sec for that of the native soil). New springs and seeps will likely issue from the toe of the fill, in locations further down-gradient from their former positions.~~

The effect on local users of ground water from cutting, filling and grading the Unit 3 site will be negligible. The upland deposits of southern Calvert County are deeply incised by stream erosion, such that they are laterally discontinuous. This condition causes dissection of the Surficial aquifer into relatively small areas that are effectively isolated and have limited hydraulic connection. Furthermore, because of its thin and variable saturated thickness (typically less than 20 feet at CCNPP) and vulnerability to low yield during droughts, few water wells are completed in the Surficial aquifer in southern Calvert County. Deeper aquifers beneath the Surficial aquifer are effectively segregated from flow in the shallow aquifer. For these reasons, users of ground water near CCNPP are expected to experience no significant impacts to their water supplies due to construction or operation of Unit 3.

Ground water within the Surficial aquifer beneath the pre-construction CCNPP Unit 3 facility area ranges from approximately elevation 68 to 85.7 ft (20.7 to 26.1 m) msl. Therefore, it is expected that the saturated sands within the Surficial aquifer will be encountered during grading and excavation activities. The saturated sands, where present, rest on at least 10 ft (3 m) of relatively low permeability clays and silts at an approximate elevation of 65 to 75 ft (19.8 to 22.9 m) msl. A temporary ground water management system may need to be employed during excavation to drain and control ground water flow through the Surficial aquifer. The expected lateral ground water flow rate discharging to the excavation during construction is estimated to be 25 gpm (95 lpm) or 4,817 ft^3/day (137 m^3/day). This is estimated by:

$$Q_{gw} = q_R A_R \qquad \text{Eq 2.4.12-1}$$

where

Q_{gw} is the rate of ground water discharge into the excavation area
q_R is the rate of ground water discharge
A_R is the source area bounded by the estimated ground water divide and the perimeter of the excavation

As stated above, q_R = 5 in/yr (0.13 m/yr) for an average year (i.e., 11.4 percent of the mean annual precipitation) based on the results of the ground water model calibration. The source area bounded by the estimated ground water divide and the perimeter of the excavation is A_R = 4,220,000 ft^2 (392,050 m^2).

Therefore,

$Q_{gw} = q_R A_R$ = 5 in/yr/(12 in/ft) * 4,220,000 ft^2 / (365 days/yr) = 4817 ft^3/day (137 m^3/day) = 25 gpm (95 lpm).

As a measure of possible fluctuation above the average of steady-state rate of ground water discharge to the excavation, the calculation of discharge was also performed using the largest

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Because the CCNPP Unit 3 cut and fill operations, site grading, and construction activities will alter the existing ground water system, ground water modeling using a three-dimensional five layer numerical model was employed to evaluate these effects. The model was developed using Visual MODFLOW (Schlumberger, 2008), Each layer approximately describes one of the hydrostratigraphic units of the shallow groundwater system. Specifically, most of the top layer of the model (layer 1) represents the Surficial aquifer; most of the next lower layer (layer 2) represents the Upper Chesapeake aquitard; layer 3 represents the Upper Chesapeake unit, layer 4 the Middle Chesapeake aquitard, and layer 5, the lowermost layer of the model, describes the Lower Chesapeake unit. The two uppermost hydrostratigraphic units, the Surficial aquifer and the Upper Chesapeake aquitard, do not extend over the entire model domain. Because Visual Modflow requires that all layers extend over the entire model domain, cells within a particular layer, where the hydrostratigraphic unit generally corresponding to that layer is absent, were assigned the hydraulic properties of the unit that is present at that location.

The Lower Chesapeake aquitard, which separates the Lower Chesapeake unit from the Piney Point/Nanjemoy aquifer, was not included explicitly in the three-dimensional model. The Lower Chesapeake aquitard is below the bottom of the model, which was treated as a no-flow boundary. A sensitivity analysis was conducted to assess the effect of this assumption. The sensitivity analysis indicated that the leakance to the Piney Point Aquifer, which can be estimated by the flux through a general head boundary at the bottom of Layer 5, is relatively negligible compared with the horizontal flux towards Chesapeake Bay.

The thickness of each of the five units included in the model was defined from borehole data collected as part of the geotechnical investigation at the site. The model grid was rotated 90 degrees from the plant design grid so that the model north is equivalent to the plant east. All references to the signs of the compass are with respect with the model north, which is at 45-degree angle with the true north, pointing to the true northeast. The total areal extent of the model is about one and a quarter square miles (3.24 km^2), covering an area of 5180 ft (1579 m) by 6790 ft (2070 m). The model domain extends southward approximately 0.25 mi (0.40 km) beyond the southern side of the Unit 3 switchyard into the Johns Creek watershed. To the model north, the domain extends into Chesapeake Bay about 50 ft (15 m) beyond the tip of the barge dock. In the model east-west direction, the domain extends about 0.35 mi (0.56 km) to the east of the eastern side of the Unit 3 powerblock and about 0.45 mi (0.72 km) to the west of the western side of the Unit 3 cooling tower.

Because the exact location of groundwater discharge from the Surficial aquifer and the Upper Chesapeake unit into nearby streams and other low-lying areas is not known, a drain condition was applied over the entire top layer of the model, except over the part of the model that is in Chesapeake Bay. The elevation of each drain was set at 0.1 ft (0.03 m) below the ground surface. A high value for the conductance of these drains was used to allow the discharge of groundwater out of the aquifer system when the water table reaches the ground surface.

In the top layer of the model, a constant head boundary condition was used to represent the Chesapeake Bay, and no flow conditions were used along the other three sides of the model. In the layers of the model representing the Upper and the Lower Chesapeake units, a general boundary condition was used on the southern and northern boundaries and a no-flow condition on the eastern and western sides. Layer 2 and layer 4 in the model represent the two aquitards, with the exception of the north side of layer 2 where the Upper Chesapeake unit is present. The northern boundary of layer

2 used a general head boundary while other boundaries in layers 2 and 4 were treated as no-flow boundaries.

Different zones of groundwater recharge were used in the model simulations. These zones include forested areas, open undeveloped areas (i.e., areas covered with grasses and low shrubs), and paved areas. Also, different recharge zones were defined for forested areas over the Surficial aquifer, over the outcrop of the Upper Chesapeake aquitard and over the outcrop of the Upper Chesapeake unit.

In most simulations, each of the five hydrostratigraphic units was represented with a single value of horizontal hydraulic conductivity and a single value of vertical hydraulic conductivity. One alternative, conceptual geologic scenario and corresponding model employed two zones of horizontal hydraulic conductivity for the Upper Chesapeake unit. The second value represented a zone of low horizontal hydraulic conductivity relative the major portion of the unit. The horizontal to vertical anisotropy of hydraulic conductivity for all aquifer units was assumed to be 10:1.

Calibration parameters included hydraulic conductivity values in all units and the rate of groundwater recharge at the top layer of the model. Piezometric level data from monitoring wells discussed in Section 2.4.12.3.1 were used as calibration targets. The model was calibrated for steady-state conditions. For this purpose, the average value of the monthly or quarterly observations at each well in 2007 was used as a calibration target representing long-term average conditions. The calibrated hydraulic conductivity values were within the range of measured values in the hydraulic tests conducted in each aquifer unit. The calibrated hydraulic conductivity values for the aquitards were within the range of values for the confining layers used by the Maryland Geological Survey in their regional model (MGS, 2007b).

The simulated ground water levels were found to agree with the observed values and reproduce the salient features of the flow patterns shown in Figures 2.4-70 through 2.4-73 and Figure 2.4-99 for the Surficial aquifer, in Figures 2.4-75 through 2.4-78 and Figure 2.4-100 for the Upper Chesapeake aquitard, and in Figures 2.4-80 through 2.4-83 and Figure 2.4-101 for the Upper Chesapeake unit based on the interpretation of the measured water levels. Because of inherent spatial variability in aquifer hydraulic conductivity, and potential spatial variability in actual infiltration versus runoff, an exact match between observed and calibrated ground water elevations is not expected.

The model was used to predict groundwater levels and flow direction at the site under post-construction conditions. For this purpose, the model was modified by replacing the current topography with the post-construction topography as shown in Figure 2.5-173. The post-construction model accounted for hydraulic properties of backfill and other fill material used to achieve the final grade plan, treated buildings within deep foundations as barriers to shallow groundwater flow, incorporated stormwater treatment measures including surface sand filters, and considered changes in groundwater recharge resulting from the construction of Unit 3 and supporting facilities and structures.

Model cells in areas where building foundations extend to or near the bottom of the Surficial aquifer were designated as inactive and excluded from the model to indicate that the foundations are barriers to groundwater flow. Recharge rates over the area of the proposed buildings in the Unit 3 powerblock area were reduced to zero. The rate of recharge from the surface sand filters surrounding the powerblock area was estimated based on the amount of flow directed to the surface sand filters and the ability of the subsurface materials in these areas to accommodate these rates.

The post-construction model was used to estimate piezometric levels in the powerblock area. Modeled post-construction depth to the water table in the powerblock area is shown on Figure 2.4-97. The elevation of the water table across the powerblock area is shown on Figure 2.4-98. The model post-construction topography is shown on Figure 2.4-107.

In addition, the post-construction model was used to identify likely and other plausible pathways of postulated accidental effluent releases in the Nuclear Auxiliary Building (NAB). The post-construction model was also used to quantify the impact of the construction of Unit 3 on groundwater discharge in Johns Creek. A sensitivity analysis was conducted to assess the impact of different assumptions and input parameter values on the model predictions. The sensitivity analysis included simulations for different values of hydraulic conductivity of the fill material, different assumptions for the performance of the surface sand filters designed to enhance groundwater recharge, an alternative hydraulic conductivity distribution in the Upper Chesapeake unit assumptions, and an assumption of leakage through the bottom of the Lower Chesapeake unit.

The major conclusions from the post construction simulations are:

a) The water table in the powerblock area will be well below the site grade level. In all simulations, the water table in the powerblock area was more than 30 ft (9.1 m) below the site grade level of 85 ft (26 m) (NGVD).

b) The groundwater pathway for liquid effluent releases from the NAB depends on the hydraulic conductivity of the fill material.

   - If the hydraulic conductivity of the fill is equal to the lower end of the range of expected values ($1x10^{-3}$ cm/s (2.8 ft/day)), then releases from the bottom of the NAB will move first downward to the Upper Chesapeake unit and then horizontally through this unit toward Chesapeake Bay where they eventually discharge. Even with a conservative assumption of 0.145 for the effective porosity for the Upper Chesapeake unit, the estimated travel time from the release point to Chesapeake Bay is over 22 years.

   - If the hydraulic conductivity of the fill is equal to the upper end of the range of expected values ($1x10^{-2}$ cm/s (28 ft/day)), then releases from the bottom of the NAB will move horizontally through the fill material and discharge into Branch 2. The estimated travel time from the release point to discharge point is less than a year.

c) The impact of the construction of Unit 3 on groundwater discharge in Johns Creek will be negligible.

Details on the development of the groundwater model, the assumptions and input parameter values used as well as simulation results are presented in the Groundwater Model Report (Bechtel, 2010).

++++++++ END INSERT 1 to FSAR Subsection 2.4.12.5 ++++++++

annual precipitation on record (64.6 inches in 1979) and assuming the same percentage infiltration rate (11.4 percent) which results in q_R - 7.4 inches (0.19 m) of recharge for the year.

With the same contributing area applied, the calculated lateral ground water flow rate obtained is:

$Q_{gw} = q_R A_R$ = 7.4 in/yr/(12 in/ft) * 4,220,000 ft^2 / (365 days/yr) = 7,130 ft^3/day (202 m^3/day) = 37 gpm (140 lpm).

This estimate ignores integration of antecedent conditions, the time delay between infiltration and discharge, and assumes a direct proportion of infiltration to precipitation. For these reasons it is considered a conservatively high estimate of maximum ground water discharge to be expected.

