SNC000073
Vogtle ESP Mandatory Hearing Presentation #2 and #3
Safety Topic #2 and #3

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Accidental Release & Transport of Radioactive Liquid Effluents & Potential Groundwater Impacts

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- Education
  - PhD in Civil Engineering, Stanford University
- Registered Professional Engineer (PE)
- 35 years of professional experience
  - Groundwater flow & transport
  - Modeling
  - Environmental hydraulics & hydrology
  - Water resources
- Authored or co-author of numerous publications
  - 32 papers in peer-reviewed journals
  - 56 papers in technical conferences proceedings
- Chair/member of various IAHR & ASCE committees
- Bechtel Fellow (highest technical recognition in Bechtel)
- Consulting Professor, Stanford University

Exhibit SNC000074

Topics

- Relevant site hydrology
- Effluent release points
- Transport paths
- Site characteristics that impact transport
- Use of on-site measurements to establish transport parameters
- Conservatism embodied in the analysis
- Compliance with
  - 10 CFR part 20.1302
  - 10 CFR part 52.17
  - 10 CFR part 100.20(c)(3)

Surface hydrology features

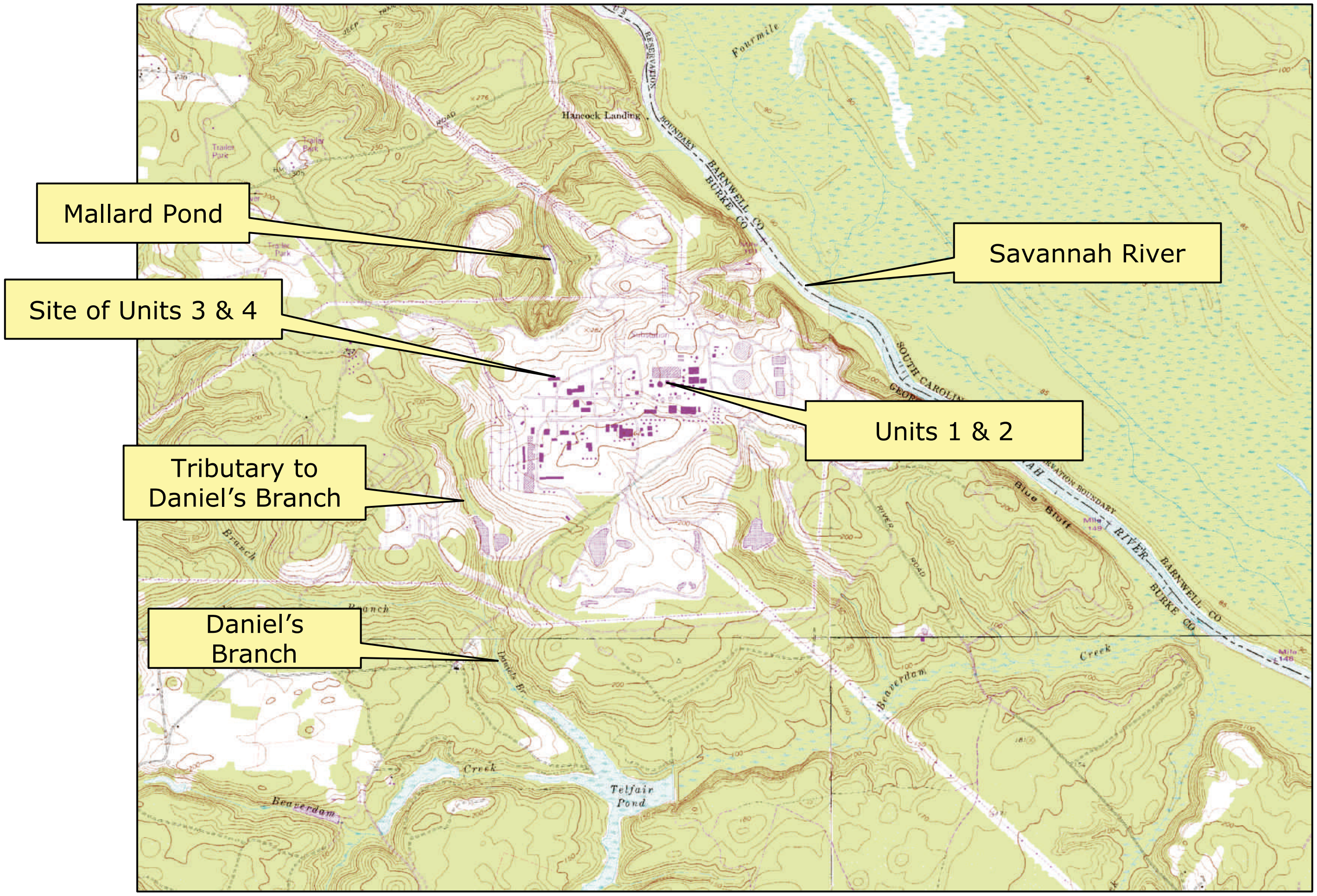


Exhibit SNC00075, SSAR Figure 2.4.1-3, p.2.4.122

Hydrostratigraphy

- Three aquifers underlie the VEGP site
  - Water Table Aquifer
  - Tertiary Aquifer
  - Cretaceous Aquifer
- No hydraulic communication between the Water Table Aquifer and the lower aquifers
  - Blue Bluff Marl (Lisbon Formation) between the Water Table Aquifer and the Tertiary Aquifer
    - Average thickness 63 ft
    - Very low permeability (0.000014 to 0.024 ft/day)

Exhibit SNC000075, p. 2.4.12-7,2.4.12-10,2.4.12-21

The Water Table Aquifer

- Water Table Aquifer consists of the Barnwell Group
  - Sands, clays, and silts of the Barnwell Formation
  - Discontinuous deposits of the Utley limestone
- Base of the Water Table Aquifer is the top of the Blue Bluff Marl
- The outcrop of the Blue Bluff Marl defines the extent of the Water Table Aquifer
- Depth to water table at the site of Units 3 & 4 is more than 60 ft

