the dewatering would appear to pose little threat to the wetland east of the proposed expansion since it is tidally affected and renewed daily.

The areal impact of dewatering may also affect the stability of existing structures. The following existing structures are within the projected zone of dewatering influence.

- HC Cooling Tower
- Salem and HC ISFSI
- Waste Treatment Plant
- HC Switchyard
- Learning and Development Center
- HC Nuclear Island
- Fuel Oil Tank
- Material Center
- Low Level Radioactive Waste Building
- Salem Nuclear Island
- Nuclear Operations Support Facility

The degree to which drawdowns occur in the alluvial or structural fill about these units is largely a function of the competence of the Kirkwood aquitard. Additional data gathered in concert with pumping tests in the proposed expansion areas will be needed to more accurately evaluate the potential drawdowns once the final selection for the expansion technology is determined.

8.3 Anticipated Changes in Shallow Groundwater Flow Patterns

Modeling of post-construction conditions suggests that groundwater flow patterns and water levels would return to the pre-construction conditions over most of the model domain. Only slight increases of about 0.5 feet were noted in some portions of the model. Changes to the site, following construction would also include:

- The presence of the soil retention barriers (likely permanent elements extending from elevation -5 ft NAVD88 to -90 ft NAVD88);
- A localized gap (window) in the Kirkwood aquitard that would be replaced with structural fill;
- Placement of fill to establish a plant grade approximately 27 ft higher than the existing grade;
- The existing shallow perched ponds within the excavation footprint will be removed; and
- Replacement of the existing vegetation with developed hard surface.

These physical changes will cause some variation in flow patterns; however the projected piezometric heads in the fill and alluvial materials are not expected to be much greater than the current static conditions.

Simulations for post-development suggest a potential average hydrostatic loading of about 3 to 4.5 feet NAVD 88 on the new unit, but based on considerations of potential tidal effects in the Vincentown, a design loading of 6 feet NAVD 88 is recommended and is consistent with that proposed for the Hope Creek Station. The elevations of the bottom of the new structures may be deeper than the groundwater table; however, under normal conditions, pre- and post-construction water levels in shallow units would appear to be similar across the PSEG facility, with post-construction shallow water levels about a half-foot higher in some areas of existing structures (e.g., the cooling tower or Hope Creek unit) requiring no permanent long-term dewatering at the new unit. The characteristics of the soil retention barriers, which likely will be left in place, may also locally affect the hydrostatic loading.

Generally, because the ground surface for the new plant will be raised to approximately 36.9 feet NAVD88 and the groundwater barrier walls will remain in place, the maximum anticipated groundwater elevations within the groundwater barrier walls is 6 ft NAVD88. Thus the groundwater will be approximately 30 ft below the final plant grade. Thus, the anticipated hydrostatic loading on the future structures is less than the conservative hydrostatic water level on which the Design Control Documents (DCDs) are based.

Therefore, the proposed expansion would appear to alter groundwater flow patterns only slightly from current conditions in the areas of present facilities, and the need for a permanent dewatering system is not envisioned.

8.4 Sensitive Parameters in the Model

During calibration of the model, the most sensitive input parameters were determined to be recharge applied over the model (including seepage losses from ponds in the new plant location), horizontal hydraulic conductivity of the alluvial and Mount Laurel-Wenonah aquifer units, vertical conductivity of the Kirkwood, reference elevation for the Delaware River, and GHB reference heads in the Vincentown and Mount Laurel-Wenonah Formations. During the dewatering simulations, the most sensitive parameters included the hydraulic conductivity of the Vincentown and Hornerstown Formations.

8.5 Sensitivity Analyses

Sensitivity analyses were performed on the dewatering model run, varying key parameters of the hydraulic conductivity of the Vincentown Formation, the vertical hydraulic conductivity of the leaky Navesink aquitard, and the vertical hydraulic conductivity of the Kirkwood aquitard. Averaging short-term initial rates, the model provided best estimates for the construction dewatering from about 5,200 to 5,600 gallons per minute over a year's simulation. The sensitivity analysis indicated that an expected range might vary from about 3,000 to 7,600 gallons per minute (averaging short-term initial rates). Given the larger proposed area for dewatering than that conducted for the Hope Creek unit, the estimated dewatering rates are generally consistent with those documented during the construction of the Hope Creek Generating Station. The estimated dewatering rates do not include storm water which may fall within the excavation limits. Collection sumps and high rate pumps will likely be needed to evacuate storm water from the excavation.

8.6 Summary

This groundwater model has been completed in support of the ESP application for the PSEG Site. The model provides estimates of the expected groundwater response to dewatering and post-construction scenarios. However, the dewatering scenario and dewatering estimates are intended to be preliminary and are based on the assumed excavation boundaries. Groundwater modeling will be refined after the reactor vendor is selected, and the final excavation geometry is determined. Preparation of the COLA will likely require additional data, which could be obtained from pumping tests or other methods to further refine hydrogeologic parameters and model estimates of dewatering rates and drawdowns beneath existing site structures. Data gathered in support of the ESP combined with the location and size of the proposed plant excavation area has indicated that additional data is needed to refine estimates of dewatering rates and the potential for excessive drawdown at existing structures during the dewatering period. Once the technology and site layout has been determined, pumping tests are recommended at the PSEG site to further refine the groundwater model. The purposes for the pumping tests will be to determine aquifer characteristics of the Vincentown Formation in the proposed area of construction (the increased area of the power block extends beyond the explorations conducted in that area), determine the effectiveness of the Kirkwood aquitard to limit drawdown in the alluvial aquifer and fill (since it is absent in some locations and estimated dewatering drawdown effects in the alluvium are very sensitive to the vertical hydraulic conductivity of the Kirkwood aquitard), to assess potentials for upwelling from the underlying Mount Laurel-Wenonah Formation during dewatering, and assess the potential for encountering recharge boundaries in the Vincentown Formation in the northern portion of the proposed power block area.

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FIGURES

LEGEND

- Site Boundary
- New Plant Location
- East Area Location

N
W E
S

0 500 1,000
Feet

PSEG Power, LLC

PSEG Site ESPA
Groundwater Model Calc. Package

Site Location and Proposed Expansion Locations

FIGURE 1

Rev 0

Era	Period	Epoch	Formation/Unit	Primary Lithologies	Geologic Conditions	Unit Thickness	Occurrence in Site Area
CENOZOIC	Quaternary	Holocene	Quaternary Marsh deposits	muck and peat; silt, sand and clay	aggradation of Delaware Bay estuary	variable thickness	present over most of the site area in low lying areas
			~~ unconformity ~~~~~~~~~~				
		Pleistocene	DELAWARE: Delaware Bay Group — Scotts Corners Formation ~~ unconformity ~~ Lynch Heights Formation; NEW JERSEY: Cape May Formation	estuarine terrace deposits with coarse to fine sand and pebbles with concentrations of heavy minerals; peat; isolated fluvial deposits?	transgressive and regressive cycles	variable thickness	outcrops in eastern and western portions of the site area
			~~ unconformity ~~~~~~~~~~		regression and erosion		
	Tertiary	Upper Tertiary (Miocene)	Kirkwood Formation	clay silt and sand deposited in two or three marine cycles	polycyclic transgression and regression phases	90 feet at southern portions of site area; pinches out northward	subcrop only
			~~ unconformity ~~~~~~~~~~		regression and erosion		
		Lower Tertiary	Shark River Formation	glauconitic sand and mudstone	low sediment input	70 feet (Benson, 2004)	subcrop only
			~~ unconformity ~~~~~~~~~~		regression and erosion		
			Manasquan Formation	lower glauconitic member, upper clayey sand to silt member	low sediment input and bioturbation	40 feet (Benson, 2004)	subcrop only
			~~ unconformity ~~~~~~~~~~		regression and erosion		
			Vincentown Formation	quartz sand to quartz-rich calcareous sand with bryozoans and foraminifera	low sediment input and extreme bioturbation	90 feet (Benson, 2004)	outcrops in NW site area
			Hornerstown Formation	highly glauconitic sand with distinctive green color		30 feet (Benson, 2004)	
MESOZOIC	Cretaceous	Upper Cretaceous	Navesink	fossiliferous, clayey glauconitic sand	transgression to midshelf conditions	20 feet (Benson, 2004)	subcrop only
			Mount Laurel Formation	thinly bedded clays and sands with cross-bedding; thin pebbly sands	regressive pulse; low sediment input	100 feet (Benson, 2004)	subsurface only
			Wenonah Formation	clayey, silty, slightly glauconitic fine sand			
			Marshalltown Formation	intensely burrowed, very silty fine sand with glauconite	transgression; low sediment input	20 feet (Benson, 2004)	
			Englishtown Formation	micaceous silt to very fine sand	regressive pulse	25 feet (Benson, 2004)	
			Woodbury Formation	micaceous, chloritic, silty clay			
			Merchantville Formation	glauconitic sand to micaceous silty clay	transgression and establishment of widespread marine conditions; low sediment rates	120 feet (Benson, 2004)	
			Magothy Formation	beach and estuarine deposits of cross-bedded sand, with clay and silt layers; some lignite	transition to marine conditions	50 feet, pinches out north of site location (Benson, 2004)	
			~~ unconformity ~~~~~~~~~~		regression and erosion		
		Lower Cretaceous	Potomac Group (Formation)	white, gray and red interbedded silts, clays, and quartose sand	aggrefating alluvial plain; thermal subsidence	800 to 1650 feet (Benson, 2004)	
			~~ pre-Cretaceous unconformity ~~~~~~~~~~		uplift and erosion		
			Basement Complex				
	Triassic	Upper Triassic	Triassic Basin?	Fanglomerates and lacustrine sediments; diabase volcanics	Amalgamation of Pangea followed by rifting to form North America	undetermined	
PRECAMBRIAN? PALEOZOIC?	Proterozoic? Paleozoic?	NeoProterozoic to Silurian?	Carolina Superterrane? / Philadelphia Terrane?	meta mafic to felsic plutons and volcanics with sediments, and ultramafic components / aluminous to quartz-rich schist with interbedded amphibolites (Wissahickon Formation) with ultramafic components; Wilmington Complex felsic to mafic arc complex			