Based on these evaluations, a permanent ground water dewatering system is not anticipated to be a design feature for the CCNPP Unit 3 facility. Control of precipitation seepage and runoff and passive temporary ground water seepage controls to manage the estimated 25 gpm to 37 gpm (95 lpm to 140 lpm) excavation inflow are expected during construction activities. It is expected that surface swales may be required in areas of higher elevations adjacent to the CCNPP Unit 3 facilities to redirect surface runoff away from the site, and passive ground water drainage systems consisting of ditches, sumps, and pumps will be used to manage the limited amount of projected ground water inflow during construction. Stormwater and Surficial aquifer ground water runoff will be directed to Stormwater Management Basin(s) for settlement prior to discharge to the Chesapeake Bay. If required, this water may also be used for control of construction dust or for other non-potable water use.

From the period of July 2006 through June 2007, ground water elevations in the Upper Chesapeake unit at the proposed power block area ranged from a high of approximately 42.1 ft (12.7 m) msl in observation well OW-401 to a low of approximately 17.6 ft (5.4 m) msl at well OW-703A. The bottom of the deepest base of the excavation for construction of the reactor building will be at an elevation of approximately 40 ft (12.2 m) msl within the clays and silts separating the overlying Surficial aquifer from the Chesapeake sand units. Therefore, it is anticipated that a ground water management/dewatering system may not be required for the Upper Chesapeake unit. Ground water elevations will continue to be monitored, and any observed deviations in ground water elevations that could impact construction will be evaluated with respect to the need for a temporary construction dewatering system, as appropriate.

Based on current ground water conditions and the anticipated facility surface grade between elevations of 72 to 85 ft (21.9 to 25.9 m), ground water is expected to be encountered at depths of 6 to 16 ft (1.8 to 4.9 m) below grade. Surface water controls to minimize precipitation infiltration and the redirection of surface runoff away from the facility area are expected, further minimizing water infiltration to the ground water system beneath the site.

Electrical manholes within the facility area are expected to be at depths of 10 to 15 ft (3 to 4.6 m) below grade and, therefore, have the potential for encountering ground water that may eventually le[...] water seepin[...]

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Table deleted

Table 2.4-38—{CCNPP Unit 3 Aquifer Unit Geotechnical Parameters}

Exploratory Boring	Sample Top Elevation (ft)	Geotechnical Laboratory Test Results			Calculated Values		
		Natural Moisture (%)	Moist Unit Weight (PCF)	Specific Gravity	Void Ratio	Porosity (%)	Effective Porosity (%)
Surficial Aquifer							
B-320	67.9	29.4%	124	2.63	0.713	41.6%	33.3%
B-722	66.3	26.8%	120	2.76	0.820	45.0%	36.0%
B-732	75.3	23.1%	124	2.75	0.704	41.3%	33.0%
				Mean =	0.745	42.7%	34.1%
Upper Chesapeake							
B-328	12.8	44.2%	121	2.66	0.978	49.4%	39.6%
B-321	-2.8	28.5%	120.5	2.67	0.777	43.7%	35.0%
B-423	6.6	23.1%	120	2.74	0.754	43.0%	34.4%
B-420	-0.9	28.3%	117	2.75	0.882	46.9%	37.5%
B-440	5.3	30.0%	116	2.75	0.923	48.0%	38.4%
				Mean =	0.863	46.2%	37.0%
Lower Chesapeake							
B-304	-30.5	42.1%	113.2	2.65	1.076	51.82%	41.5%
B-401	-26.4	50.5%	117	2.70	1.167	53.86%	43.1%
B-701	-38.8	37.3%	116	2.64	0.950	48.71%	39.0%
				Mean =	1.064	51.5%	41.2%

Calculations:
Void Ratio = (Specific Gravity (x) Unit Weight of Water (x) (1+ Natural Moisture)/(Moist Unit Weight)-1)
Unit Weight Water = 62.4
Porosity = (Void Ratio)/(1+Void Ratio)
Effective Porosity = 80% of Total Porosity)

Around

Figure 2.4-97—{Modeled Post-Construction Depth to the ~~Surficial Aquifer~~ Water Table ~~in~~ the Unit 3 Power Block Area}

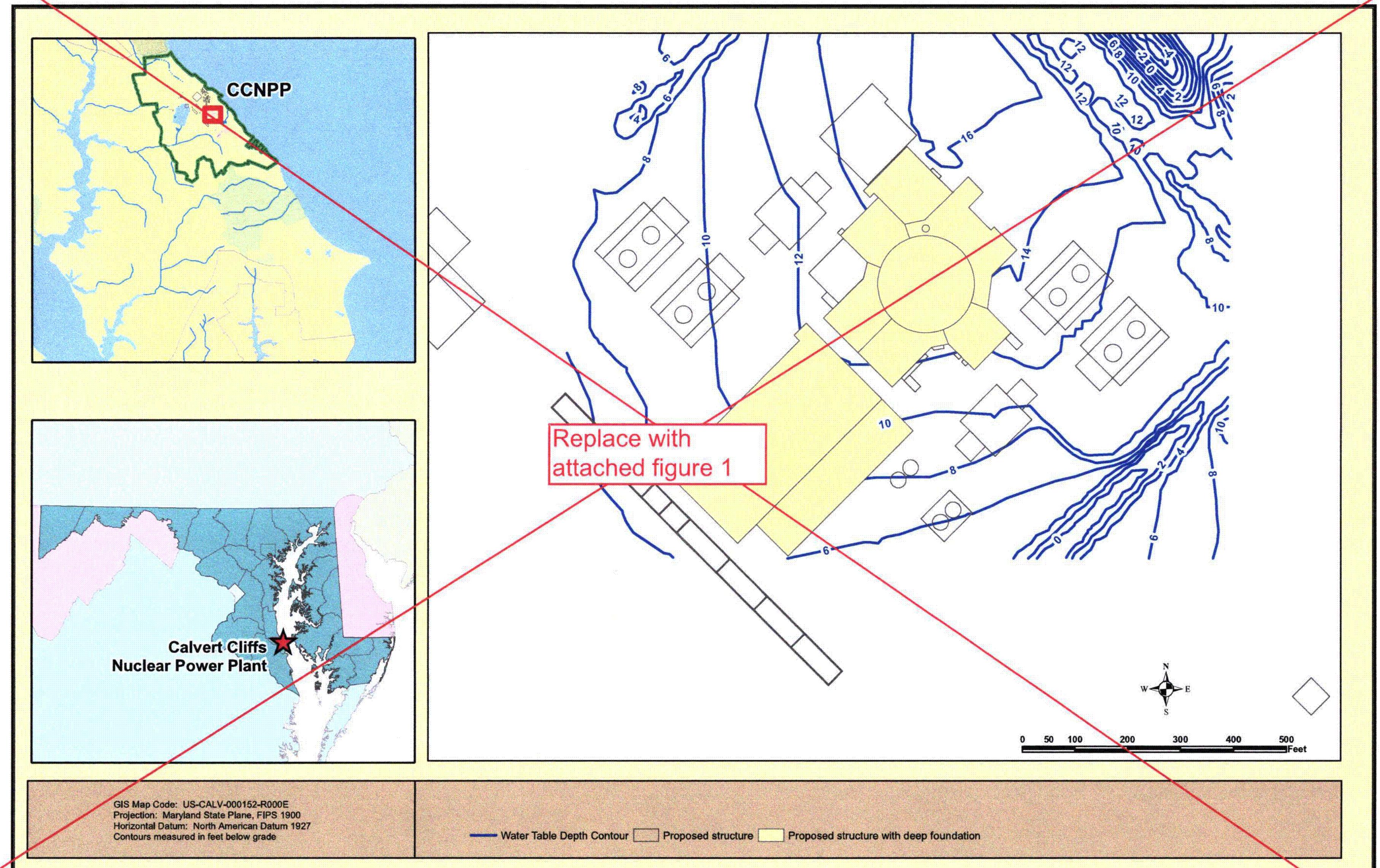
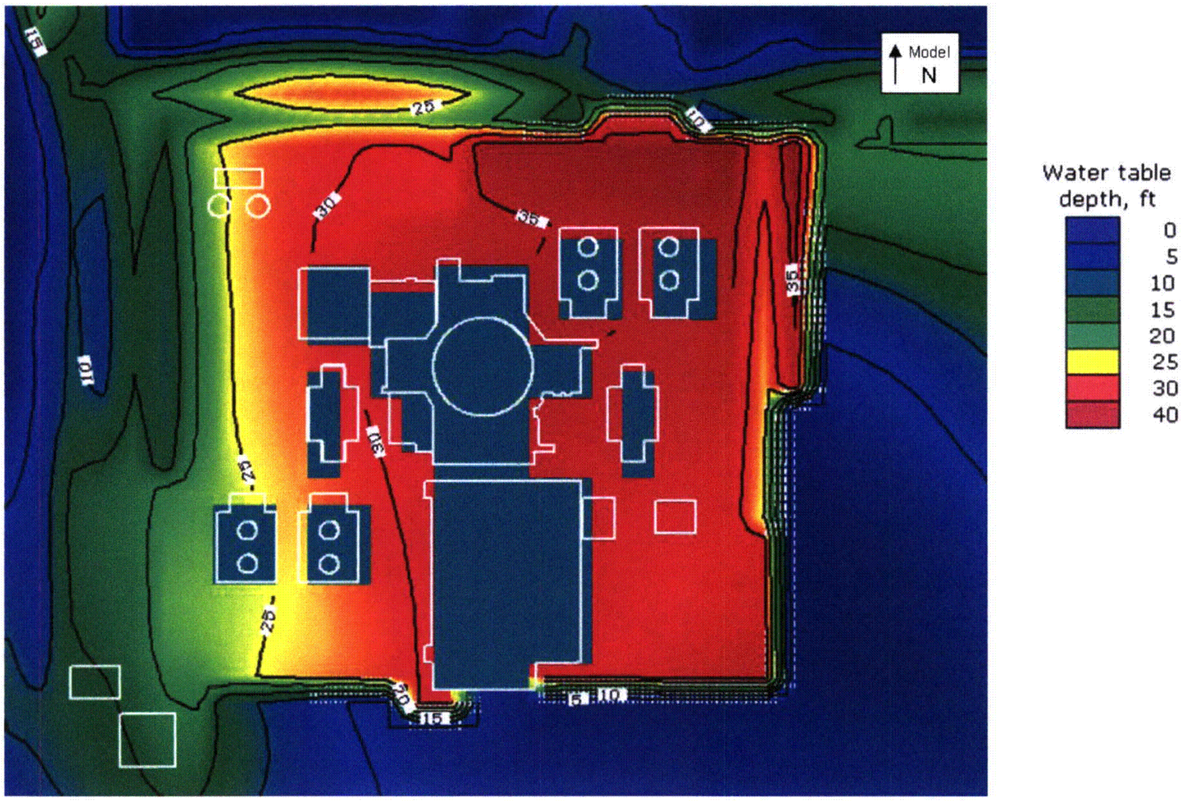


