Nuclear Regulatory Commission
Exhibit # - NRC000061-MA-BD01
Docket # - 05200011
Identified: 03/23/2009
Admitted: 03/23/2009
Rejected:
Withdrawn:
Stricken:

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

Vogtle ESP Mandatory Hearing

March 23-25, 2009

NRC Staff Presentation Topic #3

Groundwater Impacts on Safety-Related Structures

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UNITED STATES NUCLEAR REGULATORY COMMISSION

Protecting People and the Environment

Presenters:

Charles Kincaid, Ph.D., PNNL

Hosung Ahn, Ph.D., NRC

Division of Site and Environmental Reviews

Hydrologic Engineering Branch

Office of New Reactors

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Purpose of Presentation

- Review the potential groundwater impacts on the subsurface portion of safety-related structures, systems, and components (SSCs)
- Focus: How the staff assured that the evaluation in the SER is conservative
- Included are remarks on
  - Pre-construction site hydrology
    - Parameters versus on-site measurements
  - Post-construction site hydrology
  - Analysis and Assurance of Conservative Results

Pre-Construction Site Hydrology

- Issued Open Item 2.4-2
  - Required an improved and complete description of the current and future local hydrological conditions, including alternate conceptual models, to demonstrate that the design basis related to groundwater induced loadings on subsurface portions of safety-related SSCs would not be exceeded.
- Plausible Alternative Conceptual Models
  - Performed review of the groundwater model for the water table aquifer – submitted by SNC in response to Open Items 2.4-2, 2.4-3 & RAIs.
  - From the model files submitted, Staff selected a base case model that most closely represented the measured water table – then modified it slightly (drain elevations & conductivity) – for independent confirmation.
- Performed sensitivity analyses – based on post-construction recharge distributions.

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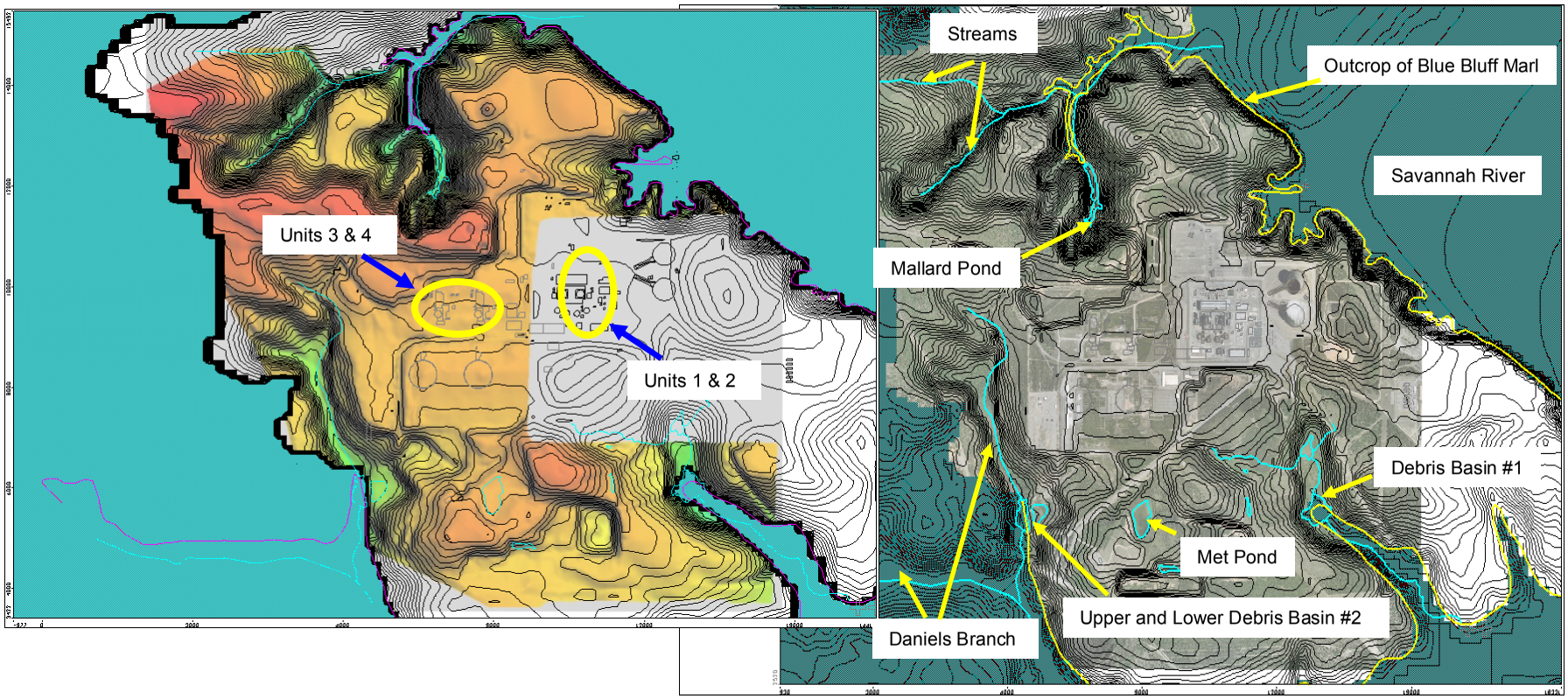
Staff Reviews to Assure a Plausible Conceptual Model of Pre-Construction