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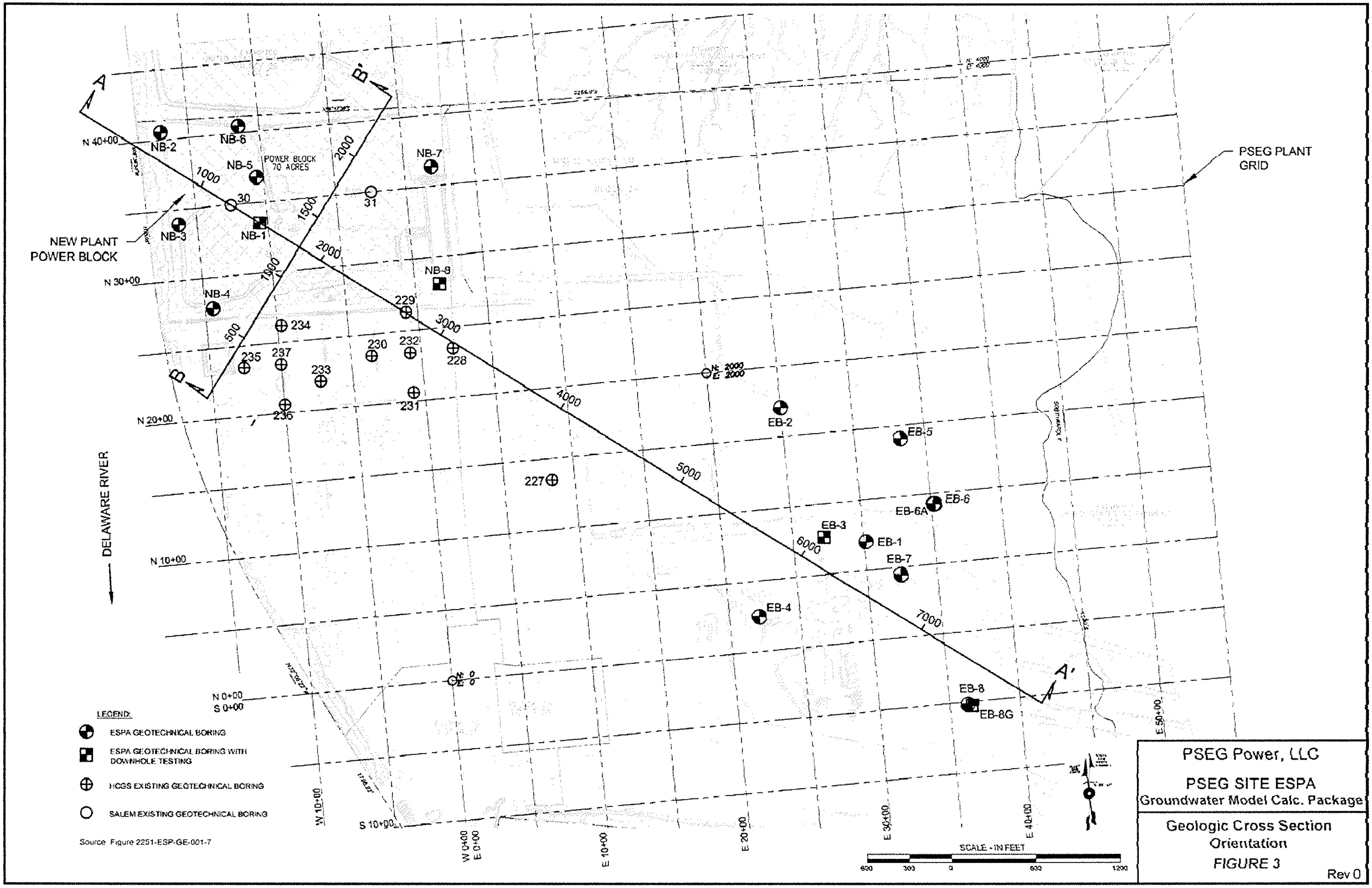
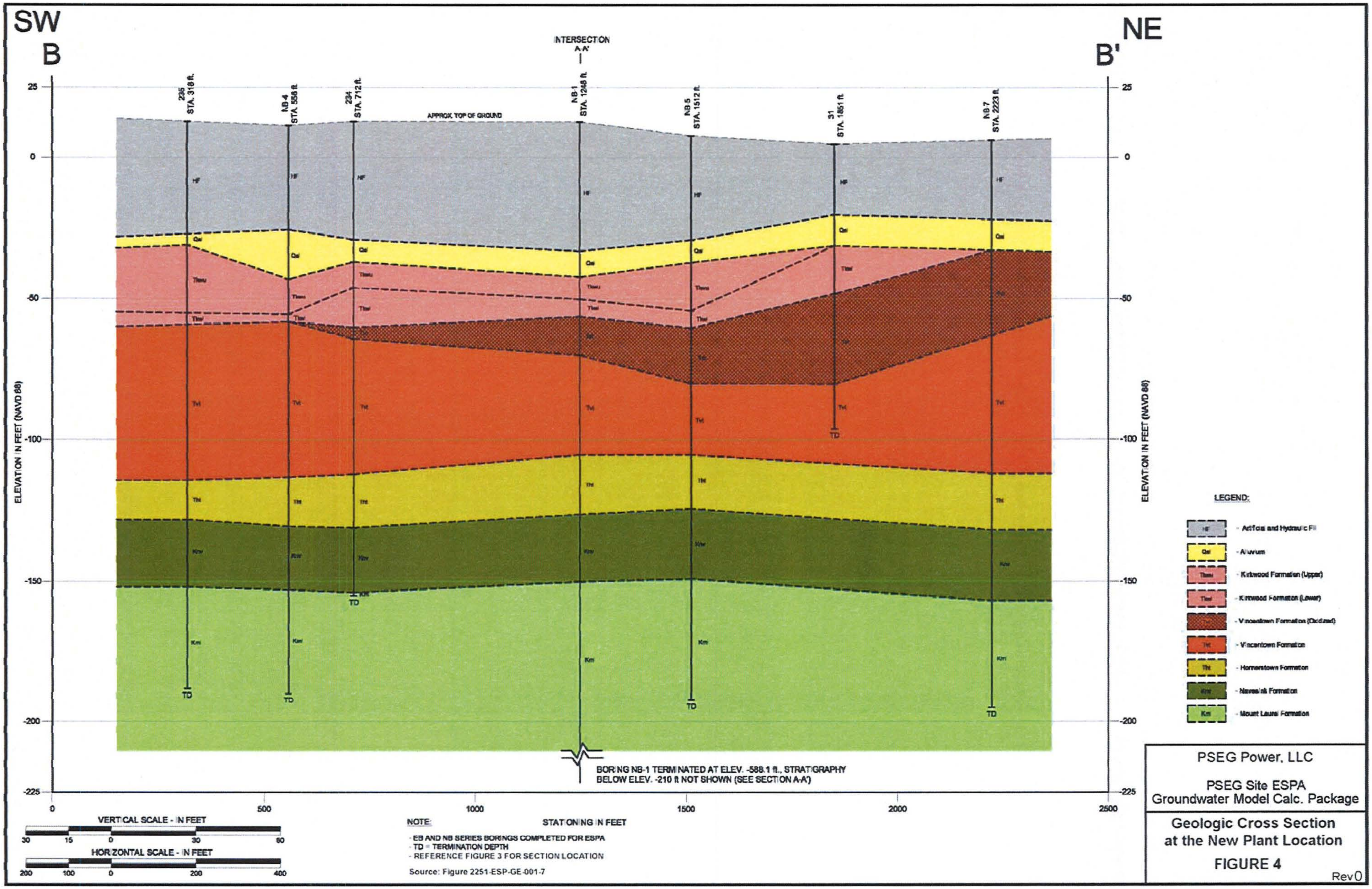
Groundwater Model Calc. Package

Hydrogeologic Unit Sequence

FIGURE 2

Rev 0


A
B'
A'
B
N 40+00
N 30+00
N 20+00
N 10+00
N 0+00
S 0+00
S 10+00
NB-2
NB-6
NB-5
NB-7
NB-3
NB-1
NB-4
NB-9
POWER BLOCK 70 ACRES
30
31
NEW PLANT POWER BLOCK
PSEG PLANT GRID
DELAWARE RIVER
229
234
235
237
233
230
232
228
231
236
227
EB-2
EB-5
EB-6
EB-6A
EB-3
EB-1
EB-7
EB-4
EB-8
EB-8G
1000
1500
2000
3000
4000
5000
6000
7000
500
W 10+00
W 0+00
E 0+00
E 10+00
E 20+00
E 30+00
E 40+00
E 50+00
LEGEND:
ESPA GEOTECHNICAL BORING
ESPA GEOTECHNICAL BORING WITH DOWNHOLE TESTING
HCGS EXISTING GEOTECHNICAL BORING
SALEM EXISTING GEOTECHNICAL BORING
Source: Figure 2251-ESP-GE-001-7
SCALE - IN FEET
600
300
0
600
1200
PSEG Power, LLC
PSEG SITE ESPA
Groundwater Model Calc. Package
Geologic Cross Section Orientation
FIGURE 3
Rev 0


SW
B
NE
B'
INTERSECTION A-A'
235 STA. 318 ft.
NB-4 STA. 558 ft.
234 STA. 712 ft.
NB-1 STA. 1248 ft.
NB-5 STA. 1512 ft.
31 STA. 1851 ft.
NB-7 STA. 2223 ft.
APPROX. TOP OF GROUND
ELEVATION IN FEET (NAVD 88)
BORING NB-1 TERMINATED AT ELEV. -588.1 ft., STRATIGRAPHY BELOW ELEV. -210 ft NOT SHOWN (SEE SECTION A-A')
STATIONING IN FEET
VERTICAL SCALE - IN FEET
HORIZONTAL SCALE - IN FEET
NOTE:
- EB AND NB SERIES BORINGS COMPLETED FOR ESPA
- TD = TERMINATION DEPTH
- REFERENCE FIGURE 3 FOR SECTION LOCATION
Source: Figure 2251-ESP-GE-001-7
LEGEND:
HF - Artificial and Hydraulic Fill
Qal - Alluvium
Tkwu - Kirkwood Formation (Upper)
Tkwl - Kirkwood Formation (Lower)
- Vincentown Formation (Oxidized)
Tvt - Vincentown Formation
Tht - Hornerstown Formation
Knv - Navesink Formation
Kml - Mount Laurel Formation
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PSEG Site ESPA
Groundwater Model Calc. Package
Geologic Cross Section
at the New Plant Location
FIGURE 4
Rev0

PSEG Power, LLC

PSEG Site ESPA
Groundwater Model Calc. Package

Location of Water Level
Data Observations

FIGURE 5

Rev 0

TABLES

Table 1

Regional and Site-Specific Aquifer Characteristics

Formation	Transmissivity	Hydraulic Conductivity	Porosity	Storage Coefficient	Specific Yield	Specific Capacity	Leakance	Reference
Structural Fill		0.09 to 4.3 ft/d; 6.5 ft/d						12
Riverbed Sands and Gravel	13.2 to 440 gpd/ft	0.9 to 13.1 gpd/ft^2						8
		0.12 to 1.75 ft/d; 1.8 to 59 ft/d						7
		0.03 to 2.27 ft/d						12
Kirkwood Aquitard		Kv = 0.00002 to 0.00005 ft/d						8
							1e-5/d	10
Basal Kirkwood-Vincentown Aquifer						0.5 to 8.3 gpm/ft		2
	5,000 to 11,000 gpd/ft	0.95 to 2.5 ft/d				0.3 to 1.9 gpm/ft		7
	530 ft^2/d							8
	2,000 to 2,500 ft^2/d							10
		14 ft/d						14
		2.95 ft/d						12
	1,987 to 2,791 ft^2/d							11
Hornerstown - Navesink Aquitard		4 to 8.7 ft/d	0.522 to 0.543					2
		Kv = 0.42 gpd/ft^2						8
		Kv = 0.003 to 9 ft/d						8
							5e-5/d	10
							3.35e-5 to 6.87e-5/d	11
Mt. Laurel - Wenonah Aquifer	7,000 gpd/ft	18.7 ft/d						1
		10 ft/d	0.444			0.7 to 9 gpm/ft		2
	7,500 to 14,000 gpd/ft							3
	4,900 to 8,700 gpd/ft	0.67 to 4.5 ft/d				0.2 to 3.8 gpm/ft		7
	360 to 1.430 ft^2/d	13 to 19 ft/d						8
	1,000 ft^2/d							10
	815 ft^2/d							13
	726 to 922 ft^2/d							11
Marshalltown-Wenonah Aquitard		0.001 to 0.01 gpd/ft^2						2
		Kv = 0.00006 to 0.13 ft/d						8
							6e-6/d	10
							5.91e-6 to 7.13e-6/d	11
Englishtown Aquifer						up to 10 gpm/ft		2
	1,100 to 2,100 ft^2/d	12 to 67 ft/d						8
	500 ft^2/d							10
	415 to 552 ft^2/d							11
Merchantville-Woodbury Confining Unt		Kv = 0.000004 to 0.0004 ft/d						8
							3e-6/d	10
							2.15e-6 to 3.85e-6/d	11
Upper PRM Aquifer	10,000 to 25,000 gpd/ft							4
	15,000 to 25,000 gpd/ft							5
	9,000 to 27,000 gpd/ft					10.6 to 26.7 gpm/ft		7
	870 to 24,210 gpd/ft	240 ft/d						8
	2,000 ft^2/d							10
	1,086 to 2,419 ft^2/d							11
Confining Unit, Upper to Middle PRM		Kv = 0.084 ft/d						8
							2e-6/d	10
							1.797e-7 to 2.69e-7/d	11
Middle PRM Aquifer	4,700 to 11,500 gpd/ft							4
	8,590 gpd/ft	129.5 ft/d		0.0025				6
	670 to 4,000 gpd/ft							7
	4,000 ft^2/d							10
	3,024 to 3,813 ft^2/d							11
Confining Unit, Middle to Lower PRM							5e-6/d	10
							7.19e-7 to 1.67e-5/d	11
Lower PRM Aquifer	2,300 to 16,600 ft^2/d							8
	4,000 to 5,000 ft^2/d							10
	4,844 to 5,299 ft^2/d							11