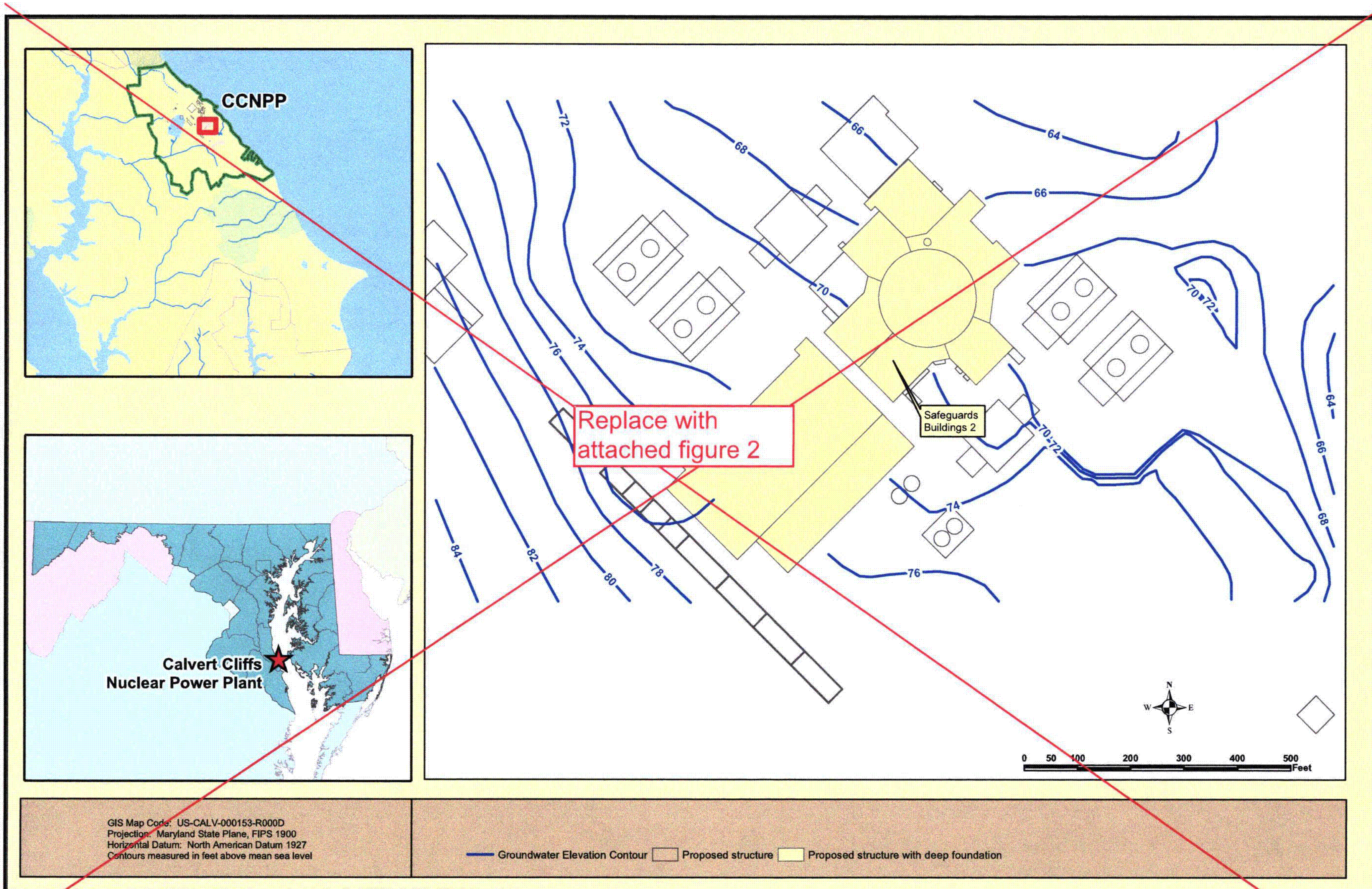
Figure 1

Replacement FSAR Figure 2.4-97



Around

Figure 2.4-98—{Modeled Post-Construction Elevation of the ~~Surficial Aquifer~~ Water Table ~~in~~ the Unit 3 Power Block Area}



Replace with attached figure 2

Figure 2

Replacement Figure 2.4-98

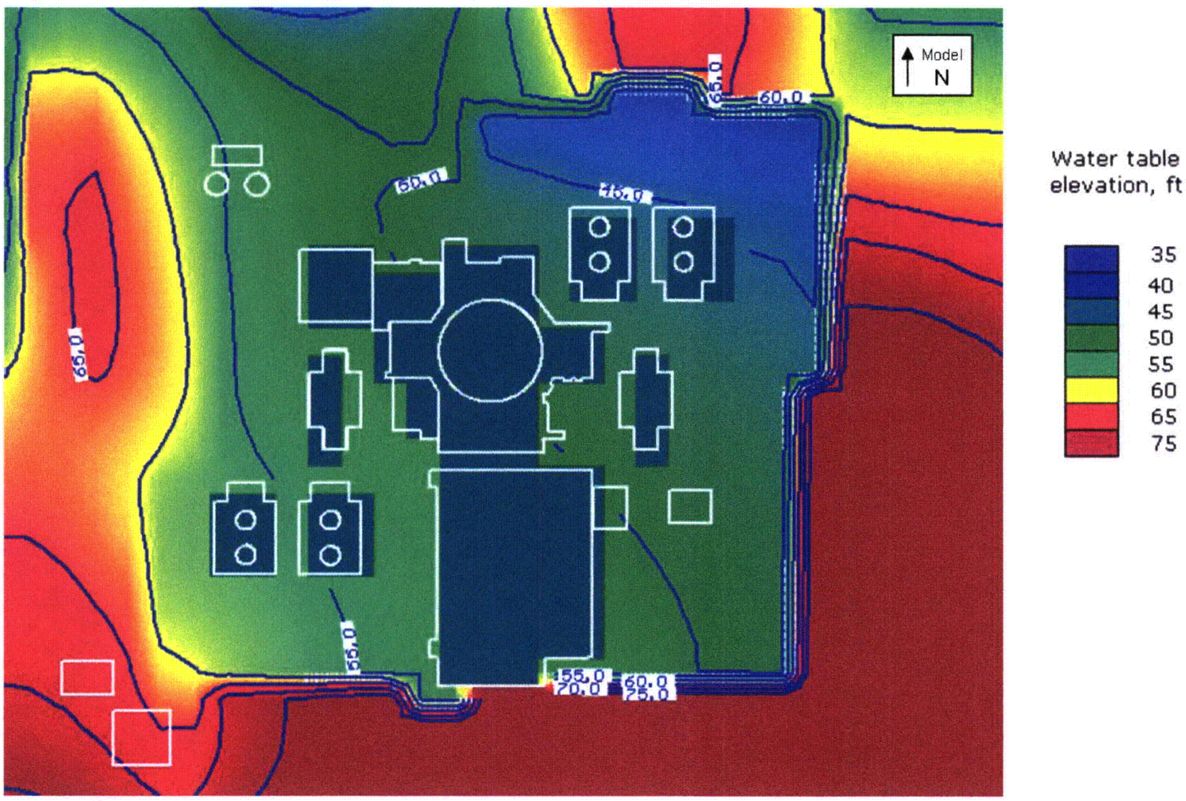


Figure 2.4-107—{Topography of the Post-Construction Groundwater Flow Model Domain}

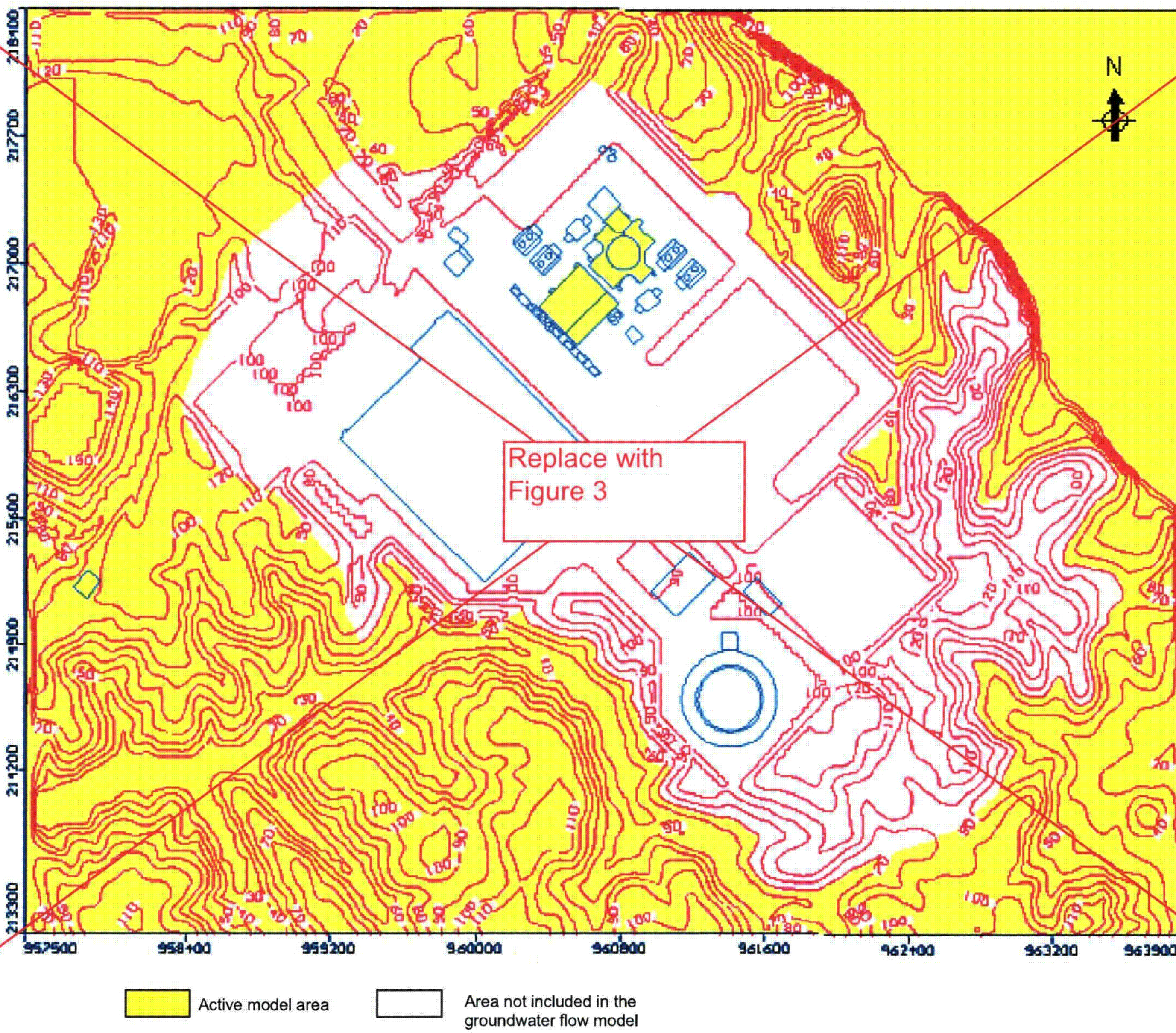
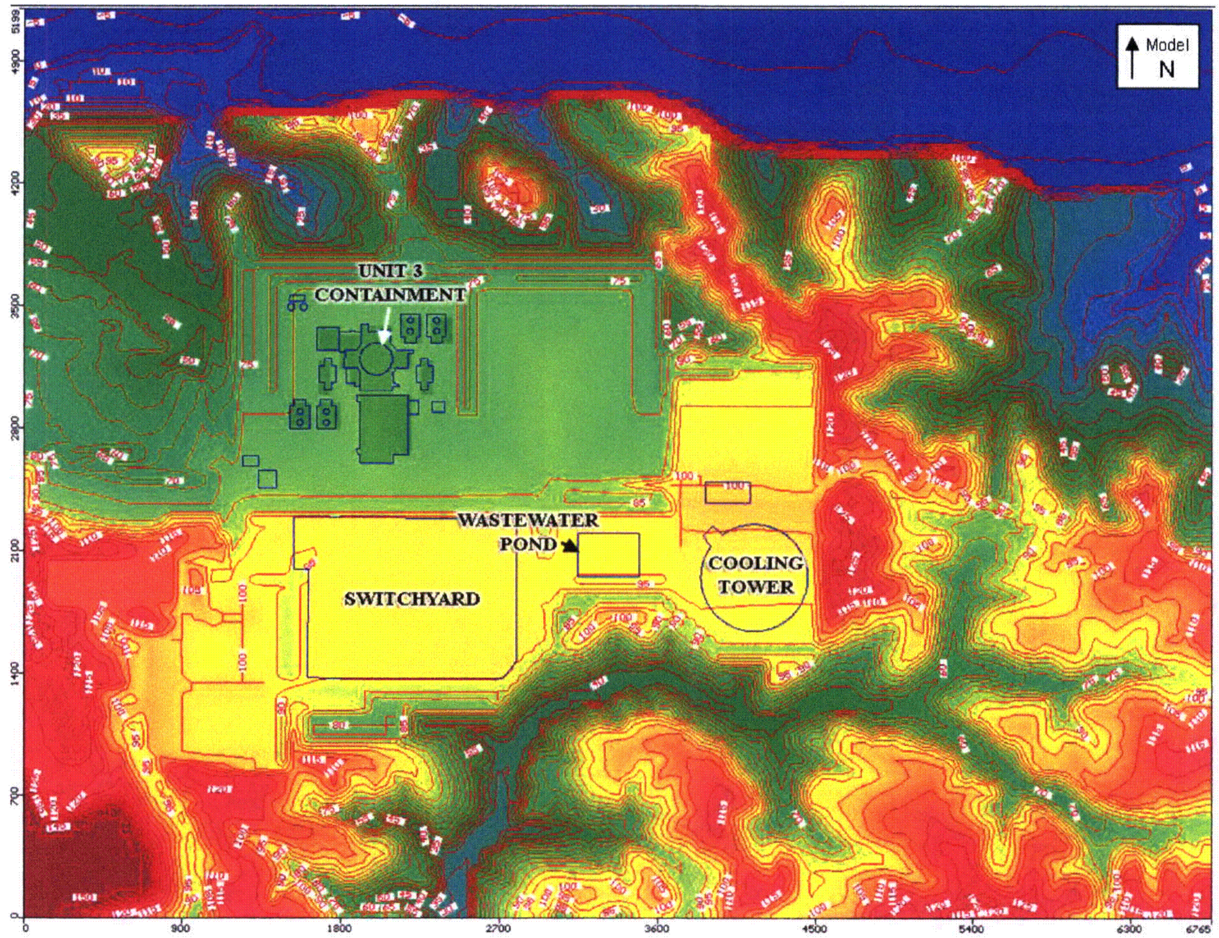