- Pre-Construction Site Hydrology Reviewed
  - Land Surface: use of LiDAR and DEM data sets
    - LiDAR – Light Detection and Ranging
    - DEM – Digital Elevation Model
  - Base of model: use of top of Blue Bluff Marl (BBM)
  - Boundary Conditions (BC)
    - Drain BC – outcrop of BBM, streambeds
      - LiDAR and DEM elevation, conductance
    - Constant Head BC – ponds, perennial wetlands
    - No-flow BC – groundwater divides at top of watershed
  - Hydraulic conductivity distributions and magnitude
    - Influence of the Utley limestone and engineered backfill
  - Recharge distributions and magnitude
    - Influence of the surface, slope, structures, vegetation
  - Reviewed SNC's combinations of hydraulic conductivity and recharge (space, magnitude), & the selection of representative values

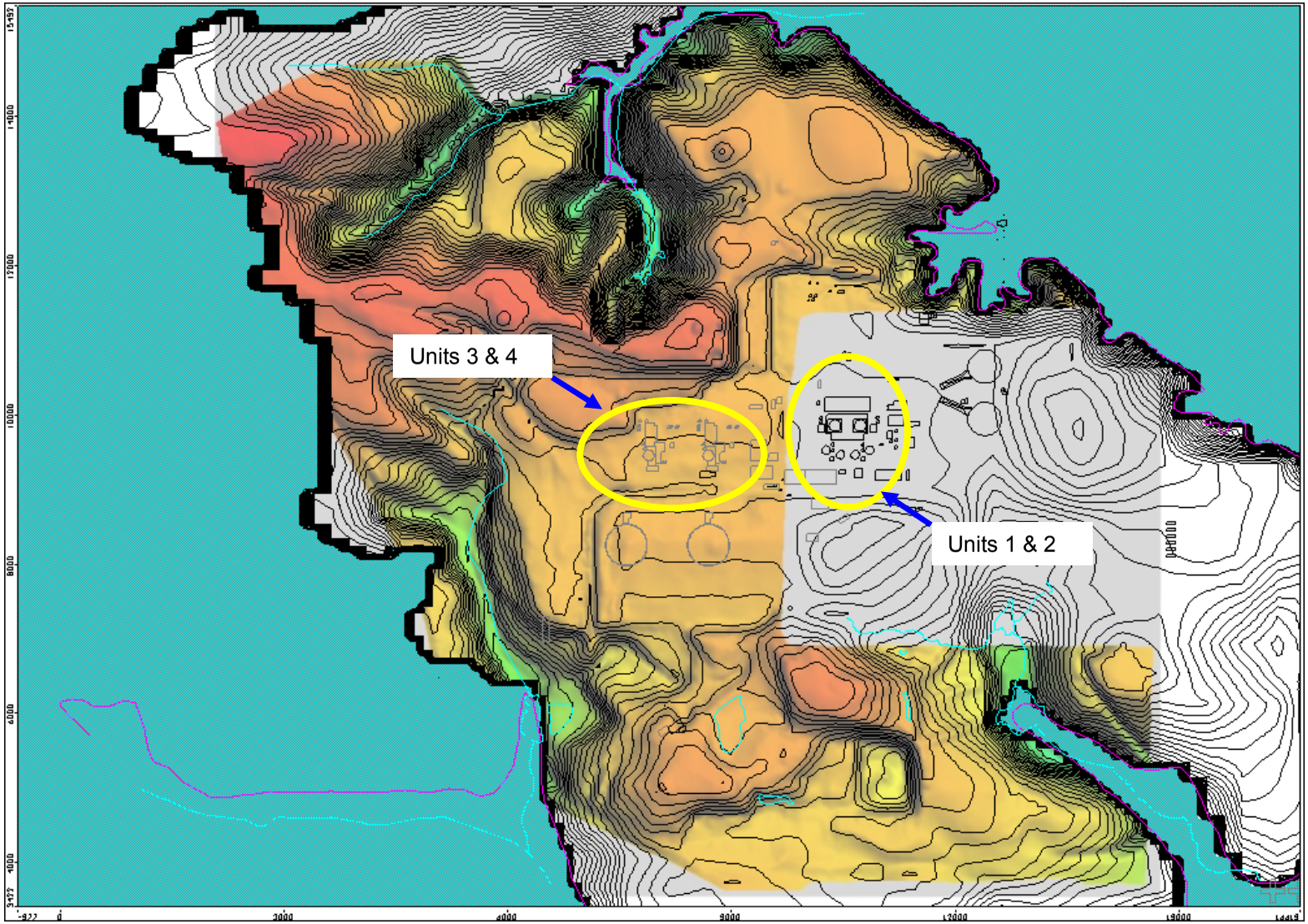
Site Topography & Boundaries

LiDAR (colored region)