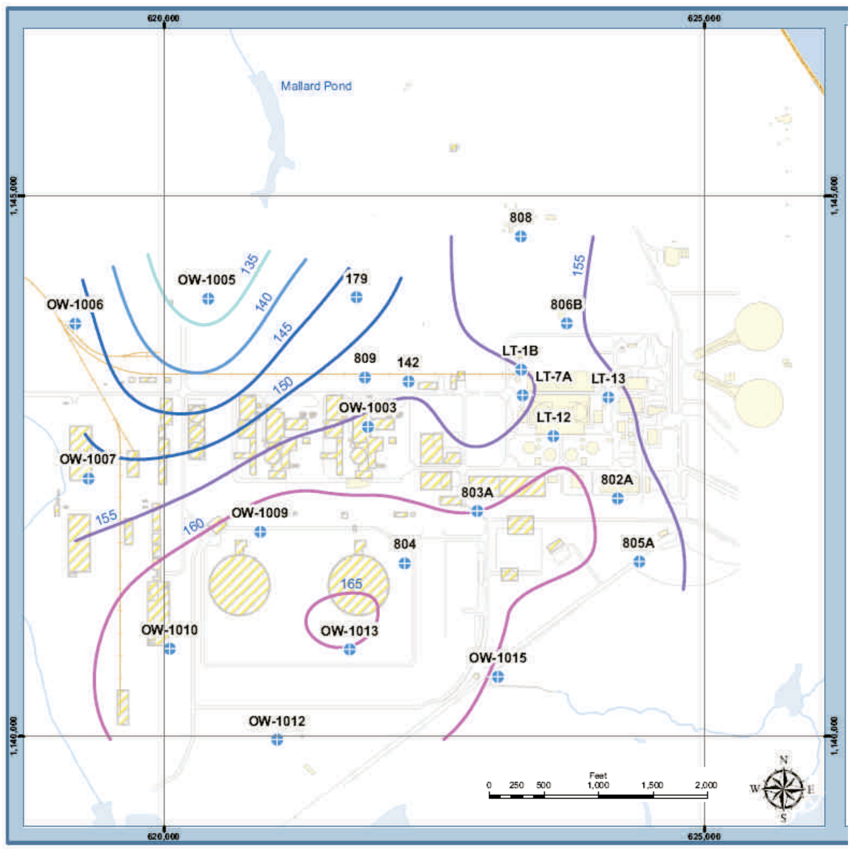
Exhibit SNC000075, p. 2.4.12-11, App. 2.4B, p.15

Groundwater flow

- Monthly groundwater level data collected at 22 monitoring wells from June 2005 to July 2007
- Average seasonal variability 1.7 ft
- Direction of groundwater flow
  - From the power block area of Units 3 & 4 groundwater flows to the north, towards Mallard Pond
  - Groundwater high in the area of the cooling towers of Units 3 & 4

Exhibit SNC000075, pp 2.4.12-12, 2.4.12-14, 2.4.12.1, 2.4.12-26 (Table 2.4.12.1)

Groundwater data

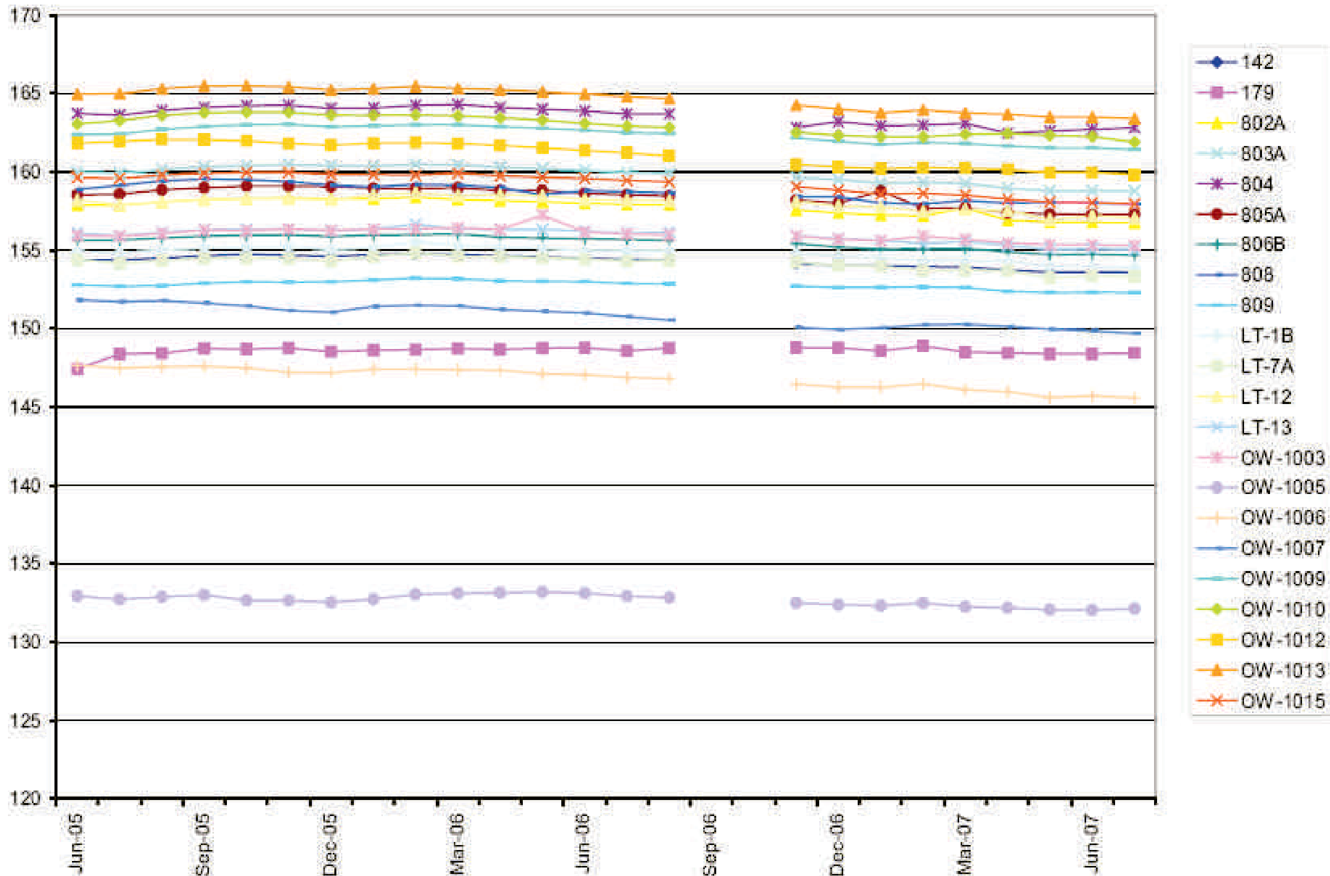


Water table aquifer contours - June 2005 data

- Groundwater flow from Units 3 & 4 is to the North

Exhibit SNC000075, p. 2.4.12-65 (Figure 2.4.12-7)

Groundwater data



Measured water levels in the water table aquifer

- Small variability over time

Hydraulic Conductivity

- Tests for Units 1 & 2
  - Utley limestone
    - 5 Pumping tests (8.9 to 343 ft/day)
    - 7 Falling head tests (0.26 to 16 ft/day)
    - 4 Constant head tests (0.44 to 8.8 ft/day)
  - Barnwell sands
    - 2 Constant head tests (0.5, 0.7 ft/day)
    - 3 Laboratory tests (0.03 to 0.8 ft/day
  - Backfill
    - 4 tests (1.3 to 3.3 ft/day)
- Tests for Units 3 & 4
  - 9 slug tests (0.12 to 2.65 ft/day)