Figure 3

Replacement Figure 2.4-107



3.4 WATER LEVEL (FLOOD) DESIGN

This section of the U.S. EPR FSAR is incorporated by reference with the departures and supplements as described in the following sections.

Seismic Category I structures, systems and components (SSCs) can withstand the effects of flooding due to natural phenomena or onsite equipment failures without losing the capability to perform their safety-related functions. The maximum flood and ground water elevations for the U.S. EPR are shown in U.S. EPR FSAR Table 2.1-1 and Table 2.0-1.

{The U.S. EPR FSAR flood and ground water design elevations bound the Calvert Cliffs site-specific elevations or otherwise calculations have been performed to demonstrate that these loadings will not adversely affect the ability of safety-related structures to perform their safety functions during or after such events.}

3.4.1 INTERNAL FLOOD PROTECTION

The U.S. EPR FSAR includes the following COL Holder Items in Section 3.4.1:

A COL applicant that references the U.S. EPR design certification will perform internal flooding analyses prior to fuel load for the Safeguard Buildings and Fuel Building to demonstrate that the impact of internal flooding is contained within the Safeguard Building or Fuel Building division of origin.

This COL Holder Item is addressed as follows:

{Calvert Cliffs 3 Nuclear Project, LLC and UniStar Nuclear Operating Services, LLC} shall perform ... g to ... g or ... wn.

> This section of the U.S. EPR FSAR is incorporated by reference with the supplements described below:
>
> The maximum groundwater elevation for the U.S. EPR generic design is 3.3 ft (1m) below finished grade. The maximum groundwater level at CCNPP Unit 3 Powerblock is approximately 30 ft (9.1 m) below finished grade as discussed in Section 2.4.12.5.

... internal flood level or is designed to withstand flooding.

This COL Holder Item is addressed as follows:

{Calvert Cliffs 3 Nuclear Project, LLC and UniStar Nuclear Operating Services, LLC} shall perform an internal flooding analysis prior to fuel load for the Reactor Building and Reactor Building Annulus to demonstrate that the essential equipment required for safe shutdown is located above the internal flood level or is designed to withstand flooding. Locations of essential SSC and features provided to withstand flooding will be verified by walk-down.

3.4.2 EXTERNAL FLOOD PROTECTION

{~~This section of the U.S. EPR FSAR is incorporated by reference with the departures described below:~~

~~The U.S. EPR design requires ground water to be at least 3.3 ft (1 m) below grade. The ground water level at the CCNPP Unit 3 site ranges between 4.0 ft (1.2 m) and 10.0 ft (3 m) below proposed grade at all safety-related structures, with the exception of the Essential Service Water Cooling Tower 1 and the Emergency Power Generating Buildings 1 and 2.~~

- ~~While the water table averages approximately 4.0 ft (1.2) below grade at the Essential Service Water Cooling Tower 1, the ground water under some areas of this structure is less than 3.3 feet (1 m) below grade. This does not comply with the U.S. EPR design ground water level of 3.3 feet (1 m) below grade. A calculation demonstrated that the Essential Service Water Cooling Tower 1 can still perform its safety-related function with the ground water at this elevation. The results of the calculation are discussed in Section 3.8.5.5.3.~~

- ~~The Emergency Power Generating Buildings 1 and 2 are located approximately 3.0 ft (0.9 m) above ground water level. This does not comply with the U.S. EPR design ground water level of 3.3 ft (1 m) below grade. A calculation demonstrated that Emergency Power Generating Buildings 1 and 2 can still perform their safety related functions with the ground water at this elevation. The results of the calculation are discussed in Section 3.8.5.5.2.~~

~~U.S. EPR FSAR Section 3.8.5.4 describes the methods and procedures used to evaluate static and dynamic effects of ground water on structures.~~

~~The following information supplements the U. S. EPR FSAR:~~

The U.S. EPR FSAR requires the Probable Maximum Flood (PMF) elevation to be 1 ft (0.3 m) below finished yard grade. This requirement envelopes the CCNPP Unit 3 maximum flood level for all safety-related structures, except the Ultimate Heat Sink (UHS) Makeup Water Intake Structure and the UHS Electrical Building. The UHS Makeup Water Intake Structure and the UHS Electrical Building are located at the shoreline. Since the UHS Makeup Water Intake Structure and the UHS Electrical Building are classified as safety-related buildings, they will be designed to meet the requirements of Regulatory Guide 1.27 (NRC, 1976). The UHS Makeup Water Intake Structure and the UHS Electrical Building are designed to be watertight to prevent internal flooding of the buildings. The UHS Makeup Water Intake Structure and the UHS Electrical Building are discussed in Section 2.4.10, Section 3.4.3.10, Section 3.8.5 and Section 9.2.5.}

3.4.3 ANALYSIS OF FLOODING EVENTS

3.4.3.1 Internal Flooding Events

{No departures or supplements.}

3.4.3.2 External Flooding Events

The U.S. EPR FSAR includes the following COL Item in Section 3.4.3.2:

> A COL applicant that references the U.S. EPR design certification will confirm the potential site-specific external flooding events are bounded by the U.S. EPR design basis flood values or otherwise demonstrate that the design is acceptable.

This COL Item is addressed as follows:

{U.S. EPR FSAR Section 3.4.3.2 states: "The Seismic Category I structures are not designed for dynamic effects associated with external flooding (e.g., wind, waves, currents) because the design basis flood level is below the finished yard grade." The design of the CCNPP Unit 3 safety-related structures is consistent with this statement, except the UHS Makeup Water Intake Structure and the UHS Electrical Building. Flooding of these structures is addressed in Section 3.4.3.10.}

Enclosure 3

Update of COLA Part 3, ER
to incorporate the new Groundwater Model

Calvert Cliffs Nuclear Power Plant, Unit 3

CCNPP Unit 3. Although the water level in the vicinity of CCNPP will be lowered, the results of numerical modeling indicate the projected drawdown (using extreme assumptions) in the closest wells of major water users to be approximately 13 ft. even after 6 years of increased pumping from the CCNPP wells and from those of other domestic and major users of the Aquia aquifer. Drawdowns of this amount do not significantly impact the relevant water management factors.

It is important to note that the anticipated use of the additional groundwater is for construction purposes which are expected to last approximately 6 years. After that time, a desalination plant is planned to be on-line producing 1,225 gpm (1,764,000 gpd).

2.3.2.2.10 Groundwater Monitoring

Groundwater monitoring (water level observations) for the CCNPP Unit 3 area is currently being implemented through the use of the groundwater observation wells installed in 2006 for the CCNPP Unit 3 site subsurface investigation and through the periodic review of water levels from selected wells within the Calvert County Ground Water Level Monitoring Network as discussed in Section 2.3.2.2.7. Some of the existing CCNPP Unit 3 area observation wells will need to be taken out of service prior to construction activities due to anticipated earth moving and construction requirements. Prior to construction activities, the observation well monitoring network will be evaluated in order to determine groundwater data gaps and needs created by the abandonment of existing wells. These data needs will be met by the installation of additional observation wells, if required. Additionally, the hydrologic properties and groundwater flow regimes of the shallow water bearing units (Surficial aquifer, and to a lesser extent, the Chesapeake units) will be impacted by the proposed earthmoving, regarding, and construction of infrastructure (buildings, parking lots, etc.). Revisions to the observation well network will be implemented to ensure that the resulting changes in the local groundwater regime from construction activities will be identified.

Safeguards will be used to minimize the potential for adverse impacts to the groundwater caused by construction and operation of CCNPP Unit 3. These safeguards will include the use of lined containment structures around storage tanks (where appropriate), hazardous materials storage areas, emergency cleanup procedures to capture and remove surface contaminants, and other measures deemed necessary to prevent or minimize adverse impacts to the groundwater beneath the CCNPP site.

nsert 4

2.3.2.2.11 Site Characteristics for Subsurface Hydrostatic Loading and Dewatering

The completed surface grade for CCNPP Unit 3 is expected to range between elevations of 72 and 85 ft (21.9 and 25.9 m) msl, requiring cut and fill across the CCNPP site area. The proposed grade elevation of the nuclear island ranges from approximately 82.0 ft to 85.0 ft (25.0 m to 25.9 m) msl. The maximum design depth for construction of foundations is estimated to be at an approximate elevation of 44 ft (13.4 m) msl for the reactor containment structure. Groundwater elevations within the Surficial aquifer range from approximately 68.1 to 84.8 ft (20.8 to 25.8 m) msl with the highest observed elevations occurring in the CCNPP Unit 3 power block area. ~~The current maximum observed Surficial aquifer groundwater elevation is at the proposed maximum grade level in the nuclear island area. This maximum water level is approximately 41 ft (12.5 m) above the lowest subsurface portions of safety-related structures, systems, and components.~~

~~The U.S. EPR Final Safety Analysis Report (FSAR) requires that the maximum groundwater elevation be at least 3.3 ft (1.0 m) below grade for the nuclear island. As indicated above,~~

existing data indicates that the maximum groundwater level is currently at the proposed maximum grade level in the nuclear island area, and therefore exceeds the U.S. EPR FSAR design envelope. Because the CCNPP Unit 3 cut and fill operations, site grading, and construction activities will alter the existing Surficial aquifer groundwater system, groundwater modeling was employed to evaluate these effects and estimate post-construction groundwater levels below the nuclear island. Modeling results indicate the following:

- With the exception of the Essential Service Water System Cooling Tower 1 and Emergency Power Generating Building 1/2, Surficial aquifer water table elevations range approximately 4.0 to 10.0 ft (1.2 to 3.0 m) below proposed grade at all safety-related facilities (Figure 2.3-79).
- The water table averages approximately 4.0 ft (1.2 m) below grade at Essential Service Water System Cooling Tower 1 and approximately 3.0 ft (0.9 m) below grade at Emergency Power Generating Building 1/2 (Figure 2.3-79).
- Horizontal groundwater flow within the Unit 3 power block area will be predominantly to the north and east and toward the bio-retention ditches on the northwest, northeast, and southeast sides of the power block area. The southeast bio-retention ditch will intercept and drain a portion of the groundwater flowing to it from the upgradient area to the southwest (Figure 2.3-80).