Model: Top Elevation Contours

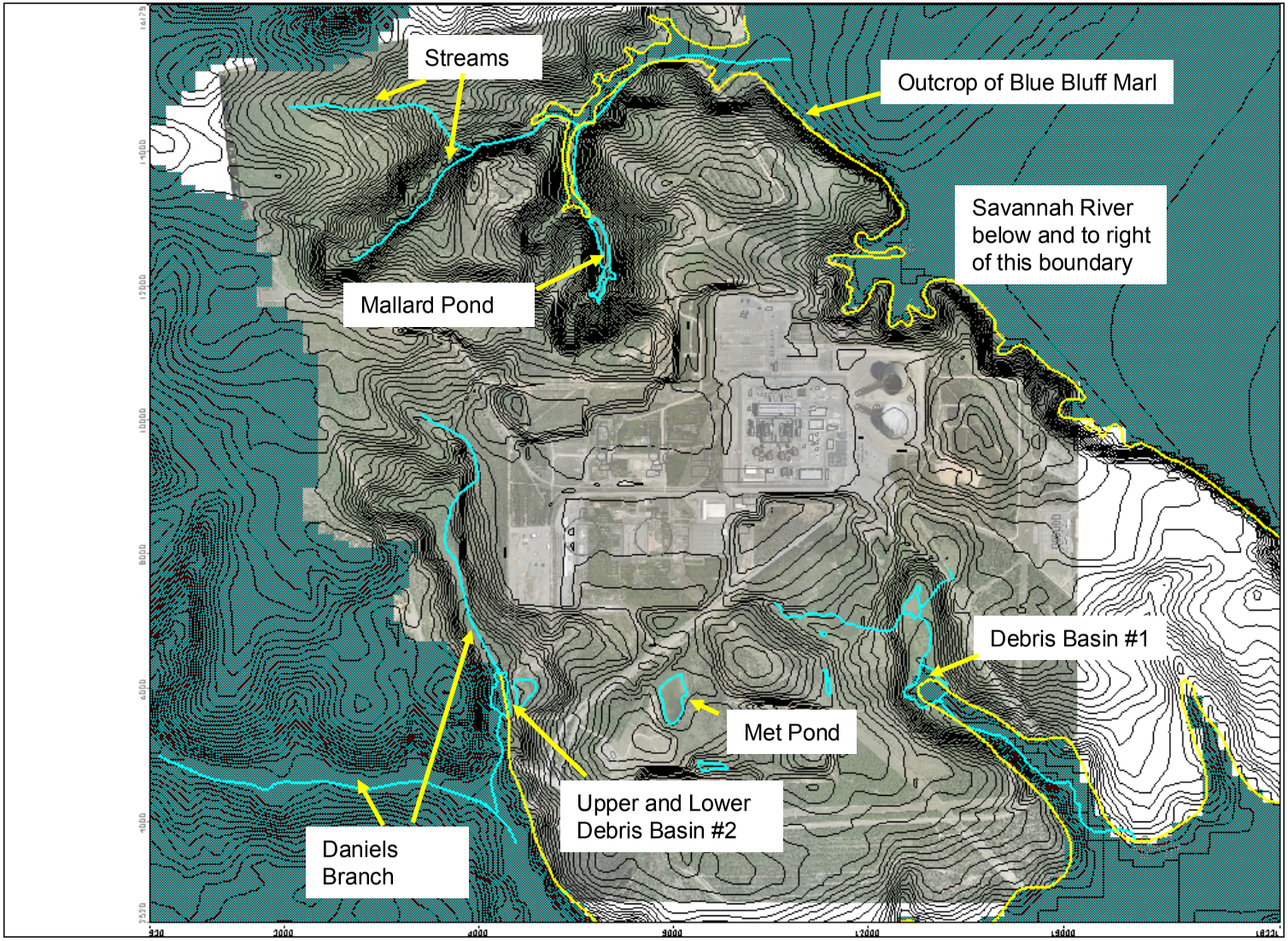


Site Topography: LiDAR (in color)