Notes:

D&M = Dames & Moore
USGS = United States Geological Survey
NJDEP = New Jersey Department of Environmental Protection
NJ = State of New Jesey
T = transmissivity
K = horizontal hydraulic conductivity
Kv = vertical hydraulic conductivity
L = leakance
n = porosity
s = storage coefficient (confined)
Sy = specific yield

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(13) Dugan, B., et al., 2008. Hydrogeologic Framework of Southern New Castle County. Open File Report No. 49. Delaware Geological Survey. Newark, Delaware.
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Table 2
Slug Test Results
for Northern Area
Shallow Aquifers

Well	Formation	Result feet/day
Shallow		
NOW-1U	Alluvium	8.0
NOW-2U	Alluvium	8.0
NOW-3U	Alluvium	0.3
NOW-4U	Alluvium	0.7
NOW-5U	Hydraulic fill	0.1
NOW-6U	Alluvium	3.5
NOW-7U	Vincentown	1.4
NOW-8U	Alluvium	0.4
Deeper		
NOW-1L	Vincentown	4.5
NOW-2L	Vincentown	3.6
NOW-3L	Vincentown	1.4
NOW-4L	Vincentown	10.7
NOW-5L	Vincentown	1.7
NOW-6L	Vincentown	6.2
NOW-7L	Vincentown	2.4
NOW-8L	Vincentown	0.3

Notes: Individual results are rounded off to one decimal place.
See Hydraulic Conductivity & Tidal Study Data Report, Rev. A (MACTEC, November 25, 2009) for details on slug testing.

Table 3
Water Level Measurements
January to December 2009
North and East Sites
Alluvium and Vincentown

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Ave	Std dev	Range
North Site Alluvium															
NOW-1U		0.36	0.61	0.59	0.66	1.32	1.14	0.94	1.13	1.22	1.18		0.92	0.33	0.96
NOW-2U	-0.10	-0.42	-0.48	-0.17	-0.08	2.04	-0.41	1.72	2.08	2.19	-0.20	0.88	0.59	1.11	2.67
NOW-3U	-0.21	-0.36	0.15	-0.19	0.18	1.20	0.56	0.66	1.13	1.18	0.60	1.23	0.51	0.59	1.59
NOW-4UB		0.03	0.46	0.36	0.40	1.18	1.00	0.75	0.95	1.09	0.95	1.34	0.77	0.41	1.31
NOW-6U	0.50	0.35	0.76	0.62	0.65	1.35	1.12	0.98	1.31	1.31	1.15	1.44	0.96	0.37	1.09
NOW-7U	0.40	0.18	0.74	0.77	0.79	1.40	1.14	1.07	1.41	1.46	1.01	1.64	1.00	0.44	1.46
NOW-8U	0.72	0.41	0.84	0.74	0.86	1.57	1.24	1.21	1.38	1.39	1.15	1.57	1.09	0.37	1.16
Vincentown															
NOW-1L		0.25	0.56	0.50	0.65	1.58	1.07	1.14	1.54	1.66	1.02	1.67	1.06	0.51	1.42
NOW-2L	-0.05	-0.31	-0.32	-0.20	0.74	2.16	-0.17	1.86	2.82	2.15	-0.01	1.10	0.81	1.16	3.14
NOW-3L	-0.14	-0.25	-0.40	0.10	-0.99	1.63	0.10	1.69	1.90	1.38	0.61	1.25	0.57	0.97	2.89
NOW-4L	-0.71	-0.30	-0.01	-0.16	0.37	1.70	0.43	1.20	1.80	1.56	0.43	1.45	0.65	0.86	2.51
NOW-5L	0.54	-0.19	0.31	0.35	0.52	1.54	0.93	0.73	1.54	1.59	0.65	1.57	0.84	0.60	1.78
NOW-6L	-0.11	-0.08	0.26	0.17	-0.58	1.56	0.88	0.80	1.54	1.63	1.04	0.21	0.61	0.74	2.21
NOW-7L	0.39		0.59	0.70	0.71	1.11	0.87	0.94	1.34	1.39	0.75	1.51	0.94	0.36	1.12
NOW-8L	0.50	0.36	0.70	0.79	0.90	1.54	1.15	1.14	1.44	1.43	1.08	1.51	1.05	0.40	1.18
East Site Alluvium															
EOW-1U	0.95	0.90	1.20	1.08	1.18	1.74	1.51		2.54	1.59	1.52	1.79	1.45	0.47	1.64
EOW-2U	2.92	2.80	2.83	2.49	2.70	3.02	2.96		2.74	3.09	2.87	3.40	2.89	0.24	0.91
EOW-5U	1.03	0.83	1.16	1.10	1.19	1.70	1.45	1.43	1.61	1.59	0.51	1.78	1.28	0.38	1.27
EOW-6U	1.00	0.79	1.20	1.12	1.16	1.71	1.45	1.43	1.59	1.60	1.49	1.78	1.36	0.30	0.99
EOW-8U	0.72	1.02	1.47	0.95	1.27		1.73	1.65	1.46	1.70	1.46	2.27	1.43	0.43	1.55
EOW-9U	-0.06	0.08	0.50	0.55	0.35	1.20	0.78	0.75	1.21	1.13	0.86		0.67	0.43	1.27
EOW-10U		1.43	1.37	1.32	1.39	2.07	1.58	1.52	1.71	1.85	1.86	2.30	1.67	0.32	0.98
Vincetown															
EOW-1L	0.79	0.62	0.92	0.98	0.95	1.59	1.29		1.59	1.59	1.27	1.59	1.20	0.36	0.97
EOW-2L	1.06	0.74	1.25	1.18	1.12	1.74	1.42	1.39	1.76	1.67	1.43	1.72	1.37	0.32	1.02
EOW-4L	0.62	0.51	1.09	0.90	1.00	1.75	1.33	1.19	1.85	1.91		1.59	1.25	0.48	1.40
EOW-5L	1.09	0.92	1.30	1.25	0.86	1.79	1.51	2.39	1.78	1.74	1.49	1.77	1.49	0.44	1.53
EOW-6L	0.98	0.70	1.30	1.14	1.06		1.45	0.47	1.80	0.74	1.45	1.74	1.17	0.43	1.33
EOW-8L	0.12	0.13	0.60	0.55	0.68	1.48	0.94	0.85	1.59	1.61	1.05	1.27	0.91	0.52	1.49
EOW-9L	0.45	0.41	0.68	0.77	0.97	1.68	1.28	1.05	1.86	1.86	1.18	1.49	1.14	0.51	1.45
EOW-10L	0.60	0.66	1.12	0.94	0.35	1.66	1.36	1.24	1.71	1.76	1.34	1.61	1.20	0.47	1.41

Notes:
- (green) Initially considered inconsistent with data set
- (orange) Outlier value deleted
- (blue) Rejected as inconsistent with data set following outlier analysis

Elevations are in feet relative to NAVD88 datum
See MACTEC, 2010, Groundwater Elevations and Hydraulic Gradients, Calculation Package 2251-ESP-GW-004 for a detailed account of the water level data analysis.

Table 4
Calibrated Model - Input Parameter Values

Hydraulic conductivities, ft/d	Horizontal	Vertical	
Hydraulic fill	0.1	0.03	
Structural fill	6.5	0.65	
Alluvium	3.89	0.48	
Kirkwood aquitard	0.02	0.003	
Vincentown	10.7	0.2	
Hornerstown	10.7	0.2	
Navesink	0.4	0.0545	
Mount Laurel-Wenonah	10	10	
Recharge	ft/d	in/yr	
Zone 1 Wetlands north	0.00003521	0.15	
Zone 2 Buildings, pavement	0	0	
Zone 3 Developed facility	0.0002907	1.27	
Zone 4 Wetlands east	0.0001385	0.61	
Zone 5 Semi-impermeable	0.0004176	1.83	
Zone 6 Near Salem units 1&2	0.001826	8	
Storage coefficient	Confined	Specific yield	Porosity
Aquifers	0.0001	0.2	0.35
Aquitards	0.0001	0.1	0.4
River package	Ref Elev	Conductance	
Delaware River	-0.1	56.6	
Ponds	4 to 5.4	0.0282 to 0.0566	
Streams	0	5.66 to 11.3	
General Head Boundaries	Ref Elev	Conductance	
Alluvium	-0.5	25.1	
Vincentown	0.5 to 2.0	408 to 640	
Hornerstown	0.5 to 2.0	148	
Mount Laurel-Wenonah	-1 to 0.8	3590 to 3940	

Notes:
1. Reference elevations are in feet NAVD88
2. Units of conductance are square feet per day
3. GHB conductances are a function of thickness and generally vary along their lengths.

Table 5
Residuals Statistical Analysis
Final Calibrated Model

Name	Easting	Northing	Layer	Observed	Computed	Residual
NOW-1U	198443	234543	2	0.93	1.04	-0.11
NOW-1L	198450	234564	4	1.08	0.79	0.29
NOW-2U	197755	235207	2	0.53	0.50	0.03
NOW-2L	197753	235228	4	0.73	0.60	0.13
NOW-3U	197885	234553	2	0.53	0.39	0.14
NOW-3L	197898	234565	4	0.60	0.64	-0.04
NOW-4UB	198147	233963	2	0.79	0.90	-0.11
NOW-4L	198148	233973	4	0.67	0.70	-0.03
NOW-5L	198438	234927	4	0.87	0.81	0.06
NOW-6U	198314	235269	2	0.98	1.13	-0.15
NOW-6L	198313	235288	4	0.63	0.80	-0.17
NOW-7U	199694	234976	2	1.02	1.11	-0.09
NOW-7L	199676	234973	4	0.93	1.01	-0.08
NOW-8U	199756	234142	2	1.11	1.99	-0.88
NOW-8L	199736	234139	4	1.06	0.97	0.09
EOW-1U	202758	232322	2	1.40	2.04	-0.64
EOW-1L	202758	232298	4	1.22	0.89	0.33
EOW-2U	202158	233275	2	2.88	2.14	0.74
EOW-2L	202178	233271	4	1.40	0.98	0.42
EOW-4L	202021	231773	4	1.26	0.83	0.43
EOW-5U	203007	233057	2	1.31	1.75	-0.44
EOW-5L	203021	233040	4	1.46	0.96	0.50
EOW-6U	203281	232587	2	1.38	1.76	-0.38
EOW-6L	203301	232588	4	1.17	0.93	0.24
EOW-8U	203520	231144	2	1.41	1.51	-0.10
EOW-8L	203516	231163	4	0.91	0.80	0.11
EOW-9U	202826	230917	2	0.69	1.54	-0.85
EOW-9L	202845	230926	4	1.14	0.76	0.38
EOW-10U	203521	231687	2	1.64	1.55	0.09
EOW-10L	203522	231707	4	1.22	0.85	0.37
Well_BA	199984	230320	2	1.97	1.80	0.17
Well_BF	199322	231301	2	1.88	1.96	-0.08
Well_BG	199212	231829	2	2.30	2.36	-0.06
Well_BH	198752	231891	2	1.77	1.54	0.23
Well_BL	198390	232627	2	1.69	1.38	0.31
Well_BM	198936	232658	2	2.26	2.66	-0.40
Well_BP	198010	233572	2	1.09	0.85	0.24
Well_BQ	198966	233401	2	2.95	2.72	0.23
Well_BR	198711	234004	2	1.72	1.91	-0.19
Well_BS	200475	234137	2	2.71	1.77	0.94
Well_BT	199958	232909	2	3.13	3.08	0.05
Well_BU	200236	231883	2	2.95	3.00	-0.05
			Residual Mean			0.04
			Res. Std. Dev.			0.36
			Sum of Squares			5.48
			Abs. Res. Mean			0.27
			Min. Residual			-0.88
			Max. Residual			0.94
			Range in Target Values			2.60
			Std. Dev./Range			0.138

Note: Target water level data were selected as the average of the acceptable data (see Table 3) with the high and low value also deleted. See Calculation Package 2251-ESP-GW-004 for details on the treatment of water level data collected for this purpose.