The modeled post-construction maximum water table elevation is approximately 77.0 ft (23.5 m) msl at the nuclear island (Figure 2.3-80). Therefore a maximum of approximately 33 ft (10.1 m) of groundwater induced hydrostatic head loadings should be used as the design basis for the subsurface portions of all safety-related structures in the power block area.

The numerical model of the Surficial aquifer has been revised to evaluate construction impacts to groundwater levels in the vicinity of the power block and stream flow off site in John's Creek. Figure 2.3-86 shows the topography of the post-construction groundwater flow model and Figure 4.2-1 shows the construction footprint of the CCNPP Unit 3 site. Both stream flow and groundwater levels after construction of CCNPP Unit 3 will be dependent upon several factors, including the hydraulic conductivity of the engineered fill material used and the rate of groundwater recharge within the graded area of the site.

The hydraulic conductivity of the engineered fill must be estimated because it has not yet been placed and, therefore, cannot be measured. The rate of groundwater recharge within the graded area of the site is difficult to predict because construction of structures, paving with impermeable surfaces and installation of stormwater drains all have the effect of reducing recharge while leveling of the topography, placement of relatively permeable engineered fill, removal of vegetation and its associated evapotranspiration and construction of stormwater retention ditches and basins all have the effect of increasing recharge. All of these activities will be undertaken during construction of CCNPP Unit 3.

A sensitivity analysis to improve estimates of the hydraulic conductivity of the engineered fill and groundwater recharge within the graded area of the site was completed using the numerical model. This analysis determined baseline values of 0.005 cm/sec and 5 in/yr, respectively, for these parameters.

Baseline values of hydraulic conductivity and groundwater recharge for the native soils were determined to be 0.001 cm/sec and 5 in/yr, respectively. Model simulations using these values produce groundwater levels that best satisfy the model calibration criteria. Assuming baseline conditions. where the rate of groundwater recharge in areas to be graded does not differ significantly from that in undisturbed wooded areas of the site (i.e. 5 in/yr), model simulations show that the estimated average groundwater discharge into John's Creek after construction of CCNPP Unit 3 will be approximately 20 percent lower than before construction.

The magnitude of this change is primarily dependent upon the rate of groundwater recharge that will occur over the graded area of the site. Assuming baseline conditions, cutting, filling and grading of the site cause the position of the existing groundwater divide to shift to the east and a greater proportion of groundwater recharge from the site to flow toward the Chesapeake Bay rather than John's Creek. However, if the rate of groundwater recharge over the graded area is actually twice as high as in the undisturbed wooded areas, the discharge to John's Creek after construction of CCNPP Unit 3 will increase by up to about 20 percent.

On the other hand, the results of modeling show that if the rate of recharge over the graded area is equal to only half the rate over the undisturbed wooded areas, the discharge to John's Creek will be reduced by about 50 percent. Several stormwater retention ditches and basins will be used to promote infiltration of site drainage, and evapotranspiration will be substantially reduced by clearing approximately 274 acres of woodland. Both of these actions will have the effect of increasing net groundwater recharge to the site. In addition, only the relatively small areas of the CCNPP Unit 3 site occupied by the access road and the nuclear island will be paved. Maintaining a low percentage of paved surface area will minimize the extent to which groundwater recharge is reduced. For these reasons, it is likely that the rate of groundwater recharge within the graded area of the site will be greater than the rate within the undisturbed wooded areas. Therefore, groundwater discharge to John's Creek most likely will not decrease substantially and may slightly increase after construction of CCNPP Unit 3.

Cutting, filling and grading will locally affect the location and flow of springs and seeps on the CCNPP Unit 3 site. These springs and seeps occur where the base of the Surficial aquifer is exposed within erosion channels and at the face of embankments. Downward flow of groundwater within the aquifer is restricted by the underlying aquitard and discharge occurs laterally at these locations, forming a spring or seep. Springs and seeps that currently exist in areas to be filled by site grading will be buried. However, they will be buried with fill whose hydraulic conductivity will likely be greater than that of the Surficial aquifer from which the springs and seeps currently flow. New springs and seeps will likely issue from the toe of the fill, in locations further down-gradient from their former positions.

The effect on local users of groundwater from cutting, filling and grading the CCNPP Unit 3 site will be negligible. The upland deposits of southern Calvert County are deeply incised by stream erosion, such that they are laterally discontinuous. This condition causes dissection of the Surficial aquifer into relatively small areas that are effectively isolated and have limited hydraulic connection. Furthermore, because of its thin and variable saturated thickness (typically less than 20 feet at CCNPP) and vulnerability to low yield during droughts, few water wells are completed in the Surficial aquifer in southern Calvert County. Deeper aquifers beneath the Surficial aquifer are effectively segregated from flow in the shallow aquifer. For these reasons, users of groundwater near CCNPP are expected to experience no significant impacts to their water supplies due to construction or operation of CCNPP Unit 3.

Groundwater within the Surficial aquifer beneath the CCNPP Unit 3 facility area ranges from approximately elevation 68.1 to 84.8 ft (20.8 to 25.8 m) msl. Therefore, it is expected that the saturated sands within the Surficial aquifer will be encountered during grading and excavation activities. The saturated sands, where present, rest on at least 10 ft (3m) of relatively low permeability clays and silts at an approximate elevation of 65 to 75 ft (19.8 to 22.9 m) msl. A temporary groundwater management system may need to be employed during excavation to drain and control groundwater flow through the Surficial aquifer. It is expected that surface swales and passive ground drains may be required in areas of higher elevations adjacent to the CCNPP Unit 3 facilities to redirected surface runoff and groundwater away from the site. Stormwater runoff and Surficial aquifer groundwater will be directed to Stormwater Management Basin(s) for collection of sediment prior to discharge to the Chesapeake Bay. If required, this water may also be redirected for use in construction dust control or other non-potable water uses.

From the period of July 2006 through March 2007, groundwater elevations in the Upper Chesapeake unit at the proposed power block area ranged from a high of approximately 41.7 ft (12.7 m) msl in observation well OW-401 to a low of approximately 17.6 ft (5.4 m) msl at well OW-703A. The deepest excavation for construction of the reactor building will be at an elevation of approximately 44 ft (13.4 m) msl within the clays and silts separating the overlying Surficial aquifer from the Chesapeake sand units. Therefore, it is anticipated that a groundwater management/dewatering system may not be required for the Upper Chesapeake unit. Groundwate impact constructi system.

Bechtel, 2010. Groundwater Model for the Calvert Cliffs Nuclear Power Plant Unit 3 Site, 25237-000-30R-GEK-00002, Revision 000.

As previously stated, a permanent groundwater dewatering system is not anticipated to be a design feature for the CCNPP Unit 3 facilities. Based on the modeled post-construction groundwater conditions and the anticipated facility surface grade between elevations of 72 to 85 ft (21.9 to 25.9 m), groundwater is not predicted to exceed the U.S. EPR DCD design envelope.

Electrical manholes within the facility area are expected to be at depths of 10 to 15 ft (3 to 4.6 m) below grade and, therefore, have the potential for encountering groundwater that may leak into these structures. Manhole sump pumps may be required to be operated periodically to remove the water seeping into these features.

2.3.2.3 References

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ER section 2.3.2.2.11

Because the CCNPP Unit 3 cut and fill operations, site grading, and construction activities will alter the existing ground water system, ground water modeling using a three-dimensional five layer numerical model was employed to evaluate these effects. The model was developed using Visual MODFLOW (Schlumberger, 2008), Each layer approximately describes one of the hydrostratigraphic units of the shallow groundwater system. Specifically, most of the top layer of the model (layer 1) represents the Surficial aquifer; most of the next lower layer (layer 2) represents the Upper Chesapeake aquitard; layer 3 represents the Upper Chesapeake unit, layer 4 the Middle Chesapeake aquitard, and layer 5, the lowermost layer of the model, describes the Lower Chesapeake unit. The two uppermost hydrostratigraphic units, the Surficial aquifer and the Upper Chesapeake aquitard, do not extend over the entire model domain. Because Visual Modflow requires that all layers extend over the entire model domain, cells within a particular layer where the hydrostratigraphic unit generally corresponding to that layer is absent were assigned the hydraulic properties of the unit that is present at that location.

The Lower Chesapeake aquitard, which separates the Lower Chesapeake unit from the Piney Point/Nanjemoy aquifer, was not included explicitly in the three-dimensional model. The Lower Chesapeake aquitard is below the bottom of the model, which was treated as a no-flow boundary. A sensitivity analysis was conducted to assess the effect of this assumption. The sensitivity analysis indicated that the leakance to the Piney Point Aquifer, which can be estimated by the flux through a general head boundary at the bottom of Layer 5, is relatively negligible compared with the horizontal flux towards Chesapeake Bay.

The simulated ground water levels were found to agree well with the observed values.

The model was used to predict groundwater levels and flow direction at the site under post-construction conditions. For this purpose, the model was modified by replacing the current topography with the post-construction topography.

The post-construction model was used to estimate piezometric levels in the powerblock area. Modeled post-construction depth to the water table in the powerblock area is shown on Figure 2.3-79. The elevation of the water table across the powerblock area is shown on Figure 2.4-80.

In addition, the post-construction model was used to identify likely and other plausible pathways of postulated accidental effluent releases in the Nuclear Auxiliary Building (NAB). The post-construction model was also used to quantify the impact of the construction of Unit 3 on groundwater discharge in Johns Creek. A sensitivity analysis was conducted to assess the impact of different assumptions and input parameter values on the model predictions. The sensitivity analysis included simulations for different values of hydraulic conductivity of the fill material, different assumptions for the performance of the surface sand filters designed to enhance groundwater recharge, an alternative hydraulic conductivity distribution in the Upper Chesapeake unit assumptions, and an assumption of leakage through the bottom of the Lower Chesapeake unit.

The major conclusions from the post construction simulations are:

a) The water table in the powerblock area will be well below the site grade level. In all simulations, the water table in the powerblock area was more than 30 ft (9.1 m) below the site grade level of 85 ft (26 m) (NGVD).

b) The groundwater pathway for liquid effluent releases from the NAB depends on the hydraulic conductivity of the fill material.

- If the hydraulic conductivity of the fill is equal to the lower end of the range of expected values ($1x10^{-3}$ cm/s (2.8 ft/day)), then releases from the bottom of the NAB will move first downward to the Upper Chesapeake unit and then horizontally through this unit toward Chesapeake Bay where they eventually discharge. Even with a conservative assumption of 0.145 for the effective porosity for the Upper Chesapeake unit, the estimated travel time from the release point to Chesapeake Bay is over 22 years.

- If the hydraulic conductivity of the fill is equal to the upper end of the range of expected values ($1x10^{-2}$ cm/s (28 ft/day)), then releases from the bottom of the NAB will move horizontally through the fill material and discharge into Branch 2. The estimated travel time from the release point to discharge point is less than a year.

c) The impact of the construction of Unit 3 on groundwater discharge in Johns Creek will be negligible.

Details on the development of the groundwater model, the assumptions and input parameter values used as well as simulation results are presented in the Groundwater Model Report (Bechtel, 2010).