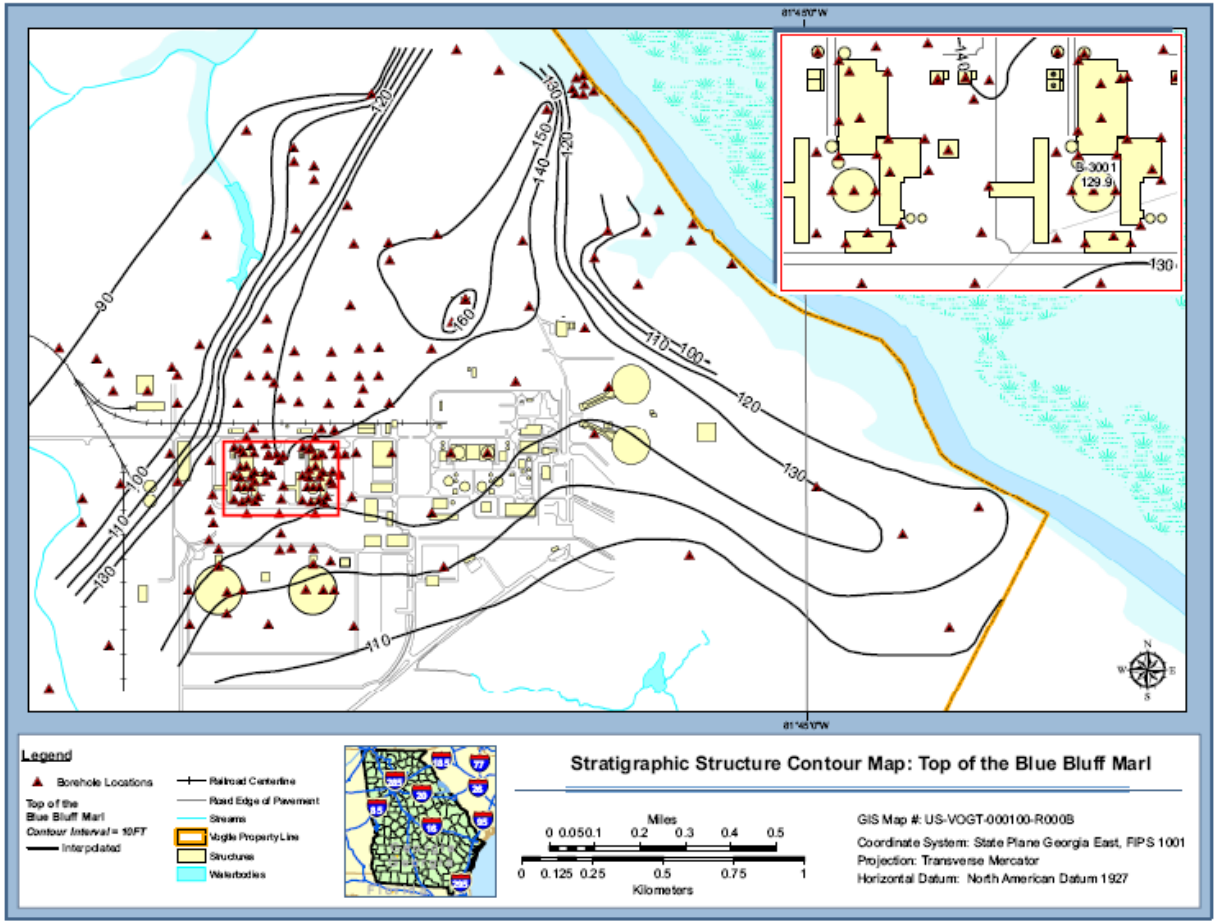


Site Topography & Boundaries

Model: Top Elevation Contours



Base of Model – Top of Blue Bluff Marl