Exhibit SNC000075, p. 2.4.12-16

Groundwater model

- SNC developed a groundwater model
  - to integrate data interpretation
  - to predict future conditions
- Single-layer model of water table aquifer
  - water table does not communicate with the underlying aquifer
    - Water table aquifer underlain by thick low-permeability blue bluff marl layer
  - no vertical hydraulic gradient within the water table aquifer
- Steady-state model

Groundwater model

- Based on site-specific data
- Developed using Visual MODFLOW
- Calibrated using measured water levels
- Alternative plausible conceptual models
  - different distribution of hydraulic conductivity
  - different recharge values

Groundwater Model

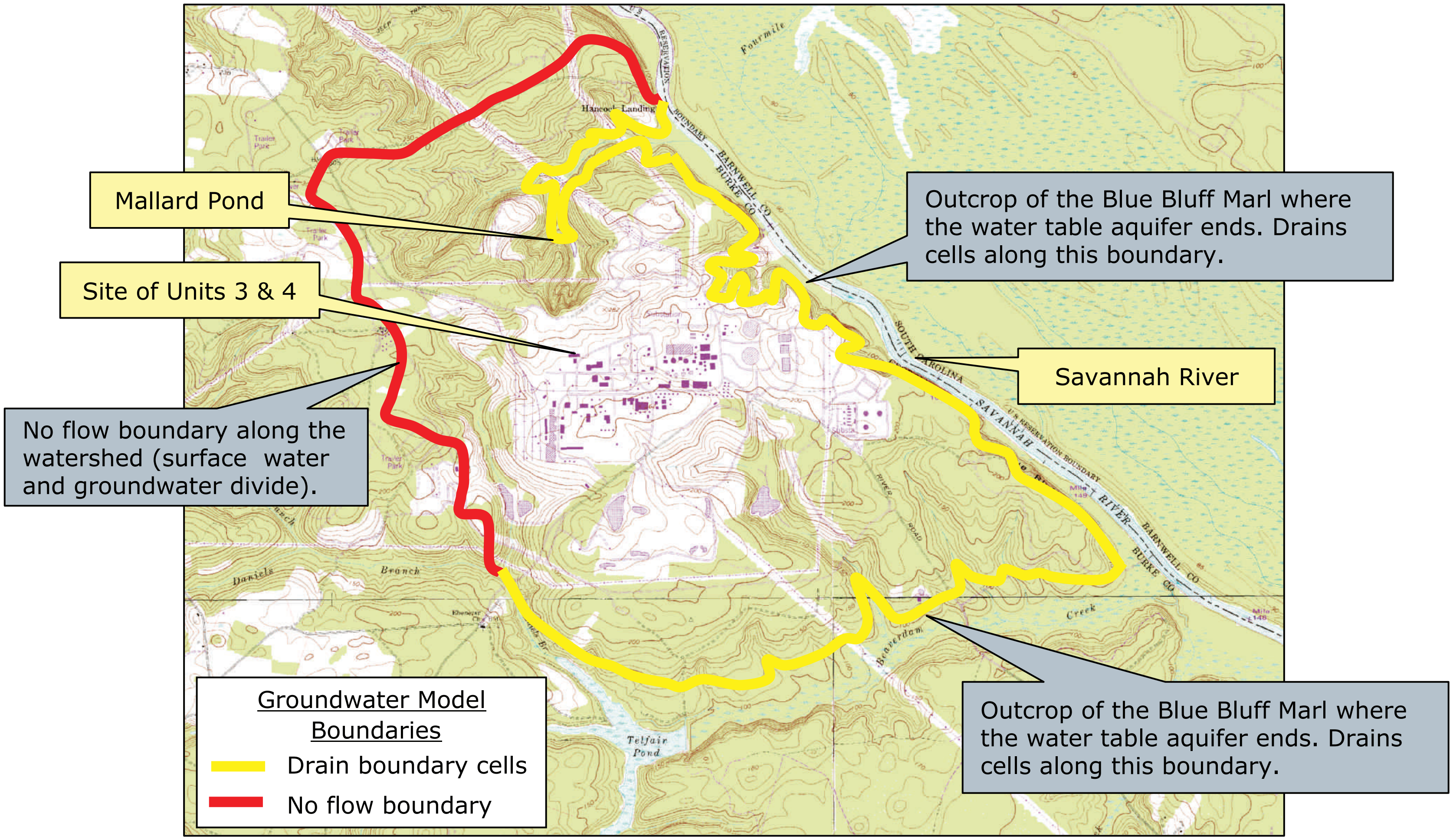
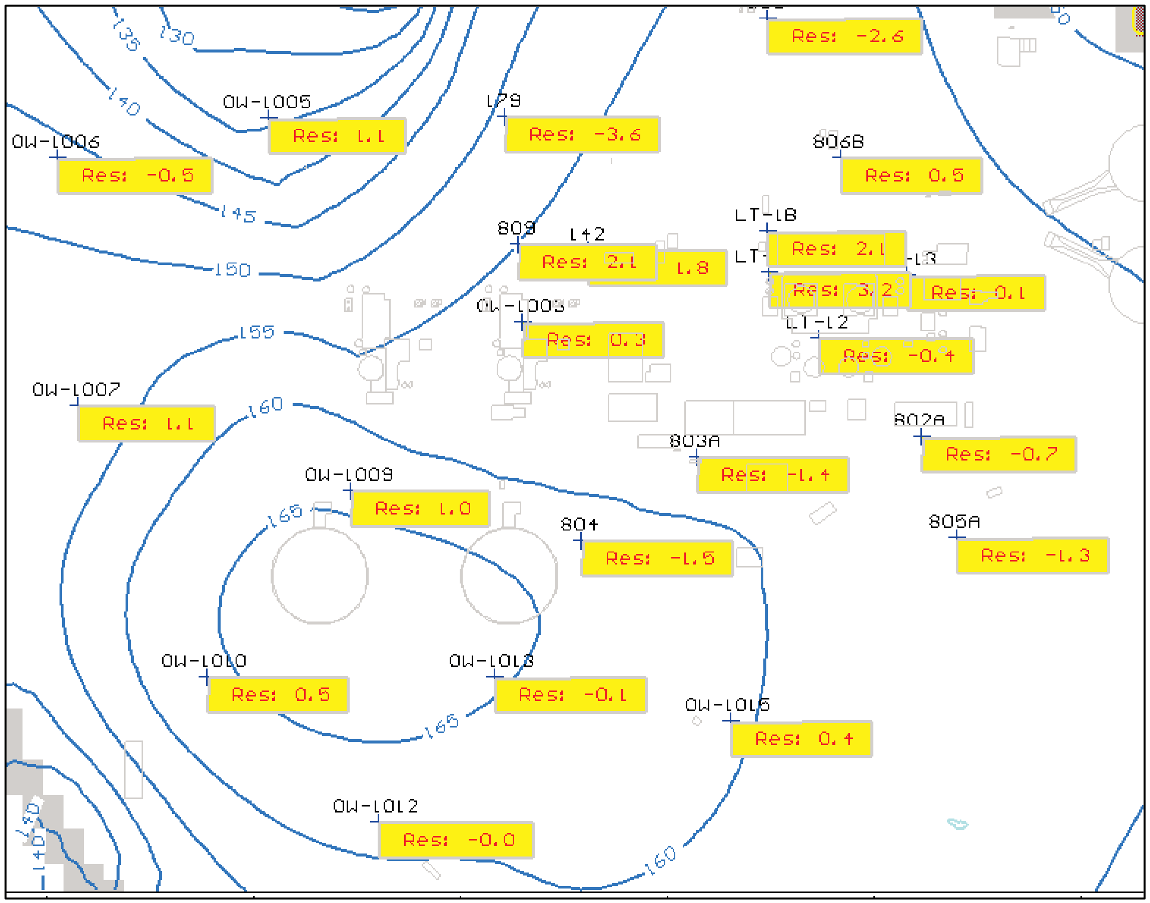