++++++++ END INSERT 2 to ER Subsection 2.3.2.2.11 ++++++++

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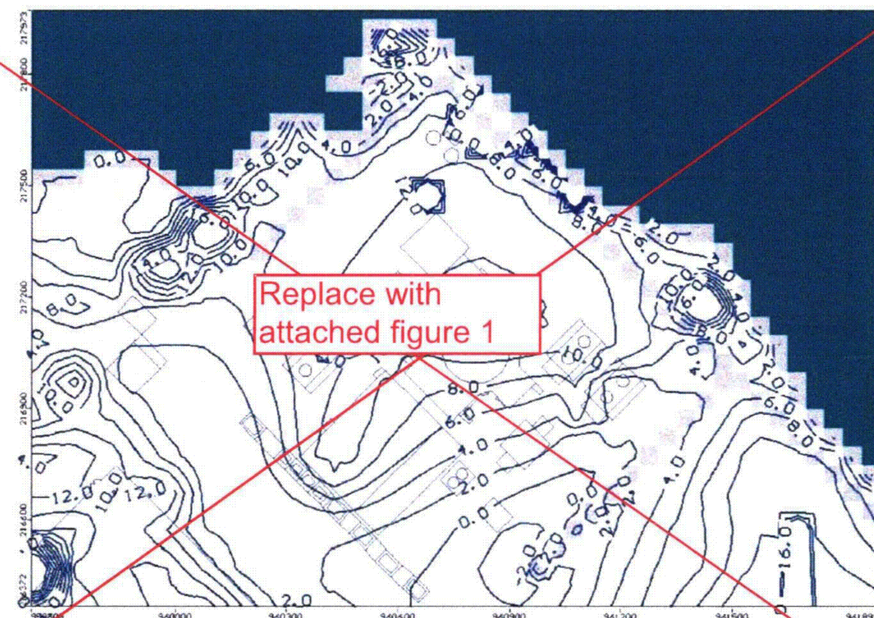
Figure 2.3-79—Modeled Post-Construction Depth to ~~Surficial Aquifier~~ Water Table Around Power Block 3



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Note: Units are Feet below grade level

Figure 1

Replacement ER Figure 2.3-79

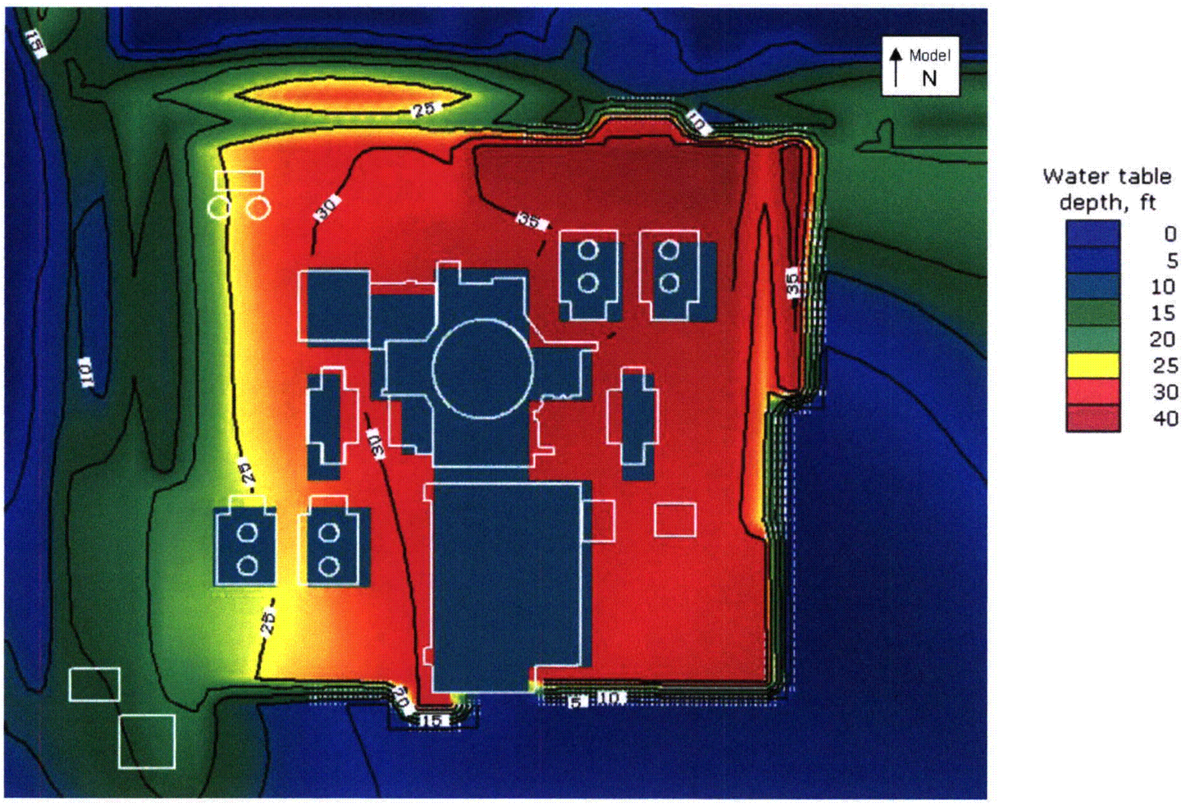

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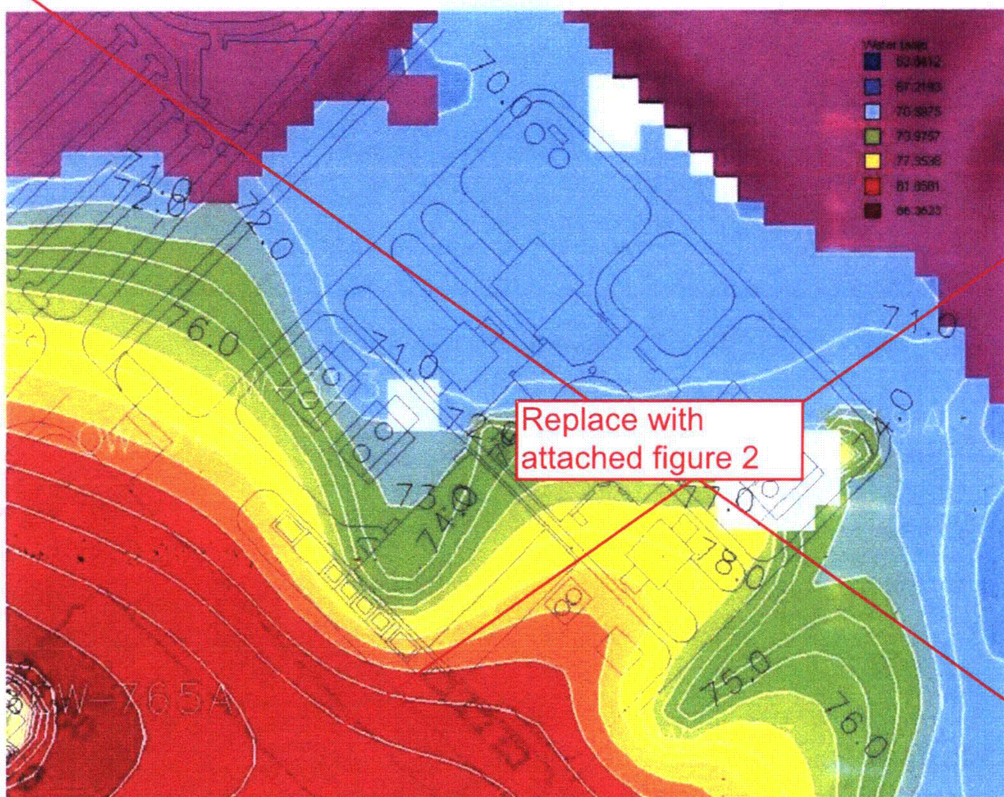
Figure 2.3-80—Modeled Post-Construction Elevation ~~to Surficial Aquifier~~ Water Table Around Power Block 3



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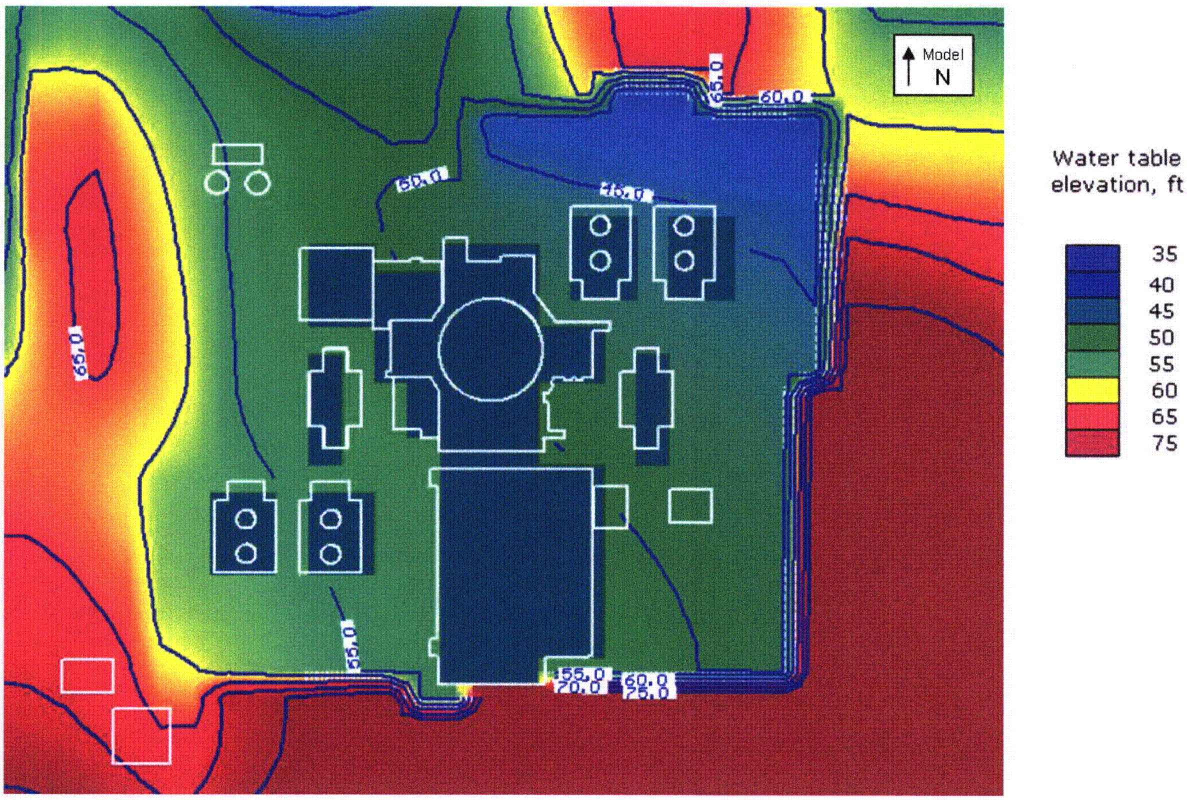
Notes:

1. Contours are in Feet msl
2. Water Table is below base of the Surficial Aquifer at cells shown in "white"

Figure 2

Replacement ER Figure 2.3-80



- Increasing runoff from the approximately 130 acres (53 hectares) of impervious surfaces (including the power block, switchyard cooling tower, laydown areas, critical areas, and roads);
- Infilling and eliminating the Camp Conoy Fishing Pond under the southeast portion of the laydown area south of the CCNPP Unit 3 power block foundation;
- Infilling and eliminating the upper reaches of Branch 2 and Branch 3, and an unnamed tributary to Johns Creek;
- Isolating portions of the upper reach of Branch 1 by construction of the laydown areas south of the CCNPP Unit 3 power block foundation;
- Disruption of the drainage in the Lake Davies dredge spoils disposal area with possible impacts on the two downstream impoundments;
- Wetlands removal and disruptions; and
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- Disruption of current Surficial aquifer recharge and discharge areas by plant construction. Hilly, vegetated areas would be cleared and graded; some streams and the Camp Conoy Fishing Pond (impoundment) would be backfilled and construction areas would be covered by less permeable materials and graded to increase runoff into bio-retention ditches. The locations of, or quantity of, water produced at springs and seeps could change downgradient of the construction areas
- Stormwater runoff from the flat, non-vegetated foundation pads, switchyard and laydown areas would be directed and concentrated into bio-retention ditches and new impoundments that could affect recharge to the Surficial aquifer. Since the ditches and impoundments are unlined, they could act as smaller, focused recharge areas and might increase the amount of water recharging the surficial aquifer
- Additional drawdown in the Aquia aquifer when the water needed for CCNPP Unit 3 construction is supplied by the CCNPP Units 1 and 2 onsite wells
- Minor shifting of the Surficial aquifer recharge area(s) to the underlying Chesapeake aquifer/confining unit

A further discussion of related construction activities is provided in Section 4.2.1.2.