Table 6
Calibrated Model - Water Balance

	Unit	Top	Bottom	GHB	River	Recharge	% error
Model	All						-0.146
In		*	*	18480	1355	6131	
Out		*	*	20468	5536	0	
Layer 1	Fills						0.0041
In		*	4135	*	1355	6119	
Out		*	6073	*	5536	0	
Layer 2	Alluvium						-0.000086
In		6073	3874	0	*	0.46	
Out		4135	3490	2322	*	0	
Layer 3	Kirkwood Aquitard						0.0013
In		3490	3859	*	*	11.7	
Out		3874	3487	*	*	0	
Layer 4	Vincentown						-0.0876
In		3487	428	11256	*	0.2	
Out		3859	10851	475	*	0	
Layer 5	Hornerstown						-0.0195
In		10851	428	7223	*	*	
Out		573	17762	460	*	*	
Layer 6	Navesink Aquitard						-0.0001
In		17763	564	*	*	*	
Out		573	17754	*	*	*	
Layer 7	Mt. Laurel-Wenonah						-0.12
In		17754	*	0	*	*	
Out		564	*	17211	*	*	

Notes: 1. * - indicates this feature not applicable
2. Rates given are in cubic feet per day

Table 7
Summary Sensitivity Statistical Analysis
Calibrated Base Model

Input Parameter	Range				
	lowest	lower	Calibrated	higher	highest
Hydraulic fill, Kh, ft/d	0.025	0.05	0.1	0.2	0.4
ave residual	-0.02	0.01	0.04	0.08	0.14
average absolute	0.29	0.28	0.27	0.29	0.31
standard deviation	0.38	0.36	0.36	0.37	0.38
sum of squares	5.94	5.52	5.48	5.93	6.84
Alluvium, Kh, ft/d	0.97	1.94	3.89	7.88	15.76
ave residual	-0.13	-0.06	0.04	0.18	0.35
average absolute	0.33	0.29	0.27	0.3	0.41
standard deviation	0.42	0.39	0.36	0.35	0.37
sum of squares	8.19	5.49	5.48	6.46	11.1
Kirkwood, Kh, ft/d	0.005	0.01	0.02	0.04	0.08
ave residual	0.04	0.04	0.04	0.04	0.04
average absolute	0.27	0.27	0.27	0.27	0.27
standard deviation	0.36	0.36	0.36	0.36	0.36
sum of squares	5.48	5.48	5.48	5.48	5.48
Vincentown, Kh, ft/d	2.67	5.35	10.7	21.4	42.8
ave residual	0.12	0.09	0.04	-0.02	-0.08
average absolute	0.3	0.28	0.27	0.26	0.26
standard deviation	0.37	0.36	0.36	0.36	0.37
sum of squares	6.41	5.91	5.48	5.48	6.01
Hornerstown, Kh, ft/d	2.67	5.35	10.7	21.4	42.8
ave residual	0.06	0.05	0.04	0.02	0
average absolute	0.27	0.27	0.27	0.27	0.26
standard deviation	0.36	0.36	0.36	0.36	0.36
sum of squares	5.58	5.54	5.48	5.42	5.42
Navesink, Kh, ft/d	0.1	0.2	0.4	0.8	1.6
ave residual	0.04	0.04	0.04	0.04	0.04
average absolute	0.27	0.27	0.27	0.27	0.27
standard deviation	0.36	0.36	0.36	0.36	0.36
sum of squares	5.48	5.48	5.48	5.48	5.48
Mt. Laurel-Wenonah, Kh, ft/d	2.5	5	10	20	40
ave residual	-0.18	-0.08	0.04	0.16	0.26
average absolute	0.3	0.27	0.27	0.31	0.36
standard deviation	0.38	0.36	0.36	0.37	0.39
sum of squares	7.41	5.77	5.48	6.86	9.14
Structural fill, Kh, ft/d	1.62	3.25	6.5	13	26
ave residual	0.01	0.03	0.04	0.05	0.06
average absolute	0.29	0.27	0.27	0.28	0.28
standard deviation	0.38	0.36	0.36	0.36	0.36
sum of squares	5.97	5.5	5.48	5.59	5.71
Recharge, zone 1, ft/d	1.761E-05	2.641E-05	3.521E-05	5.282E-05	7.042E-05
ave residual	0.05	0.05	0.04	0.03	0.01
average absolute	0.27	0.27	0.27	0.27	0.28
standard deviation	0.36	0.36	0.36	0.36	0.37
sum of squares	5.43	5.45	5.48	5.56	5.68
Recharge, zone 3, ft/d	0.0001453	0.0002179	0.0002907	0.0004361	0.0005814
ave residual	0.27	0.15	0.04	-0.19	-0.41
average absolute	0.4	0.32	0.27	0.39	0.56
standard deviation	0.45	0.38	0.36	0.48	0.72
sum of squares	11.5	7.02	5.48	11.3	28.9

Table 7
Summary Sensitivity Statistical Analysis
Calibrated Base Model

Recharge, zone 4, ft/d		0.0000693	0.0001039	0.0001385	0.0002078	0.000277
	ave residual	0.14	0.09	0.04	-0.06	-0.16
	average absolute	0.27	0.26	0.27	0.31	0.37
	standard deviation	0.35	0.34	0.36	0.44	0.57
	sum of squares	5.87	5.27	5.48	8.38	14.6
Recharge, zone 5, ft/d		0.0002088	0.0003132	0.0004176	0.0006264	0.0008352
	ave residual	0.06	0.05	0.04	0.02	0.01
	average absolute	0.28	0.27	0.27	0.28	0.29
	standard deviation	0.36	0.36	0.36	0.36	0.37
	sum of squares	5.6	5.51	5.48	5.58	5.9
Recharge, zone 6, ft/d		0.000913	0.001369	0.001826	0.002283	0.002739
	ave residual	0.08	0.06	0.04	0	-0.03
	average absolute	0.29	0.28	0.27	0.29	0.32
	standard deviation	0.38	0.37	0.36	0.38	0.43
	sum of squares	6.39	5.76	5.48	6.01	7.94
Hydraulic fill, Kv, ft/d		0.0075	0.015	0.03	0.06	0.12
	ave residual	0.01	0.02	0.04	0.06	0.07
	average absolute	0.26	0.27	0.27	0.27	0.28
	standard deviation	0.36	0.36	0.36	0.36	0.36
	sum of squares	5.46	5.44	5.48	5.59	5.72
Alluvium, Kv, ft/d		0.12	0.24	0.48	0.96	1.92
	ave residual	0.04	0.04	0.04	0.04	0.04
	average absolute	0.27	0.27	0.27	0.27	0.27
	standard deviation	0.36	0.36	0.36	0.36	0.36
	sum of squares	5.5	5.49	5.48	5.48	5.48
Kirkwood, Kv, ft/d		0.00075	0.0015	0.003	0.006	0.012
	ave residual	-0.73	-0.3	0.04	0.28	0.43
	average absolute	0.91	0.51	0.27	0.35	0.46
	standard deviation	1.11	0.63	0.36	0.39	0.49
	sum of squares	73.4	20.2	5.48	9.59	17.9
Vincentown, Kv, ft/d		0.05	0.1	0.2	0.4	0.8
	ave residual	-0.01	0.02	0.04	0.05	0.05
	average absolute	0.28	0.27	0.27	0.27	0.27
	standard deviation	0.37	0.36	0.36	0.36	0.36
	sum of squares	5.89	5.58	5.48	5.45	5.44
Hornerstown, Kv, ft/d		0.05	0.1	0.2	0.4	0.8
	ave residual	0.03	0.04	0.04	0.04	0.04
	average absolute	0.27	0.27	0.27	0.27	0.27
	standard deviation	0.36	0.36	0.36	0.36	0.36
	sum of squares	5.47	5.48	5.48	5.48	5.48
Navesink, Kv, ft/d		0.0136	0.0272	0.0545	0.109	0.218
	ave residual	-0.01	0.02	0.04	0.05	0.06
	average absolute	0.27	0.27	0.27	0.27	0.27
	standard deviation	0.36	0.36	0.36	0.36	0.36
	sum of squares	5.54	5.47	5.48	5.51	5.53
Mt. Laurel-Wenonah, Kv, ft/d		0.3	0.6	1.2	2.4	4.8
	ave residual	0.03	0.04	0.04	0.04	0.04
	average absolute	0.27	0.27	0.27	0.27	0.27
	standard deviation	0.36	0.36	0.36	0.36	0.36
	sum of squares	5.47	5.48	5.48	5.48	5.48
Structural fill, Kv, ft/d		0.16	0.32	0.65	1.3	2.6
	ave residual	0.04	0.04	0.04	0.04	0.04

Table 7
Summary Sensitivity Statistical Analysis
Calibrated Base Model

average absolute	0.27	0.27	0.27	0.27	0.27
standard deviation	0.36	0.36	0.36	0.36	0.36
sum of squares	5.47	5.47	5.48	5.49	5.49
Delaware River, ref head, ft	-2.1	-1.1	-0.1	0.9	1.9
ave residual	0.3	0.17	0.04	-0.09	-0.22
average absolute	0.42	0.34	0.27	0.31	0.42
standard deviation	0.48	0.39	0.36	0.4	0.49
sum of squares	13.4	7.66	5.48	6.95	12.2
Delaware River, conductance, 1/d	5.66	11.3	56.6	283	566
ave residual	0.01	0.03	0.04	0.04	0.04
average absolute	0.28	0.27	0.27	0.27	0.27
standard deviation	0.37	0.36	0.36	0.36	0.36
sum of squares	5.61	5.49	5.48	5.51	5.51
GHB, Alluvium, ref head, ft	-2.5	-1.5	-0.5	0.5	1.5
ave residual	0.09	0.07	0.04	0.01	-0.01
average absolute	0.29	0.28	0.27	0.27	0.29
standard deviation	0.37	0.36	0.36	0.36	0.37
sum of squares	6.12	5.68	5.48	5.53	5.83
GHB, Alluvium, conductance, 1/d	2.51	5.02	25.1	125.5	251
ave residual	0.03	0.03	0.04	0.05	0.05
average absolute	0.27	0.27	0.27	0.27	0.27
standard deviation	0.36	0.36	0.36	0.36	0.36
sum of squares	5.48	5.48	5.48	5.5	5.5
GHB, Vincentown, ref head, delta ft	-2	-1	0	1	2
average absolute	0.76	0.47	0.27	0.39	0.69
standard deviation	0.38	0.36	0.36	0.38	0.43
sum of squares	28.9	11.7	5.48	10.1	25.6
GHB, Vincentown, conductance, factor	x 0.1	x 0.2	x 1	x 5	x 10
average absolute	0.28	0.27	0.27	0.27	0.27
standard deviation	0.36	0.36	0.36	0.36	0.36
sum of squares	5.66	5.56	5.48	5.47	5.46
GHB, Hornerstown, ref head, delta ft	-2	-1	0	1	2
average absolute	0.4	0.31	0.27	0.29	0.35
standard deviation	0.36	0.36	0.36	0.37	0.38
sum of squares	8.92	6.46	5.48	5.97	7.94
GHB, Hornerstown, conductance, factor	x 0.1	x 0.2	x 1	x 5	x 10
average absolute	0.27	0.27	0.27	0.27	0.27
standard deviation	0.36	0.36	0.36	0.36	0.36
sum of squares	5.54	5.51	5.48	5.47	5.47
GHB, Mount Laurel-Wenonah, ref head, delta ft	-2	-1	0	1	2
average absolute	0.62	0.39	0.27	0.33	0.56
standard deviation	0.44	0.38	0.36	0.38	0.43
sum of squares	23.2	10.4	5.48	8.35	19.1
GHB, Mount Laurel-Wenonah, conductance, factor	x 0.1	x 0.2	x 1	x 5	x 10
average absolute	0.27	0.27	0.27	0.27	0.27
standard deviation	0.36	0.36	0.36	0.36	0.36
sum of squares	5.42	5.45	5.48	5.49	5.49