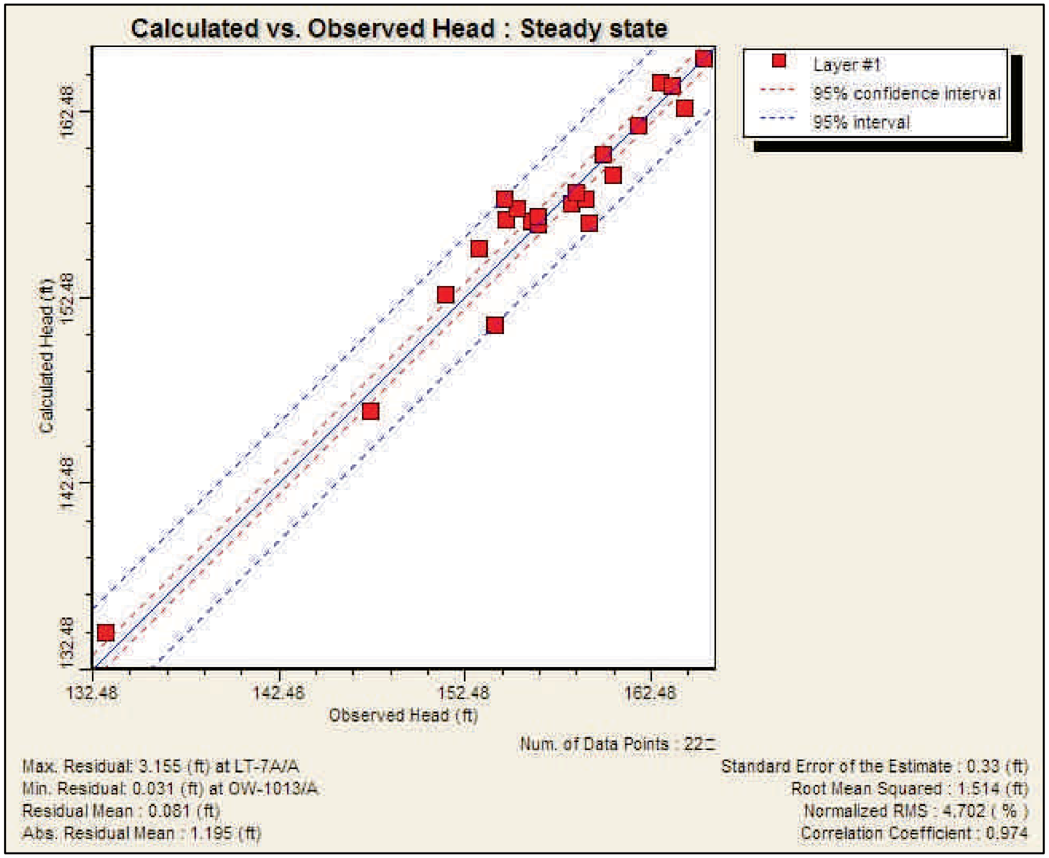
Exhibit SNC000075, Appendix 2.4B, p. 74 (Figure 18)

Model Calibration



Calibrated Head Residuals

Model Calibration



Calibration Statistics

Post-construction model

- Modeling of future conditions accounted for
  - Changes in topography
  - Changes in subsurface materials
    - Backfill
  - Changes in recharge
    - Grading
    - Surface cover
      - New buildings, paved areas, roads, etc
      - Gravel covered areas
      - Changes in vegetation cover