4.2.2.3 Physical Effects of Hydrologic Alterations

Impacts from the construction of CCNPP Unit 3 are similar to those associated with any large construction project. The construction activities that could produce hydrologic alterations to surface water bodies and groundwater aquifers are presented in Section 4.2.1.2. The potentially affected surface water bodies and groundwater aquifers are described in Section 4.2.1.4. The potential construction effects on surface water bodies and groundwater aquifers are presented in Section 4.2.1.5.

Surface Water Impacts

Because of the potential for impacting surface water resources, a number of environmental permits are needed prior to initiating construction. Table 1.3-1 in Chapter 1 provides a list of construction-related consultations and permits that have to be obtained prior to initiating construction activities.

The construction activities expected to produce the greatest impacts on the surface water bodies occur from:

- Reducing the available infiltration area
- Grading and the subsequent covering of the 46 acre (19 hectare) CCNPP Unit 3 power

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- Creation of impoundments
- Elimination of an existing impoundment (i.e., Camp Conoy Fishing Pond)
- Elimination of existing branches of Johns Creek

Site grading and new building foundations will cover and reduce existing infiltration and recharge areas. Possible increases in runoff volume and velocity in the downstream creeks may cause erosion and adversely affect riparian habitat if not controlled.

Dewatering for the proposed foundation excavations could also impact surface water bodies. Effluent from the dewatering system, and any stormwater accumulating during the excavation, would be pumped to a stormwater discharge point or into onsite impoundments. If pollutants (e.g., oil, hydraulic fluid, concrete slurry) exist in these effluents from construction activities, they could enter the impoundments, downstream channel sections, or other surface water bodies. Monitoring of construction effluents and stormwater runoff would be performed as required in the stormwater management plan, NPDES permit, and other applicable permits obtained for the construction. Depending on the design of the stormwater impoundments and discharge systems, outflow rates into the surface streams could be altered.

All water bodies within the CCNPP site boundary could have the potential to indirectly receive untreated construction effluents. The water bodies listed in Section 4.2.1.1 are potentially subject to receiving untreated construction effluents directly. It will be necessary to implement proper BMPs under state regulations such as a: General NPDES Permit for Stormwater associated with Construction Activity, Erosion and Sediment Control Plan, and a stormwater pollution prevention plan. Table 1.3-1 lists and presents additional information on the Federal, State and Local Authorizations associated with this project.

If proper BMPs are implemented under these permits, treated construction effluents could be released to the site water bodies without adverse impacts. Flow rates for untreated construction effluents will depend upon the usage of water during site construction activities and the amount of precipitation contacting construction debris during construction activities. Flow rates and physical characteristics of the construction effluents are discussed in Section 4.2.1.4. A quantitative calculation and evaluation of the construction effluents and runoff will be done as part of the state construction permit process. BMPs would be implemented to control runoff, soil erosion, and sediment transport. Good housekeeping practices and engineering controls will be implemented to prevent and contain accidental spills of fuels, lubricants, oily wastes, sanitary wastes, etc.

BMPs are implemented under a Spill Prevention Plan, a SWPPP, and an Erosion Control Plan, as described in Section 4.2.1.7 and Section 4.2.2.10. Environmental control systems installed to minimize impacts related to construction activities will comply with all Federal, state and local environmental regulations and requirements. Once the initial controls are in place, they are maintained through the completion of construction and during plant operation, as needed.

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Increasing groundwater withdrawals for construction needs from the onsite Aquia aquifer production wells, could produce a local depression of the potentiometric surface in that aquifer. These increased withdrawals could potentially induce salt water intrusion or produce land subsidence, but as discussed earlier, neither had been reported as a significant problem in Calvert County or St. Mary's County.

The hydrologic alterations that could be produced in the groundwater aquifers are expected to be localized and possibly temporary. Most of the effects are expected to occur in the uppermost or Surficial aquifer. Any effects in the deeper aquifers are expected to be minor, due to remaining within the existing permit withdrawal limits, and dependent to a large extent on groundwater travel time, thickness and physical properties of the intervening stratigraphic units, and the nature of the hydraulic connection between aquifers.

The construction activities listed in Section 4.2.1.2 that are expected to produce the greatest impacts on the Surficial aquifer are related to:

- Changing the existing recharge and discharge areas
- Possibly changing the amount of runoff available for infiltration
- Dewatering of foundation excavations during construction

Site grading and leveling for the building foundations and laydown areas will cover and possibly eliminate existing recharge areas. Runoff from the graded areas will be directed into sand filters and several proposed impoundments, possibly creating new "focused" recharge areas. Runoff velocity may be increased in the channels downstream of the impoundments, which could decrease the amount of runoff available for infiltration and recharge. Fine-grained sediments could settle out in the impoundments and channels and create less-permeable areas for infiltration and recharge. These changes affect local recharge to the Surficial aquifer. Impacts on the deeper Aquia aquifer are likely to be SMALL.

Dewatering foundation excavations also produce localized impacts on the Surficial aquifer. The deepest excavations anticipated are for the proposed reactor and auxiliary building foundations, and extend approximately 40 ft (12 m) below plant grade and approximately 60 ft (18.3 m) below pre-construction grade. The dewatering system and activities are not expected to have any significant impact on the deeper Aquia aquifer due to the main recharge area of the Aquia aquifer is to the north. Hence, it is insensitive to perturbances of the Surficial aquifer. Effluent from the dewatering system will be pumped to a stormwater discharge point. Monitoring of construction effluents and stormwater runoff will be performed as required in the stormwater pollution prevention plan, NPDES permit, and other applicable permits obtained for the construction.

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As a result of the low vertical hydraulic conductivity, large thickness and continuity of the confining beds between the Surficial aquifer and principal aquifers in the vicinity of the CCNPP (the Piney Point-Nanjemoy and Aquia aquifers) changes at the surface that may locally affect the recharge, to discharge from or water table elevation in the Surficial aquifer are not expected to alter the groundwater potentiometric surface or water availability of these deeper aquifers. While the Surficial aquifer may provide recharge to the deeper aquifers as either leakage through the intervening confining layers or as direct infiltration where it directly contacts an underlying aquifer this recharge occurs over the entire areal extent of the Surficial aquifer where it overlies the deeper aquifers. The portion that is attributable to local recharge immediately above the Piney Point-Nanjemoy and Aquia aquifers at CCNPP is a small fraction of their total recharge.

The planned construction activities may lead to a slight reduction in recharge of the Surficial aquifer in some areas (due to construction of impermeable surfaces or temporary dewatering effects) or an increase in other areas (such as stormwater retention basins). Therefore it is difficult to determine the ultimate impact of Unit 3 to the underlying aquifers. However, it is possible to make some reasonable bounding assumptions. Considering the 2006 water table elevation of about 80 ft msl in the Surficial aquifer (Figure 2.3.1-42) and a potentiometric head in the Piney Point-Nanjemoy aquifer of about 0 ft msl (Figure 2.3.2-19) a vertical thickness of about 250 ft and a vertical hydraulic conductivity of .001 ft/day for the intervening Upper Confining Bed (MGS 1997) implies a vertical flux of about $3.2x10^{-5}$ ft^3/ft^2 day (about 0.14 in/yr) between the Surficial aquifer and the Piney Point-Nanjemoy aquifer. This flux is analogous to the value modeled by MGS 2007 which has a simulated flux rate north of CCNPP of 0.1 in/yr.

If one considers a 10^6 ft^2 area approximately the size of the Unit 3 power block (e.g., a square with sides 1,000 ft long) over which groundwater recharge is totally eliminated, recharge to the Piney Point-Nanjemoy aquifer would be reduced by about 40 ft^3/day or about 300 gpd. In reality the volume of recharge would be reduced less that 300 gpd because surface runoff within the power block will be directed to bio-retention ditches and basins where infiltration is enhanced.

Three hundred gpd is not significant in comparison to the overall recharge to the deeper aquifers in southern Maryland. This value is also not significant in comparison to one of the major users of the Piney Point-Nanjemoy aquifer in the vicinity of the CCNPP. The White Sands subdivision, with a Groundwater Appropriation Permit average withdrawal rate of 8,000 gpd (Table 2.3.2-4). Therefore, even assuming a reduced recharge from the Surficial aquifer to the Piney Point-Nanjemoy aquifer of 300 gpd the effect on the Piney Point-Nanjemoy aquifer is negligible and users of groundwater from that unit are not expected to see any effect of the reduced recharge on water level in the vicinity of the CCNPP

- **Effects of changes to the Surficial aquifer on the level of the water table and discharge to John's Creek**

CCNPP Unit 3 (see Section 2.3.2.2.11).

A numerical model has been developed of the Surficial aquifer at ~~CCNPP (Groundwater Flow Model of the Surficial Aquifer).~~ The model encompasses all areas affected by construction of Unit 3 and contributing discharge to John's Creek. Simulation of post-construction conditions ~~in the Surficial aquifer~~ indicates that maximum groundwater levels around the power block area ~~will be 77~~ ft msl. The depth to the water table in this area is estimated to be ~~2 to 12~~ ft below grade level. Groundwater levels in this area are dependent on many factors including the hydraulic conductivity of the fill material and the rate of groundwater recharge over the graded areas of the site.

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will be negligible.

The impact of the construction of Unit 3 on groundwater discharge to John's Creek ~~is also dependent upon the rate of groundwater recharge over the graded areas of the site. This rate is difficult to predict because while grading, construction of buildings and impermeable surfaces and installation of stormwater drains all have the effect of reducing recharge, removal of vegetation and the associated evapotranspiration and construction of stormwater retention ditches and basins have the effect of increasing recharge. Model simulations indicate that if the rate of groundwater recharge remains relatively uncharged in the areas of the Unit 3 site to be graded which are currrently wooded and undisturbed the discharge to John's Creek will be reduced by about 20 percent. On the other hand groundwater discharge to John's Creek could increase by as much as 40 percent if recharge in the graded areas of the site is twice as high as in the existing undisturbed areas.~~

- **Effects of withdrawals from the Aquia aquifer on the users of the Aquia and Piney Point-Nanjemoy aquifers**

Increasing withdrawal from the Aquia aquifer from the average values withdrawn over the past 5 years by CCNPP Unit 1 & 2 (an average of about 387,000 gpd from July 2001 to June 2006) (Table 2.3.2-7) to the value permitted in CA69G-010 (05) of 450,000 gpd (Table 2.3.2-4), is expected to cause increased drawdowns in the vicinity of the CCNPP Unit 2 production wells. The effects of the increased withdrawal, even though limited to about 68 months for the duration of Unit 3 construction, may extend several thousand feet from the pumping wells. For example considering an infinite confined aquifer with no leakage (to maximize the potential drawdown), a transmissivity of about 1,000 ft^2/day a storativity of about 10^{-4} (MGS 1997) and discharge of 63,000 gpd from one well for 2,040 days would yield drawdown in the Aquia aquifer of about 4 ft at a distance of about 10,000 ft and drawdown of about 7 ft at a distance of about 1,000 ft from the pump well. This drawdown would be insignificant to other users of the Aquia aquifer in the vicinity of CCNPP Unit 2 and would have an insignificant effect on increasing leakage from the overlying Piney Point-Nanjemoy aquifer to the Aquia aquifer.

The impact to groundwater is SMALL and localized~~, changes to the surficial aquifer water level are expected to eventual recover once construction is complete~~.