Table 8
Summary Dewatering Simulation and Sensitivity Results
Dewatering Rates at Times into Simulation

	Flow rates (gpm) after start of dewatering simulation					
	0.48days	1.06 days	90 days	90.6 days	91.3 days	365 days
Base simulation	6,541	4,613	3,434	5,477	4,989	3,566
Sensitivity change to input parameter						
Halve VT/HT Kh to 5.35 ft/d	4,449	2,149	1,955	3,062	2,421	2,223
Double VT/HT Kh to 21.4 ft/d	8,524	6,686	5,170	7,257	6,906	5,345
Halve Navesink Kv to 0.0272 ft/d	6,455	4,532	3,300	5,267	4,797	3,375
Double Navesink Kv to 0.109 ft/d	6,617	4,685	3,549	5,631	5,135	3,727
Decrease Kirwood Kv to 0.001 ft/d	6,507	4,569	3,329	5,315	4,845	3,495
Increase Kirkwood Kv to 0.01 ft/d	6,615	4,717	3,633	5,710	5,211	3,635
Increase MLW Kh to 15 ft/d	6,592	4,473	3,587	5,692	5,072	3,796
Increase VT/HT Kv to 1.0 ft/d	7,022	5,076	3,744	6,129	5,633	3,883

Abbreviations: gpm - gallons per minute
VT/HT - Vincentown and Hornerstown Formations
MLW - Mount Laurel-Wenonah aquifer
Kh - horizontal hydraulic conductivity
ft/d - feet per day
Kv - vertical hydraulic conductivity

Table 9
Estimated Drawdown at Existing Structures During Dewatering Activities

Location	Drawdown - feet	
	Alluvium	Vincentown
Independent Spent Fuel Storage Installation	11.5	40.8
Fuel Oil Tank	11.0	29.2
Waste Water Treatment Plant	9.5	32.8
Hope Creek Switchyard	9.3	33.0
Learning and Development Center	6.4	17.0
Hope Creek Unit 1	4.6	17.3
Low Level Rad Waste Building	2.8	13.3
Nuclear Operations Support Facility	2.3	10.9
Salem Units 1 and 2	0.9	6.4

Note: Estimated drawdown taken from groundwater model at or near the center of the structure using the base calibrated model simulation (see Table 8 for simulated pumping rates).

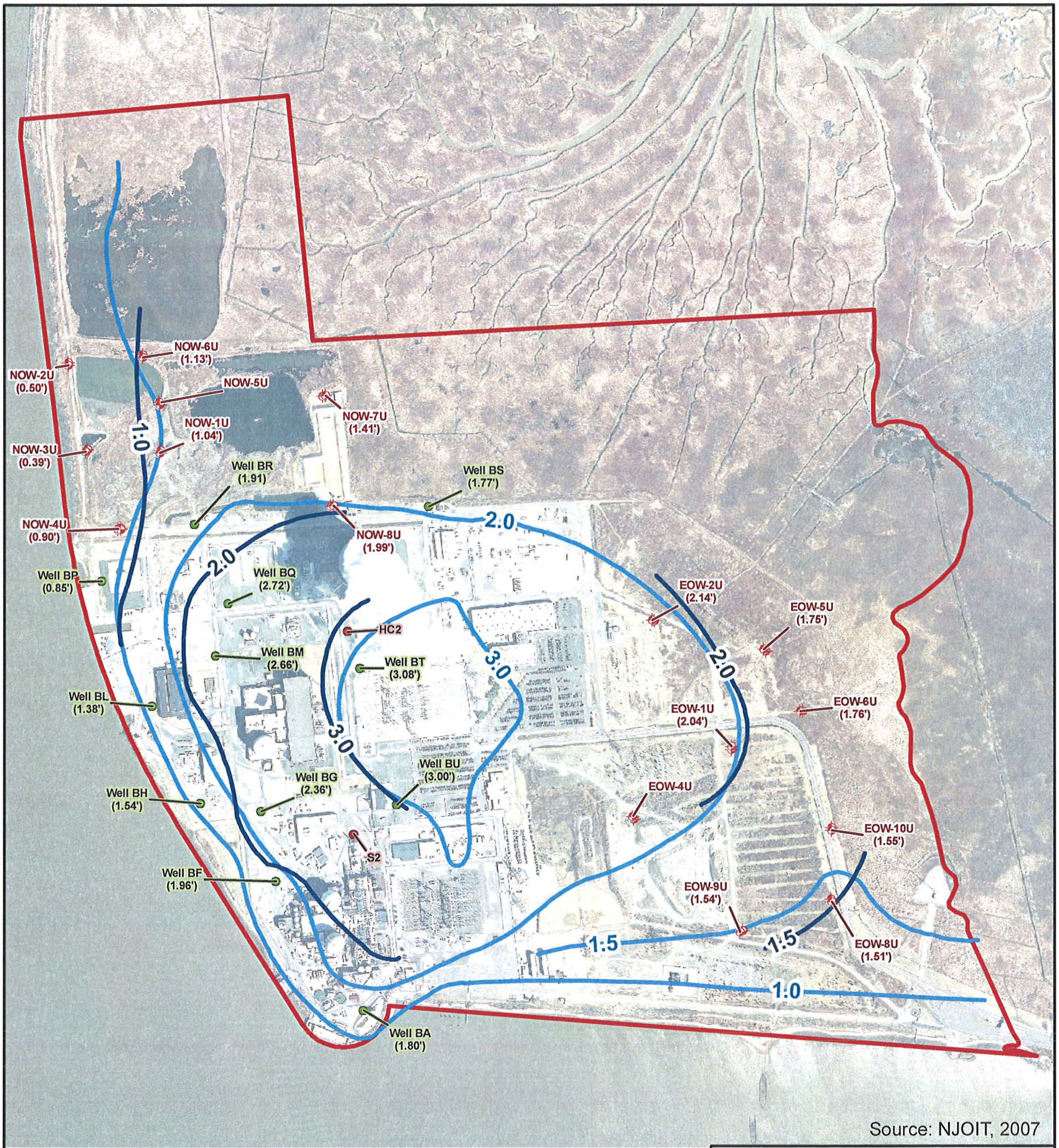
Table 10
Summary Dewatering Simulation and Sensitivity Results
Drawdowns and Heads at Selected Locations

Base simulation			
Drawdown, ft at 365 days	HC Cooling Tower	HC Unit 1	Salem 1&2
Alluvium	9.3	3.3	0.9
Vincentown Formation	33	17.7	6.4
Head, ft at 365 days at nuclear island Vincentown Formation	-68.3		
Halve VT/HT Kh to 5.35 ft/d			
Drawdown, ft at 365 days	HC Cooling Tower	HC Unit 1	Salem 1&2
Alluvium	7.4	2.5	0.6
Vincentown Formation	27.3	14.9	5.4
Head, ft at 365 days at nuclear island Vincentown Formation	-53.9		
Double VT/HT Kh to 21.4 ft/d			
Drawdown, ft at 365 days	HC Cooling Tower	HC Unit 1	Salem 1&2
Alluvium	9.6	3.4	1
Vincentown Formation	34.2	18.4	6.7
Head, ft at 365 days at nuclear island Vincentown Formation	-70		
Decrease Kv of Navesink to 0.0272 ft/d			
Drawdown, ft at 365 days	HC Cooling Tower	HC Unit 1	Salem 1&2
Alluvium	9.2	3.1	0.8
Vincentown Formation	32.8	17.1	6
Head, ft at 365 days at nuclear island Vincentown Formation	-70.3		
Increase Kv of Navesink to 0.109 ft/d			
Drawdown, ft at 365 days	HC Cooling Tower	HC Unit 1	Salem 1&2
Alluvium	9.3	3.4	0.9
Vincentown Formation	33.3	18	6.5
Head, ft at 365 days at nuclear island			
Vincentown Formation	-66.7		
Increase Kh of MLW to 15 ft/d			
Drawdown, ft at 365 days	HC Cooling Tower	HC Unit 1	Salem 1&2
Alluvium	8.7	3	0.8
Vincentown Formation	31.4	16.8	6.2
Head, ft at 365 days at nuclear island			
Vincentown Formation	-68.3		
Increase Kv of VT/HT to 1.0 ft/d			
Drawdown, ft at 365 days	HC Cooling Tower	HC Unit 1	Salem 1&2
Alluvium	8.7	3	0.8
Vincentown Formation	31.4	16.8	6.2
Head, ft at 365 days at nuclear island			
Vincentown Formation	-66.7		
Increase Kv of Kirkwood to 0.01 ft/d			
Drawdown, ft at 365 days	HC Cooling Tower	HC Unit 1	Salem 1&2
Alluvium	20.7	10.2	2.7
Vincentown Formation	31.2	16.2	5.3
Head, ft at 365 days at nuclear island			
Vincentown Formation	-67.6		
Decrease Kz of Kirkwood to 0.001 ft/d			
Drawdown, ft at 365 days	HC Cooling Tower	HC Unit 1	Salem 1&2
Alluvium	2.6	0.4	0.1
Vincentown	34.7	19	7.2
Head, ft at 365 days at nuclear island			
Vincentown	-69.2		

Notes: 1) VT/HT = Vincentown and Hornerstown Formations.
2) MLW = Mount Laurel-Wenonah aquifer
3) Kh = horizontal hydraulic conductivity.
4) Kv = vertical hydraulic conductivity
5) The drawdowns are taken at the approximate centers of the listed structures
6) The head is taken in the upper Vincentown (model layer 5) mid-point in the deeper excavation
7) The nuclear island refers to that of the new unit.