Hydraulic Conductivity

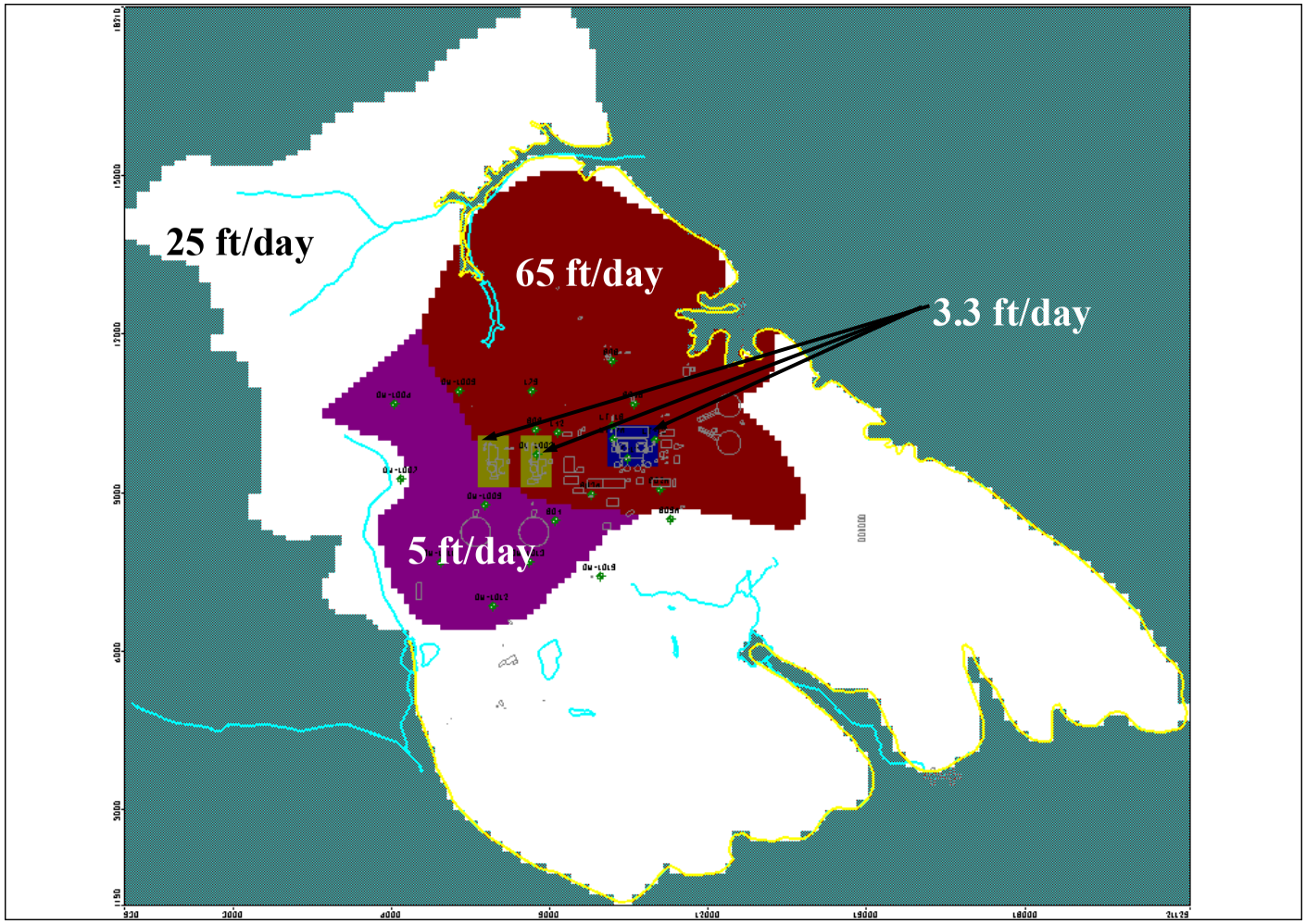
Source: Simulation Run 721-PC (PC = post-construction)