4.2.2.4 Water Quantities Available to Other Users

As described in Section 2.3.2.1.2, at present no surface water withdrawals are made in Calvert County for public potable water supply. Water use projection in Maryland for 2030 does not include surface water as a source for public water supply in southern Maryland counties including Calvert Country.

Groundwater use and trends in southern Maryland and at the CCNPP site are presented in Section 2.3.2.2 and in Section 2.4.12 of the Final Safety Analysis Report.

The Surficial aquifer is not used as a potable water source in the vicinity of the CCNPP site. The impacts expected from foundation dewatering or other construction activities will not impact any local users. The Camp Conoy facilities include four wells authorized under an MDE water appropriation permit. These wells draw from the Piney Point aquifer and have an appropriation limit of 500 gpd (1,900 lpd). These wells are expected to be abandoned. The impact on the local water supply resulting from any abandonment of these wells will be minor.

4.2.2.5 Water Bodies Receiving Construction Effluents

The surface water bodies directly downstream of the proposed construction activities could be impacted during clearing, grubbing, and grading. Locations of surface water and its users that could be impacted by construction activities are provided in Section 4.2.1.4.

Since most of the water for construction would be used for consumptive uses such as grading, soil compaction, dust control, and concrete mixing, little infiltration would be expected. Any effluents that might infiltrate would recharge the Surficial aquifer, and, potentially, the underlying Chesapeake aquifer/ confining unit, and the Castle Hayne-Aquia aquifer.

If contaminants enter the surface water bodies unchecked, there would be a potential for infiltration and subsequent groundwater contamination. If contaminants do enter groundwater, they may impact the quality of water withdrawn for industrial and commercial applications.

Any construction effluents infiltrating into the subsurface could potentially reach the Surficial aquifer if they are of sufficient volume and concentration. The plume migration would be downgradient and, depending on location, flow either eastward toward Chesapeake Bay or westward toward the Patuxent River. As described in Section 2.3.2, the horizontal groundwater flow in the Surficial aquifer is generally bi-directional. A northwest trending groundwater divide roughly follows a line extending through the southwestern boundary of the proposed power block area. Northeast of this divide, horizontal groundwater flow is northeast toward

Enclosure 4

Update of COLA Part 7, Departures and Exemption Requests to incorporate the new Groundwater Model

Calvert Cliffs Nuclear Power Plant, Unit 3

1.1 DEPARTURES

This Departure Report includes deviations in the CCNPP Unit 3 COL application FSAR from the information in the U.S. EPR FSAR, pursuant to 10 CFR Part 52. The U.S. EPR Design Certification Application is currently under review with the NRC. However, for the purposes of evaluating these deviations from the information in the U.S. FSAR, the guidance provided in Regulatory Guide 1.206, Section C.IV.3.3, has been utilized.

The following Departures are described and evaluated in detail in this report:

renumber as appropriate

1. Maximum Ground Water Level
2. Maximum Differential Settlement (across the basemat)
3. Maximum Annual Average Atmospheric Dispersion Factor (0.5 mile – limiting sector)
4. Accident Atmospheric Dispersion Factor (0-2 hour, Low Population Zone, 1.5 miles)

1.1.1 Maximum Ground Water Level

Affected U.S. EPR FSAR Sections: Tier 1 Table 5.0-1, Tier 2 Table 2.1-1, Tier 2 Section 3.8.4.3.1

Summary of Departure:

The U.S. EPR FSAR identifies a maximum groundwater level of 3.3 ft below grade. Emergency Power Generating Building 1/2 and Essential Service Water System Cooling Tower 1 have groundwater levels that exceed the U.S. EPR FSAR value.

Scope/Extent of Departure:

This Departure is identified in CCNPP Unit 3 FSAR Table 2.0-1 and Section 2.4.12.

Departure Justification:

The post construction groundwater level for Emergency Power Generating Building 1/2 is calculated to be 3.0 ft (0.9 m) below finished grade, or 0.3 ft (0.09 m) above the U.S. EPR FSAR site parameter value of 3.3 ft (1.0 m) below grade, and the post-construction groundwater level for one corner of Essential Service Water System Cooling Tower 1 is calculated to be slightly above the U.S. EPR site parameter value of 3.3 ft (1.0 m) below grade (but averages 4.0 ft (1.2 m) below grade at Essential Service Water Cooling Tower 1).

For Emergency Power Generating Building 1/2, separate foundation design calculations were performed for both the U.S. EPR FSAR and CCNPP Unit 3-specific groundwater levels, as discussed in CCNPP Unit 3 FSAR Section 3.8.5.5.2. The results show a variation in Emergency Power Generating Building 1/2 soil bearing pressures and basemat design moments of less than 5%. Factors of safety against sliding and overturning remain within allowable values for both groundwater levels.

For slight groundwater level departure associated with the one corner of Essential Service Water System Cooling Tower 1, as discussed in CCNPP Unit 3 FSAR Section 3.8.5.5.3, the effects of this local anomaly on stability (i.e., factors of safety against sliding and overturning) and soil bearing pressures of Essential Service Water System Cooling Tower 1 were determined to be negligible.

Departure Evaluation:

This Departure, associated with the maximum groundwater level for the Emergency Power Generating Building 1/2 and Essential Service Water System Cooling Tower 1 has been evaluated and determined to not adversely affect the safety function of these structures. Accordingly, this Departure does not:

1. Result in more than a minimal increase in the frequency of occurrence of an accident previously evaluated in the plant-specific FSAR;
2. Result in more than a minimal increase in the likelihood of occurrence of a malfunction of a structure, system, or component (SSC) important to safety and previously evaluated in the plant-specific FSAR;
3. Result in more than a minimal increase in the consequences of an accident previously evaluated in the plant-specific FSAR;
4. Result in more than a minimal increase in the consequences of a malfunction of an SSC important to safety previously evaluated in the plant-specific FSAR;
5. Create a possibility for an accident of a different type than any evaluated previously in the plant-specific FSAR;
6. Create a possibility for a malfunction of an SSC important to safety with a different result than any evaluated previously in the plant-specific FSAR;
7. Result in a design basis limit for a fission product barrier as described in the plant-specific FSAR being exceeded or altered; or
8. Result in a departure from a method of evaluation described in the plant-specific FSAR used in establishing the design bases or in the safety analyses.

This Departure does not affect resolution of a severe accident issue identified in the plant-specific FSAR.

Therefore, this Departure has no safety significance.

1.2 EXEMPTION REQUESTS

These exemption requests have been developed assuming approval and issuance of a design certification for the U.S. EPR and are based on the current version of the U.S. EPR FSAR.

Calvert Cliffs 3 Nuclear Project and UniStar Nuclear Operating Services request the following exemptions related to:

Renumber as appropriate

1. Maximum Ground Water Level,
2. Maximum Differential Settlement (across the basemat),
3. Maximum Annual Average Atmospheric Dispersion Factor (0.5 mile – limiting sector),
4. Accident Atmospheric Dispersion Factor (0-2 hour, Low Population Zone, 1.5 miles),
5. Fitness For Duty Program
6. Use of M5™ Advanced Zirconium Alloy Fuel Rod Cladding, and
7. Toxic Gas Detection and Isolation.

The exemption request associated with Use of M5™ Advanced Zirconium Alloy Fuel Rod Cladding, is the same as that previously requested by AREVA in support of the U.S. EPR Design Certification Application.

Discussion and justification for each of the above exemption requests are provided in the following pages.

1.2.1 Maximum Ground Water Level

Applicable Regulation: 10 CFR Part 52

The U.S. EPR FSAR Tier 1 Table 5.0-1, Tier 2 Table 2.1-1, and Tier 2 Section 3.8.4.3.1 identify a maximum groundwater level of 3.3 ft below grade. Emergency Power Generating Building 1/2 and Essential Service Water System Cooling Tower 1 have groundwater levels that exceed the U.S. EPR FSAR value.

Pursuant to 10 CFR 52.7 and 10 CFR 52.93, Calvert Cliffs 3 Nuclear Project and UniStar Nuclear Operating Services request an exemption from compliance with the U.S. EPR FSAR Tier 1 and 2 requirements associated with the maximum ground water level.

Discussion:

The post construction groundwater level for Emergency Power Generating Building 1/2 is calculated to be 3.0 ft (0.9 m) below finished grade, or 0.3 ft (0.09 m) above the U.S. EPR FSAR site parameter value of 3.3 ft (1.0 m) below grade, and the post construction groundwater level for one corner of Essential Service Water System Cooling Tower 1 is calculated to be slightly above the U.S. EPR site parameter value of 3.3 ft (1.0 m) below grade (but averages 4.0 ft (1.2 m) below grade at Essential Service Water Cooling Tower 1).

For Emergency Power Generating Building 1/2, separate foundation design calculations were performed for both the U.S. EPR FSAR and CCNPP Unit 3-specific groundwater levels, as discussed in CCNPP Unit 3 FSAR Section 3.8.5.5.2. The results show a variation in Emergency

Power Generating Building 1/2 soil bearing pressures and basemat design moments of less than 5%. Factors of safety against sliding and overturning remain within allowable values for both groundwater levels.

For slight groundwater level departure associated with the one corner of Essential Service Water System Cooling Tower 1, as discussed in CCNPP Unit 3 FSAR Section 3.8.5.5.3, the effects of this local anomaly on stability (i.e., factors of safety against sliding and overturning) and soil bearing pressures of Essential Service Water System Cooling Tower 1 were determined to be negligible.

The change associated with the maximum groundwater level for the Emergency Power Generating Building 1/2 and Essential Service Water System Cooling Tower 1 has been evaluated and determined to not adversely affect the safety function of these structures. Therefore, this change will not result in a significant decrease in the level of safety otherwise provided by the design described in the U.S. EPR FSAR.

The exemption is not inconsistent with the Atomic Energy Act or any other statute. As such, the requested exemption is authorized by law.

This change does not result in a departure from the design and does not require a change in the design described in the U.S. EPR FSAR. In addition, the change has been evaluated and determined to not adversely affect the safety function of the associated structures. Therefore, the requested exemption will not present an undue risk to the public health and safety.

The change does not relate to security and does not otherwise pertain to the common defense and security. Therefore, the requested exemption will not endanger the common defense and security.

The special circumstance necessitating the request for exemption is that the CCNPP Unit 3 Emergency Power Generating Building 1/2 and Essential Service Water System Cooling Tower 1 have groundwater levels that exceed the U.S. EPR FSAR value. However, the CCNPP Unit 3 ground water levels have been evaluated and determined to not adversely affect the safety function of the Emergency Power Generating Building 1/2 or Essential Service Water System Cooling Tower 1. As such, application of the regulation for this particular circumstance would not serve the underlying purpose of the rule and is not required to achieve the underlying purpose of the rule.

1.2.1 Note: Renumber this and subsequent sections as appropriate

This requested exemption does not require a change in the design described in the U.S. EPR FSAR. Therefore, this exemption will not result in any loss of standardization.

For these reasons, Calvert Cliffs 3 Nuclear Project and UniStar Nuclear Operating Services request approval of the requested exemption from compliance with the U.S. EPR FSAR Tier 1 and 2 requirements associated with the maximum ground water level.

1.2.2 Maximum Differential Settlement (across the basemat)

Applicable Regulation: 10 CFR Part 52

The U.S. EPR FSAR Tier 1 Table 5.0-1, Tier 2 Table 2.1-1, and Tier 2 Section 2.5.4.10.2 identify a maximum differential settlement of 1/2 inch in 50 feet (i.e., 1/1200) in any direction across the basemat. The estimated settlement values for the Nuclear Island common basemat, Emergency Generating Building foundations, and Essential Service Water System Cooling Tower foundations exceed the U.S. EPR FSAR value.

Enclosure 5

Bechtel Power Corporation Report, Groundwater Model for the Calvert Cliffs Nuclear Power Plant Unit 3 Site