ATTACHMENT A

Comparison of Observed and Computed Water Level Contours



LEGEND

- MACTEC Observation Well
- HCGS/SGS Production Well
- ARCADIS Well (B Series)
- Site Boundary
- Interpreted Contours Average of Water Level Data
- Model Computed Heads Contoured by Groundwater Vistas (Calibrated Model)

N / W / E / S

0 100 200 Meters

0 500 1,000 Feet

Note: Groundwater elevations represent data from average water level set

PSEG Power, LLC

PSEG Site ESPA
Groundwater Model Calc. Package

Comparison of Observed and Computed Water Level Contours

FIGURE A-1

Rev 0

Attachment B

Model-derived Input/Output Figures

List of Model-Generated Input/Output Figures

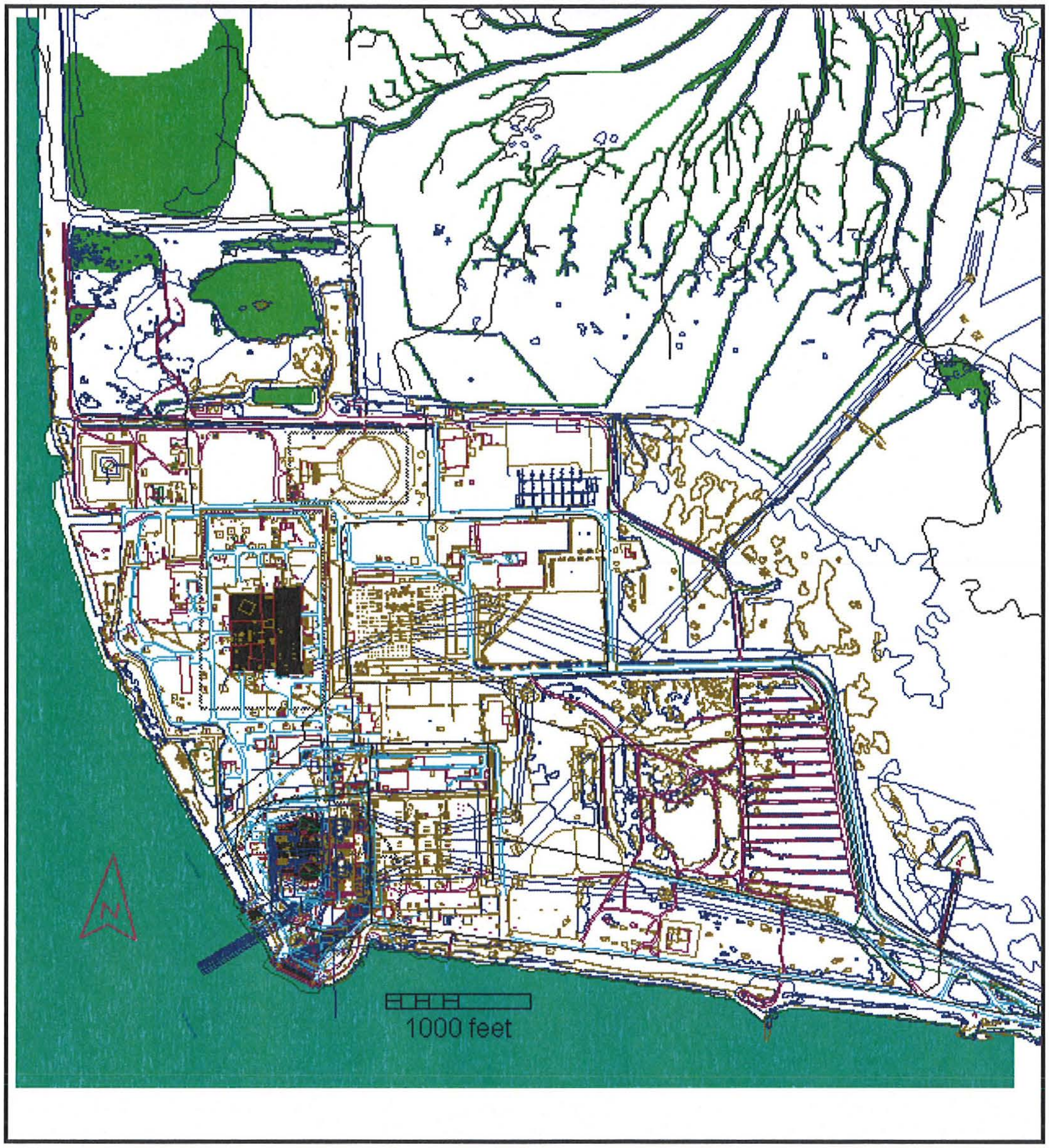


Figure B-1: Model domain and layer 1 boundary conditions. The 20-by-20-foot model grid is not shown as it is relatively fine and obscures the detail in the figure. The model has 376 rows and 350 columns, covering about 1200 acres. The detail in the base map will be deleted in most subsequent figures as it may obscure the focus of certain model outputs and inputs. The green west and south is the Delaware River, represented in the model by MODFLOW river package nodes. The green areas to the north and the northeast represent ponds and wetland areas, again using the MODFLOW river package to represent these boundary conditions. The blackened nodes locate the Hope Creek and Salem units, and use no-flow nodes to indicate impermeable structures into the water table.

Figure B-2: MODFLOW Model Grid in the New Plant Location. Grid blocks are a uniform 20-by-20 feet, north is upwards. The green to the left represents the Delaware River. Green areas in the area proposed for development are perched ponded areas and associated drainage ways.

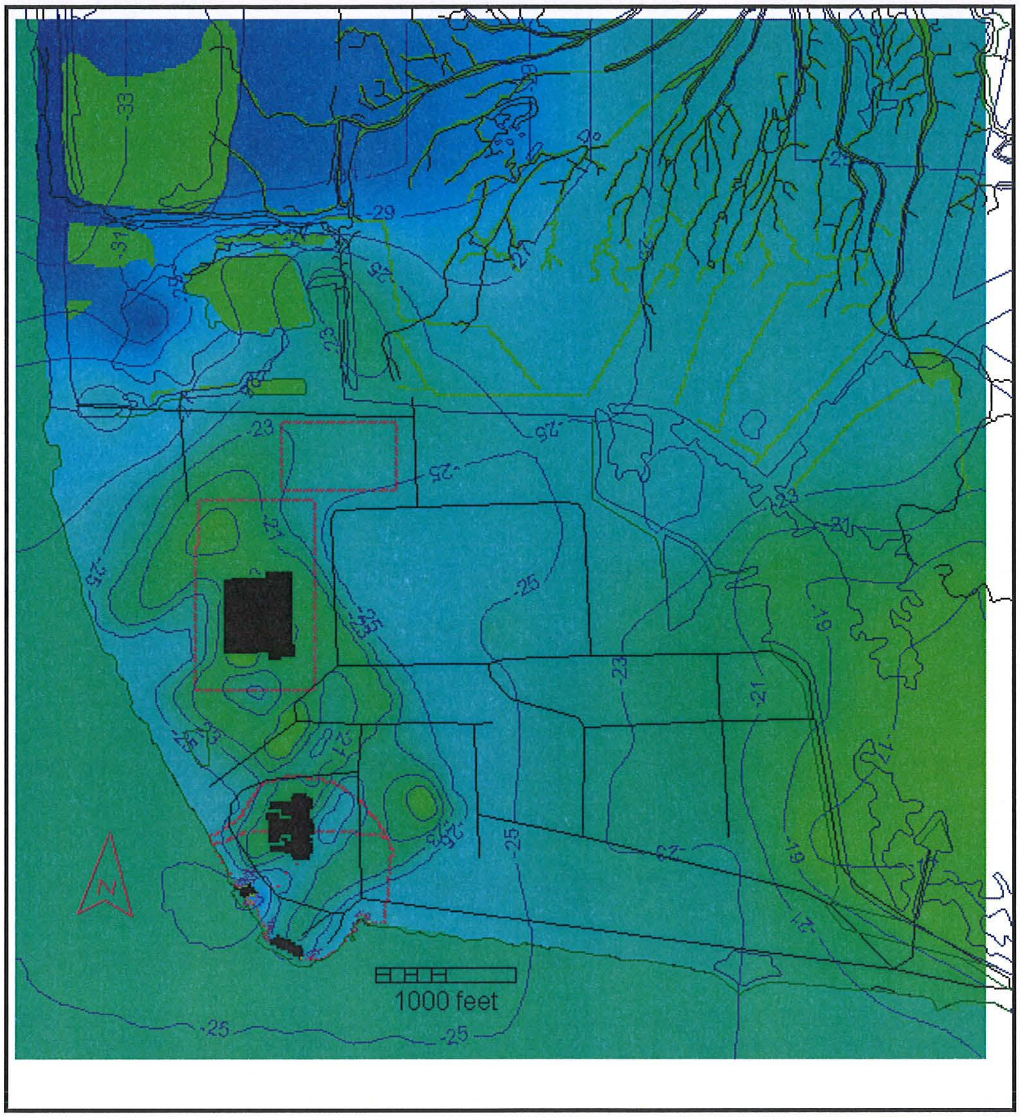


Figure B-3: Bottom of Layer 1 (Fill) Elevation Contours , feet NAVD88 Black areas denote no-flow boundaries in MODFLOW, used to represent impermeable structures extending below the water table through this particular model layer.

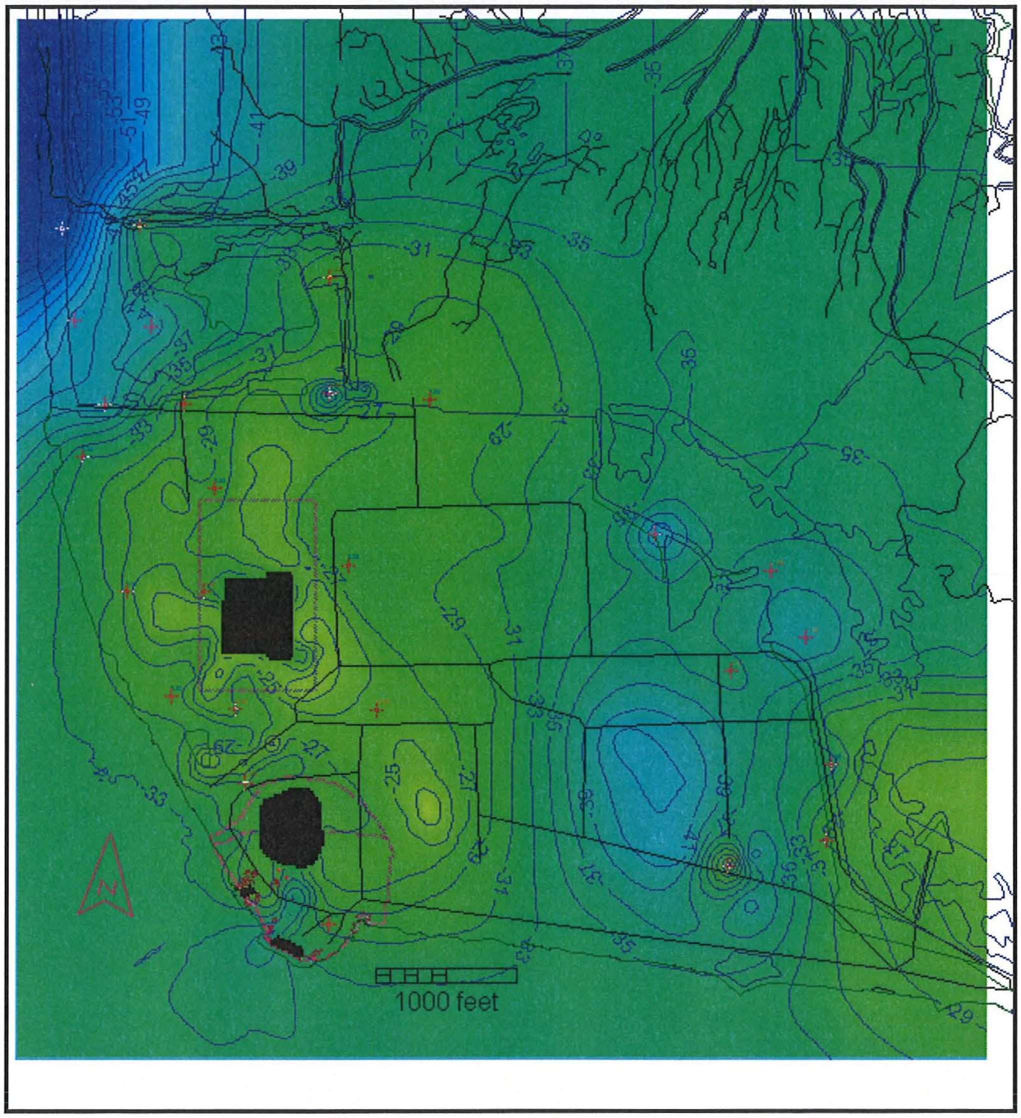


Figure B-4: Bottom of Layer 2 (Alluvium) Elevation Contours, feet NAVD88. Crosses mark locations of water level readings taken in support of the model calibration.