Measured Values:

Barnwell Group sands, silts, and clays
0.03 to 2.65 ft/day

Utley limestone
0.3 to 343 ft/day

Engineered backfill
1.3 to 3.3 ft/day

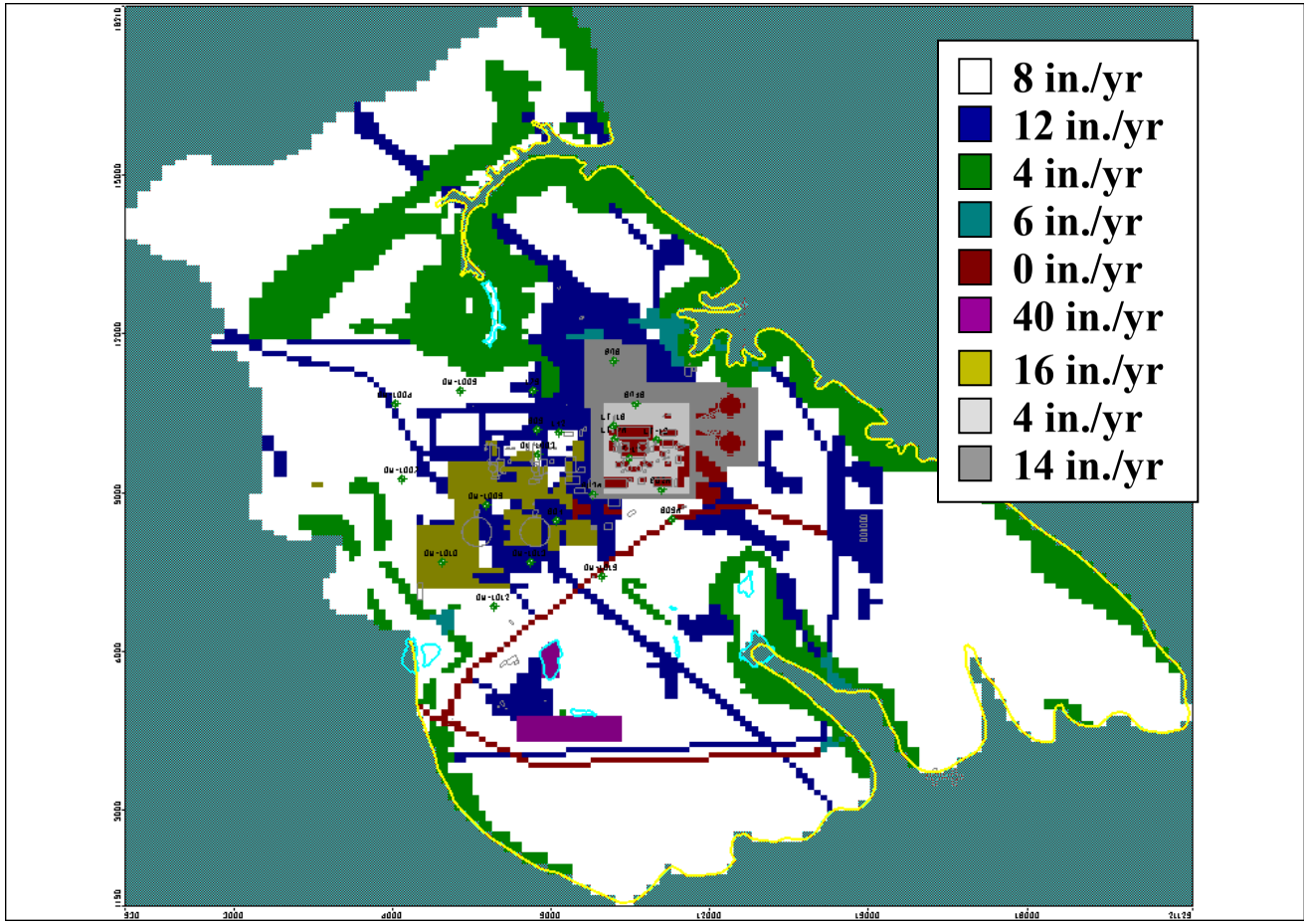


Site Recharge

Source: Simulation Run 721

USGS regional model
Long-term average