Post-construction model

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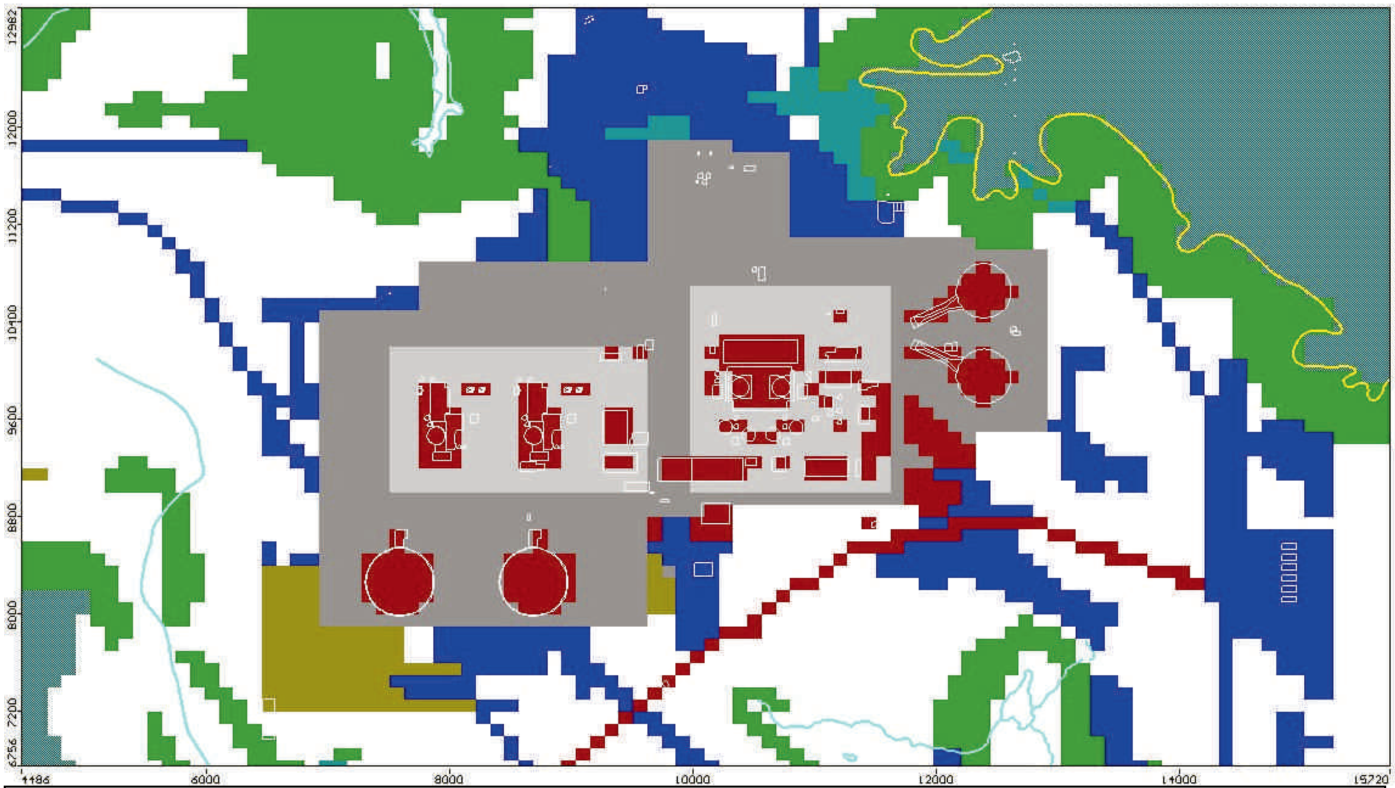
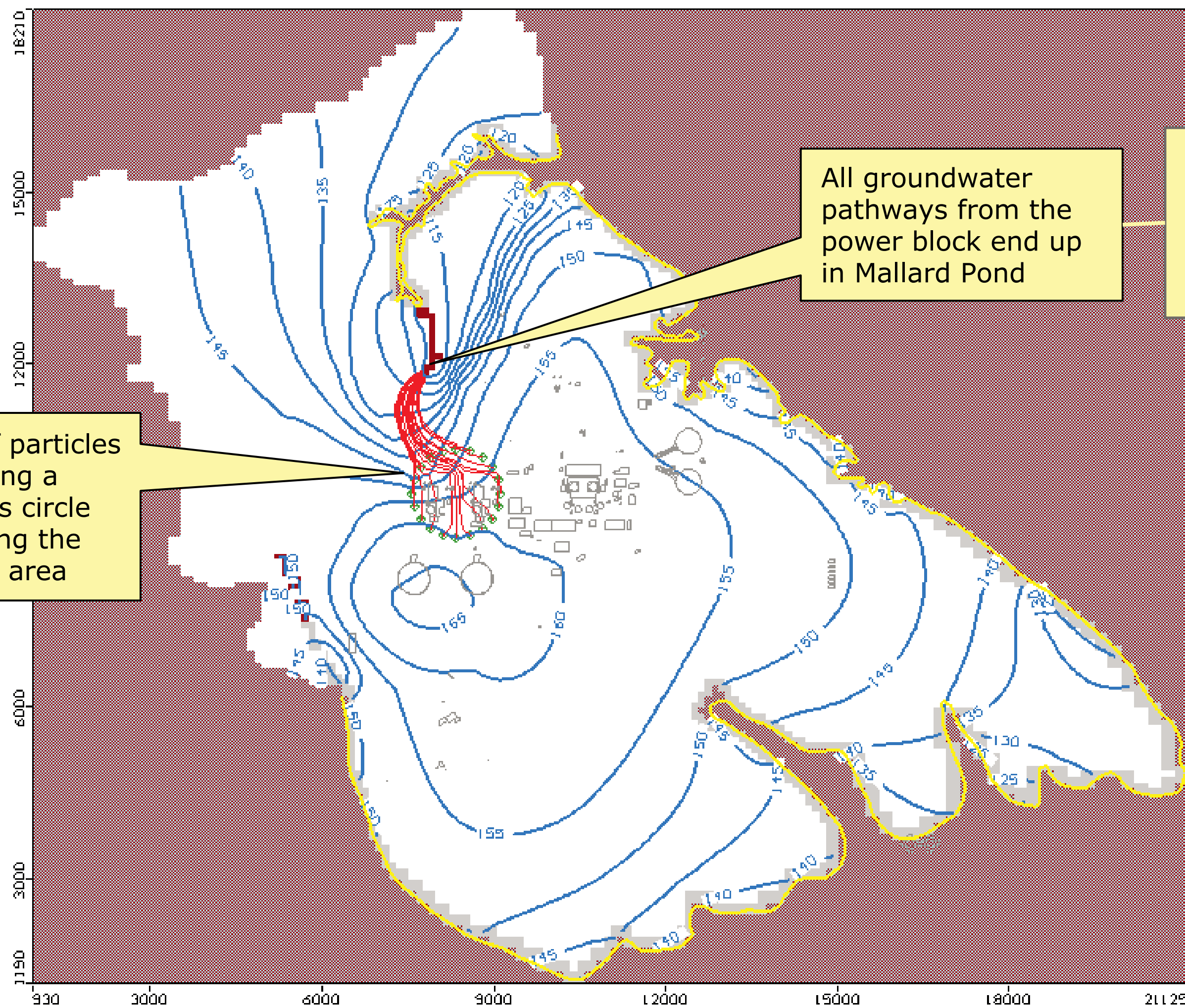


Recharge zones & values

- R_1 - Mild slopes, forested areas (8 in/yr)
- R_2 - Mild slopes, little vegetation (12 in/yr)
- R_3 - Steep slopes, forested areas (4 in/yr)
- R_4 - Steep slopes, little vegetation (6 in/yr)
- R_5 – Paved areas, buildings, roads (0 in/yr)
- R_7 - Nearly flat areas covered with gravel (16 in/yr)
- R_8 - Well-drained areas around the existing & new Units (4 in/yr)
- R_9 - Graded areas covered with compacted gravel (14 in/yr)

Groundwater recharge zones

Predicted post-construction water table & pathways



Pathways of particles released along a 775-ft radius circle encompassing the power block area

All groundwater pathways from the power block end up in Mallard Pond

The same conclusion was reached with other alternative plausible conceptual models and several combinations of parameter values