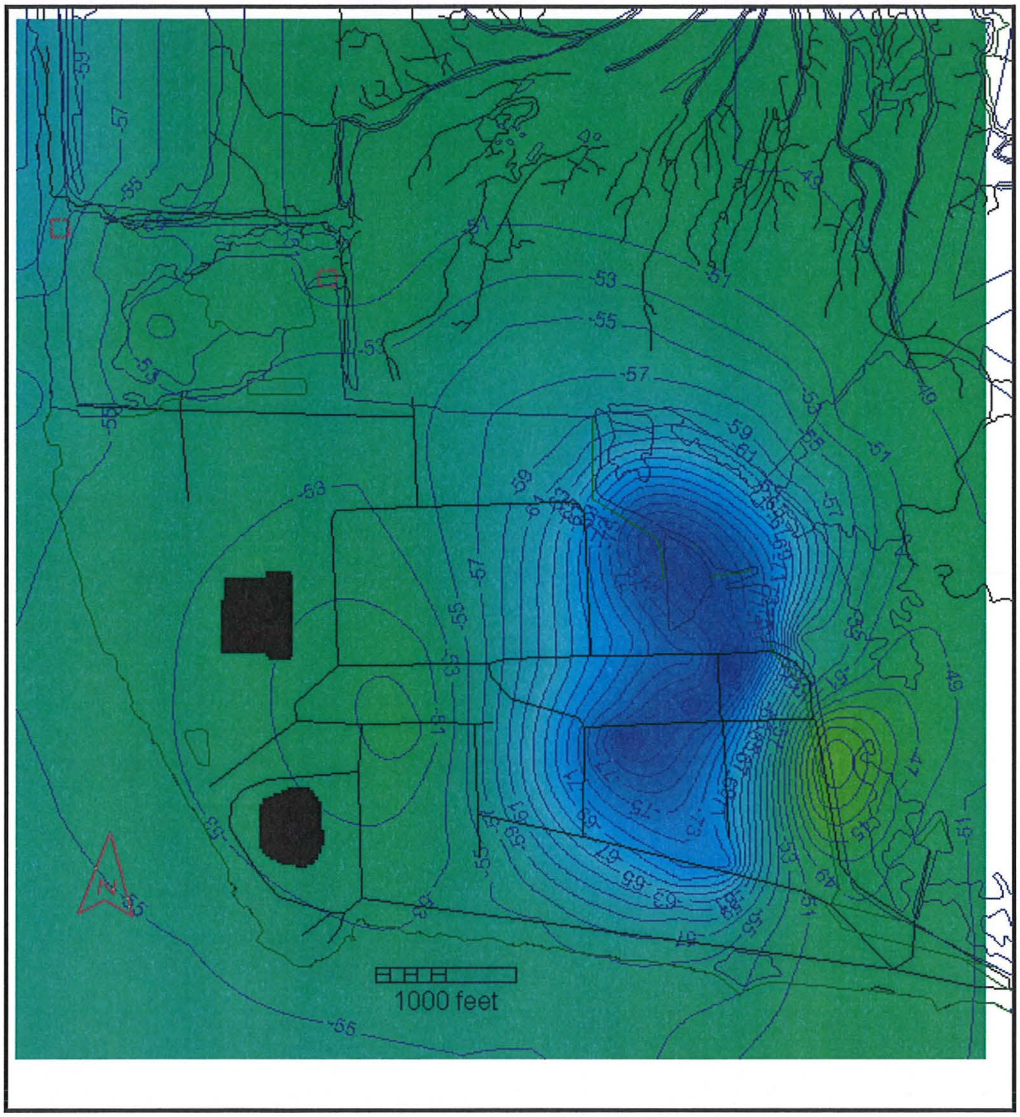


Figure B-5: Bottom of Layer 3 (Kirkwood Aquitard) Elevation Contours, feet NAVD88.

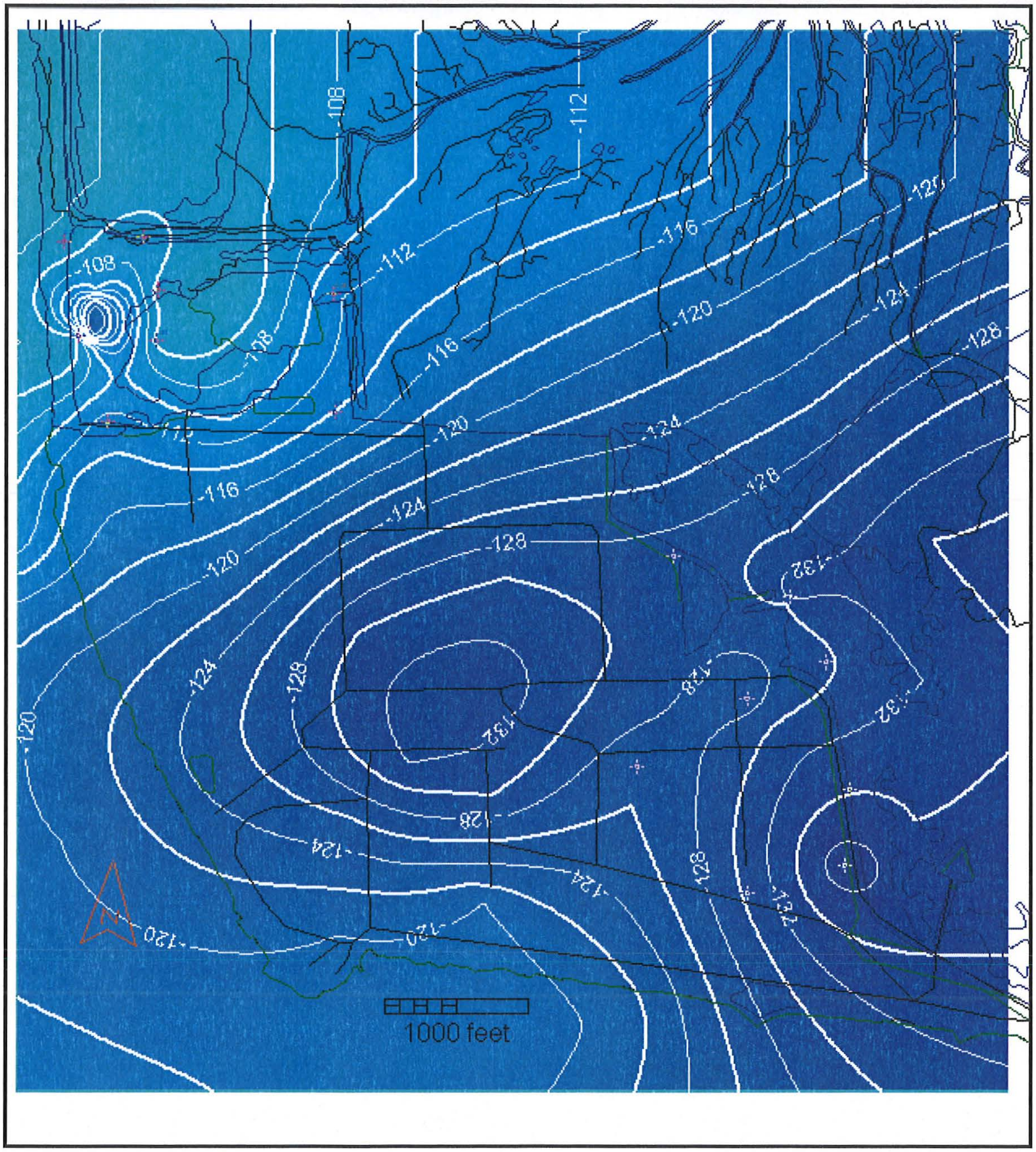


Figure B-6: Bottom of Layer 4 (Vincentown) elevation contours, feet NAVD88. The crosses mark the location of water level data in the formation in support of model calibration.

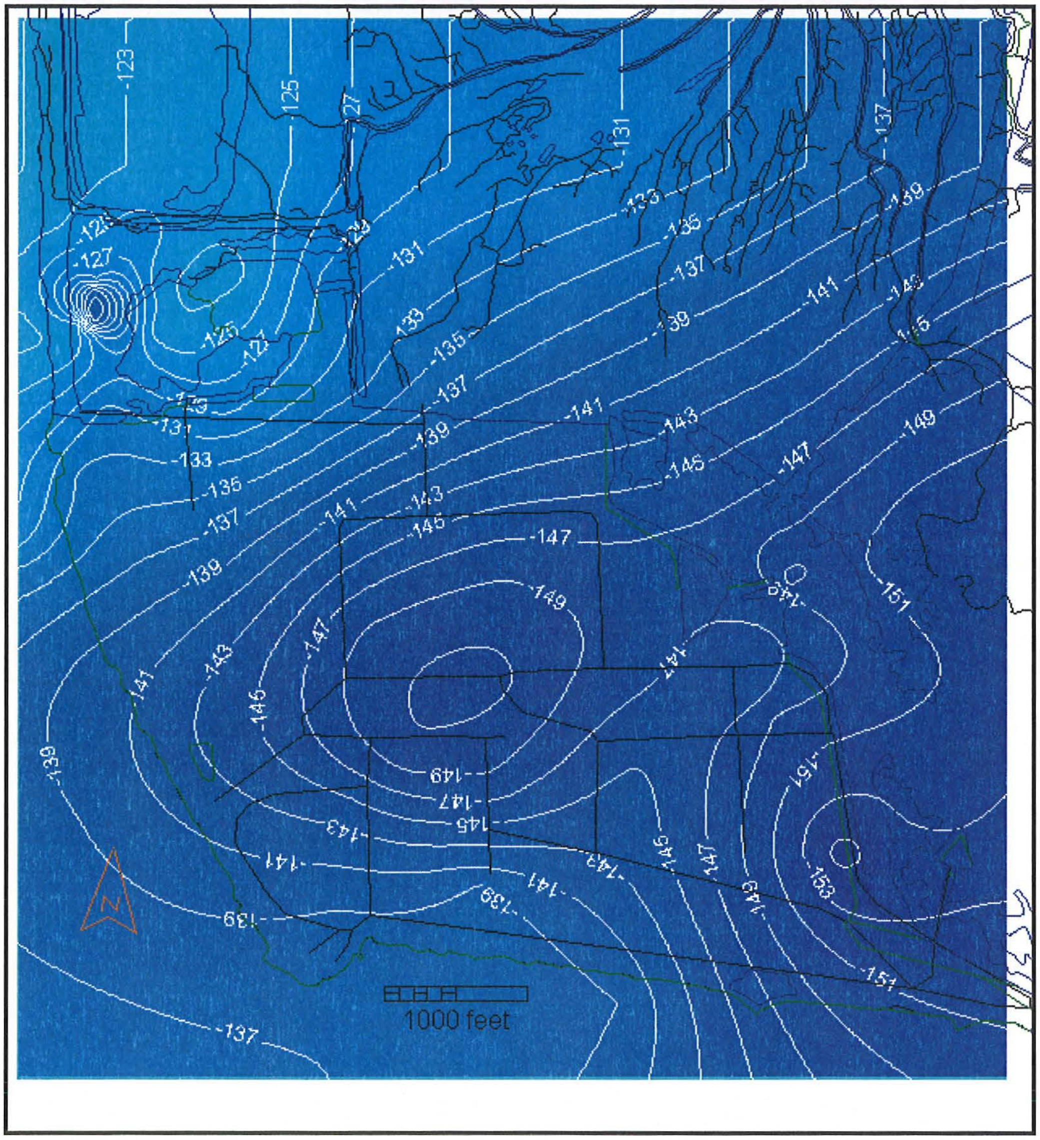


Figure B-7: Bottom of Layer 5 (Hornerstown) elevation contours, feet NAVD88.

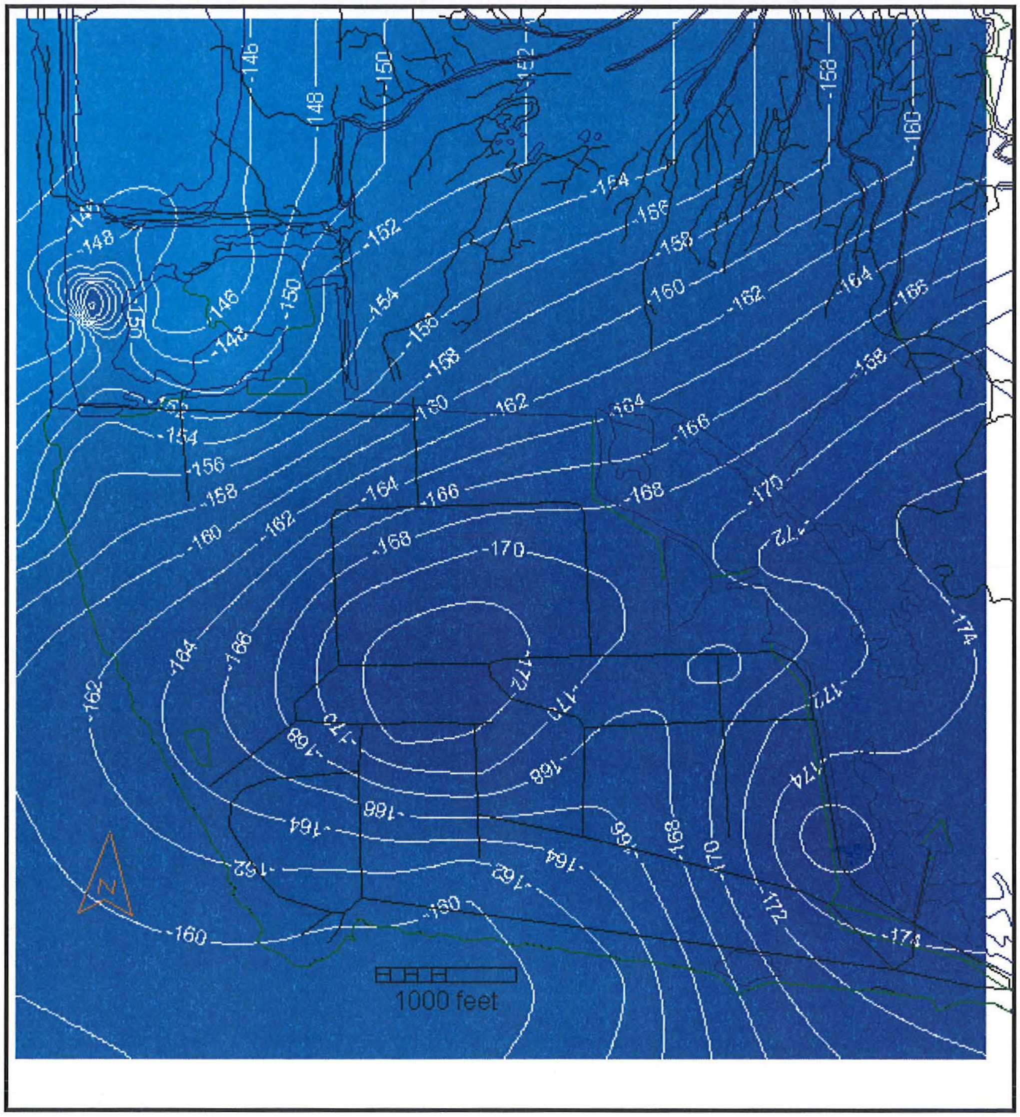


Figure B-8: Bottom of Layer 6 (Navesink Aquitard) elevation contours, feet NAVD88.

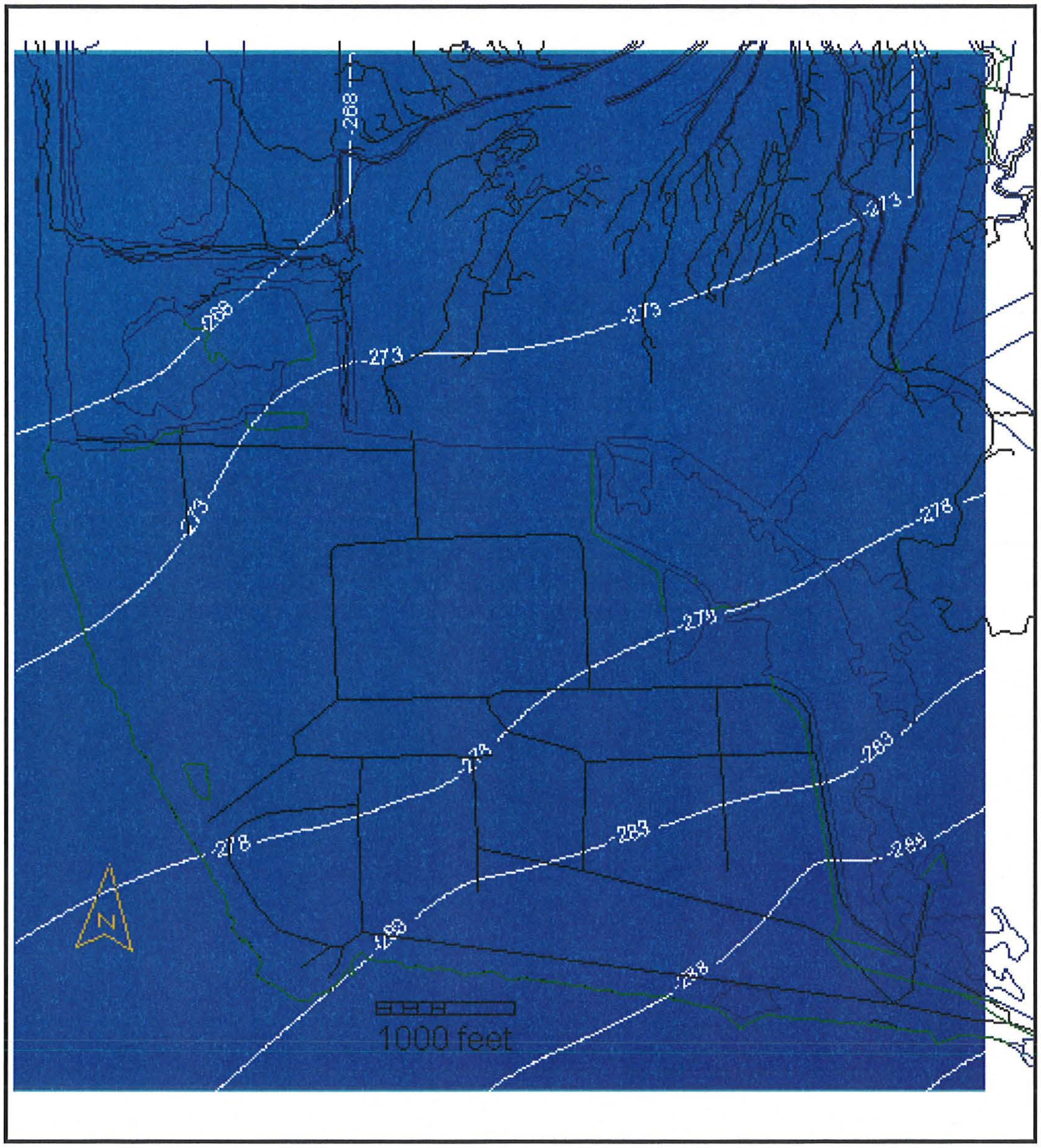


Figure B-9: Bottom of Layer 7 (Mount Laurel-Wenonah) elevation contours, feet NAVD88. This is also the base of the model as the underlying Marshalltown aquitard is thick and competent and is unlikely to allow flow to occur with the next lower aquifer.

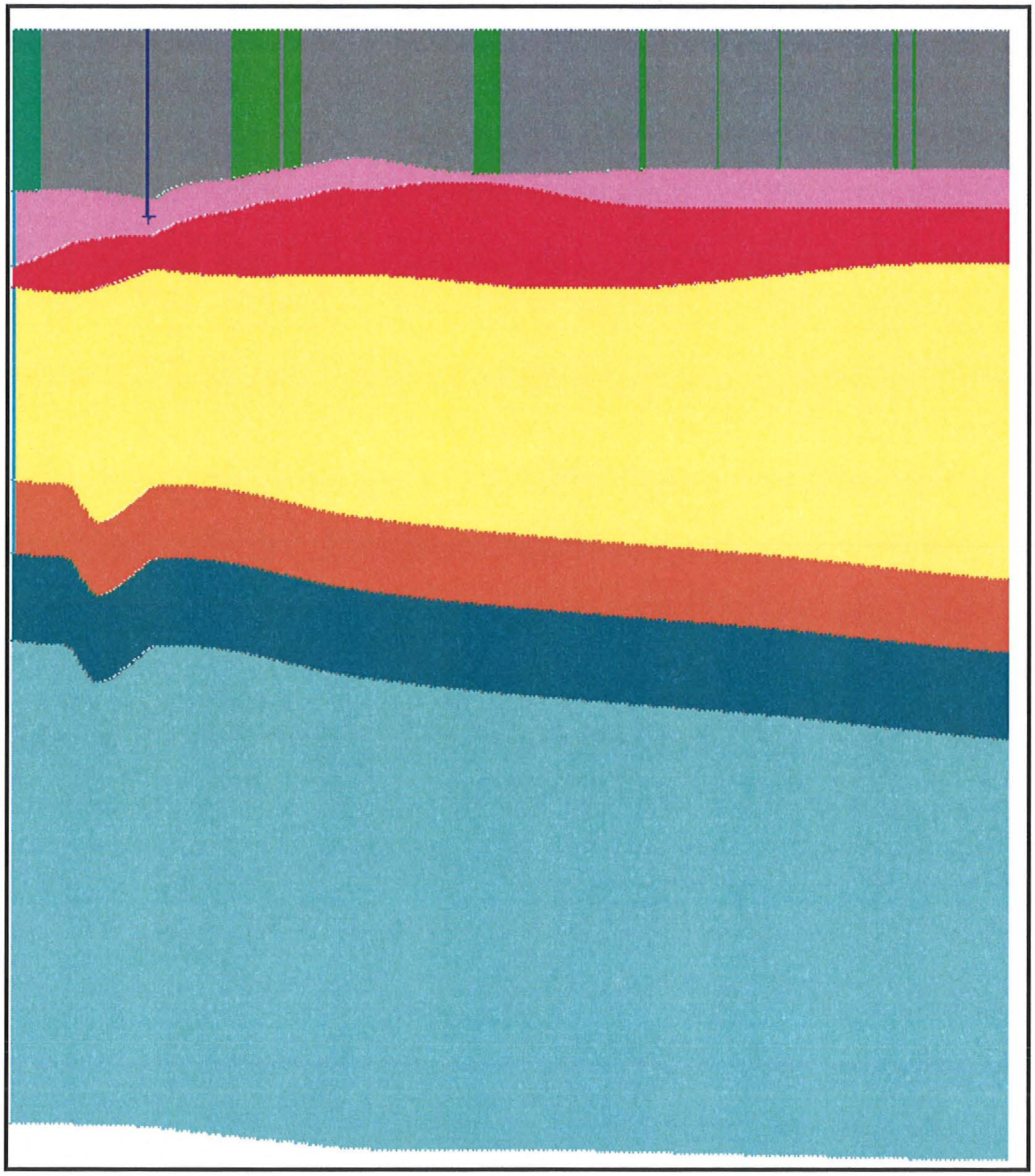


Figure B-10: Section View of model layers along model row 61 and the northern parcel selected for expansion. Starting from the bottom up, the layers represent the Mount Laurel-Wenonah, the Navesink aquitard, the Hornerstown unit, the Vincentown Formation, the Kirkwood aquitard, the alluvium, and the fill materials. Green strips in the fill material layer mark river nodes. The dark blue line in the upper left extending down into the alluvium represents boring NOW-3U.