Transport paths

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- Groundwater transport pathways from the power block area of Units 3 & 4
  - All paths are directed to the north
  - They all end in Mallard Pond
- Several plausible alternative combinations of parameters and assumptions were made and analyzed with the model
  - All such combinations led to the same conclusion
- Radionuclides in a liquid release would enter the surface water system via Mallard Pond and would be diluted in the Pond and the stream running from the Pond to the Savannah River

Transport analysis
Water Table Aquifer Pathway

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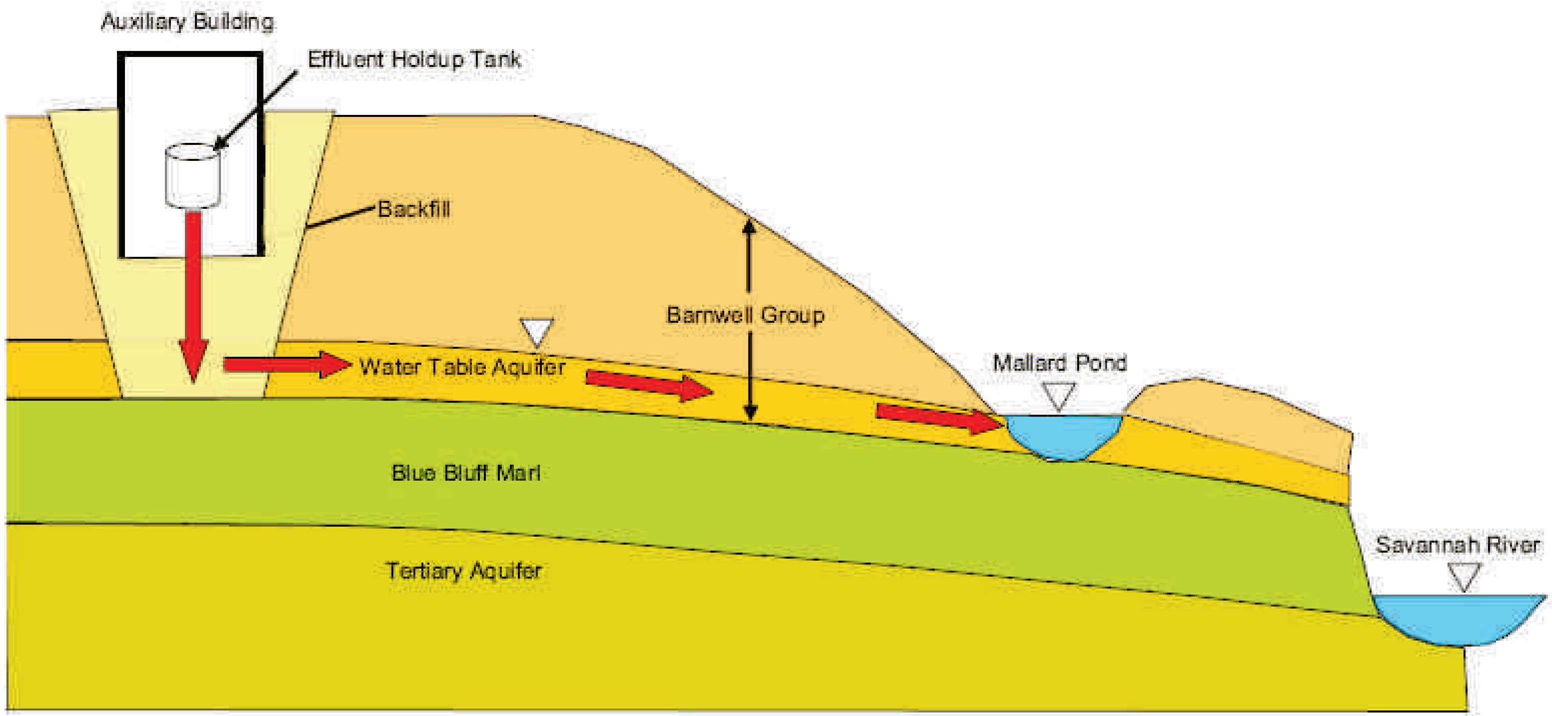


Conceptual Model for Evaluating
Radionuclide Transport in the Water Table Aquifer

Exhibit SNC000075, p.2.4.13-23 (Figure 2.4.13-1)

Compliance with 10 CFR Part 20

- Postulated accident scenario
- Transport analysis accounting for advection, decay, adsorption & dilution in surface water
- Considered compliance point at the Mallard Pond stream, within the restricted area
  - Concentrations of all nuclides much smaller than the respective Effluent Concentration Limits (ECLs) prescribed in 10 CFR Part 20
  - Sum of ratios of all nuclide concentrations in the Mallard Pond stream over respective ECLs = 0.058, i.e. much smaller than 1

Conservatism of transport analysis

- Instantaneous release to groundwater
  - 80% of effluent holdup tank's volume (22,400 gal)
- Zero travel time through unsaturated zone
- No credit for dispersion in groundwater
- Conservative estimate of adsorption
  - No credit for adsorption, except for Co, Sr, Cs
  - for Co, Sr, Cs used the minimum distribution coefficient from all samples analyzed in the lab
- Compliance point within restricted area
  - On the Mallard Pond stream
  - Additional dilution in Savannah River; using the 100-year drought flow for the Savannah River gives an additional dilution factor of around 1,300

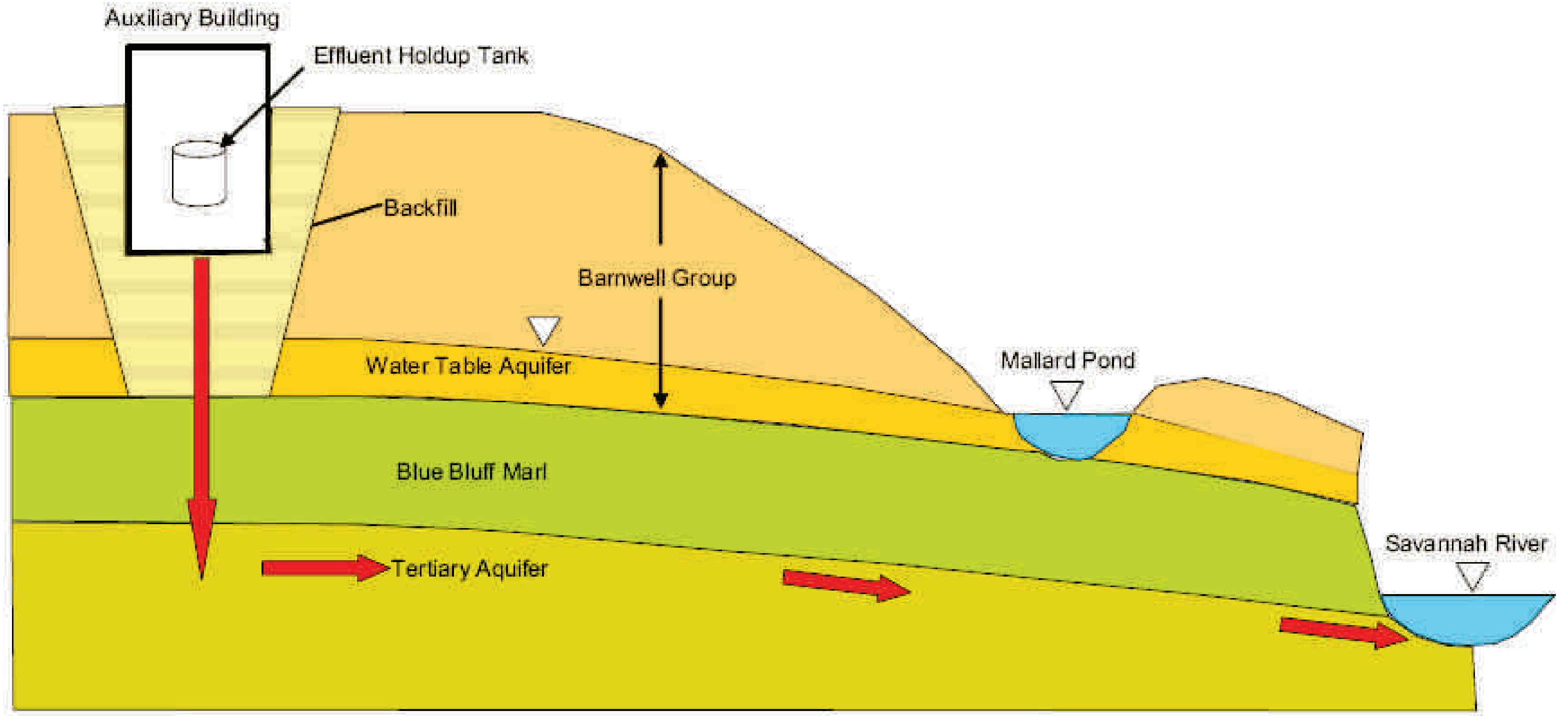
Site characteristics that impact transport

- Parameters based on site-specific data
  - Calibrated values in the groundwater model to match measured groundwater levels
- Hydraulic conductivity
  - Native materials
    - 3 zones with values ranging from 8 to 100 ft/day
    - Consistent with slug & pumping tests for Units 1 & 2 and 3 &4
  - Backfill
    - 3.3 ft/day (highest value from test in backfill for 1 & 2)

Water Table Aquifer Characteristics that impact transport

- Groundwater recharge
  - Up to 8 recharge zones, ranging from 0 to 16 in/yr depending on land use/cover & ground slope
- Porosity
  - Total porosity 0.42
    - based on site specific data
  - Effective porosity 80 percent of total porosity
    - based on literature
- Distribution coefficients
  - Co, Sr, and Cs
    - from laboratory tests of site samples
  - No credit for adsorption for all other nuclides

Transport Analysis
Tertiary Aquifer Pathway



Conceptual Model for Evaluating
Radionuclide Transport in the Tertiary Aquifer

Exhibit SNC000075, p.2.4.13-24 (Figure 2.4.13-2)

Tertiary Aquifer Analysis

- Assumed instantaneous transfer of a release into the Tertiary Aquifer
  - No credit is taken for the thick, practically impermeable BBM
- Advective velocity based on measured values of
  - Hydraulic gradient
  - Hydraulic conductivity
  - Porosity

Compliance with 10 CFR Part 20

- Transport analysis accounting for advection and decay only
- Considered compliance at nearest discharge point in the Savannah River
  - Concentrations of all nuclides much smaller than the respective Effluent Concentration Limits (ECLs) prescribed in 10 CFR Part 20
  - Sum of ratios of all nuclide concentrations in the Savannah River over respective ECLs = 0.036, i.e. much smaller than 1

Conclusions

- The transport analysis of accidental radioactive effluent releases in the Water Table Aquifer demonstrates compliance with 10 CFR part 20
- Factors important to hydrological transport obtained from site-specific measurements in accordance with 10 CFR 100.20(c)(3) and assigned conservatively

Potential Groundwater Impacts

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Topics

- Relevant post-construction site hydrology
- Use of on-site measurements to establish pre-construction water table and parameters used to predict post-construction groundwater levels
- Conservatism of the analysis
- Compliance with
  - 10 CFR part 52.17

Relevant post-construction site hydrology

- Parameters affecting post-construction site hydrology were included in the model
  - Changes in groundwater recharge
    - Site grading
    - Buildings, paved areas, areas covered with gravel, etc
  - Backfill material
- The model was used to predict future groundwater conditions following the construction of Units 3 & 4

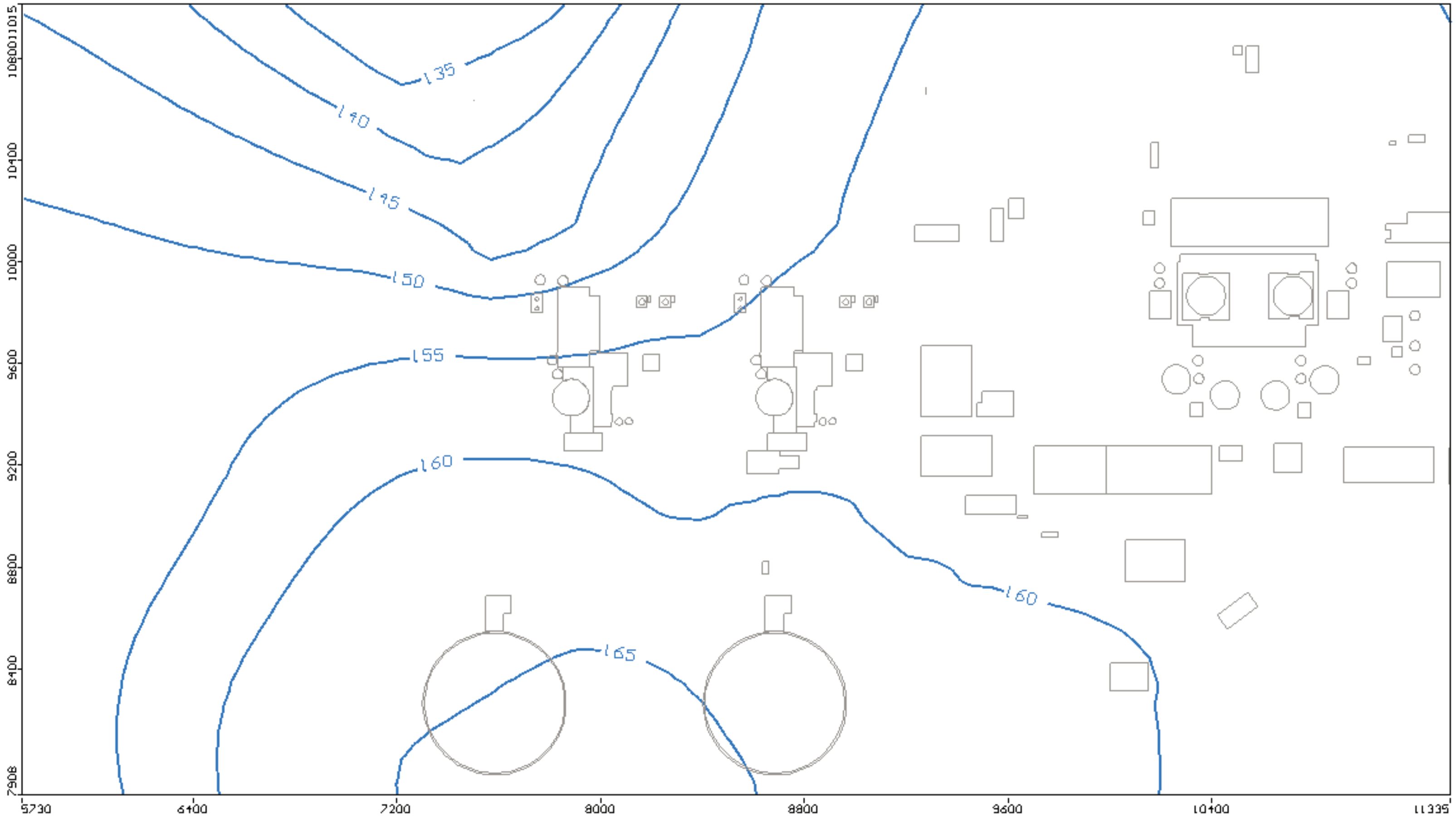
How evaluation parameters relate to on-site measurements

- Parameters used in the evaluation were based on on-site measurements
  - Calibrated values in the groundwater model to match measured groundwater levels

Conservatism of the analysis

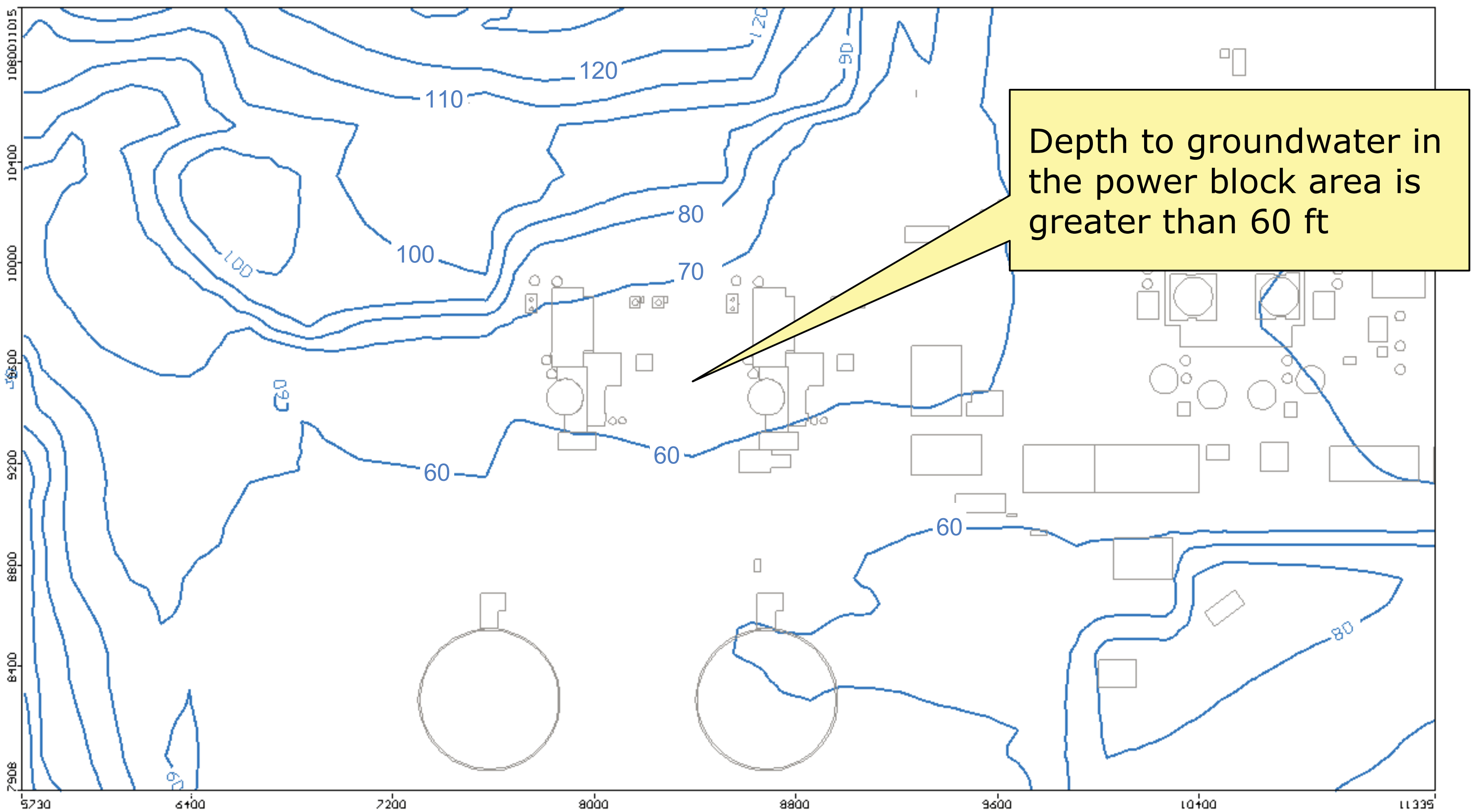
- Conservative values were used in the model
- Sensitivity analysis to key parameters
  - Hydraulic conductivity
  - Recharge

Post-construction water table



Simulated water table, contours in ft

Post-construction depth to groundwater



Simulated depth to groundwater, ft

Conclusions

- Maximum water table level under Units 3 & 4 is predicted to be around elevation 155 to 160 ft msl, i.e. well below the site grade level
- Depth to groundwater in the power block area is 60 ft, or more, below the site grade level of 220 ft msl
    - AP1000 DCD requires that the maximum design groundwater be equal or more than 2 feet below the final site grade level

Conclusions

- No hydrostatic loading on safety buildings
  - The lowest elevation of a safety-related structure, system, or component is El. 180.5 ft msl (bottom elevation of the containment building slab)
  - This elevation is about 20 to 30 ft above the highest water table elevation recorded in the power block