recharge 14.5 in/yr
in region (WRIR 97-4197)

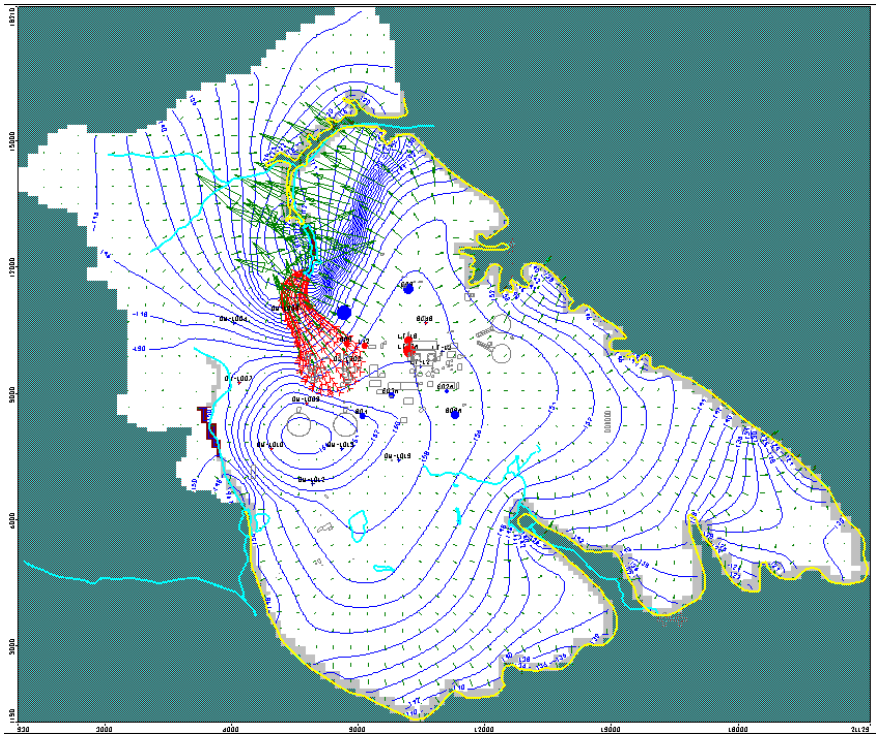
Local conditions vary
- ponds - > precipitation possible
- forest, grassland, soils, slopes - < precipitation
- structures, asphalt – zero if water routed away and not allowed to infiltrate

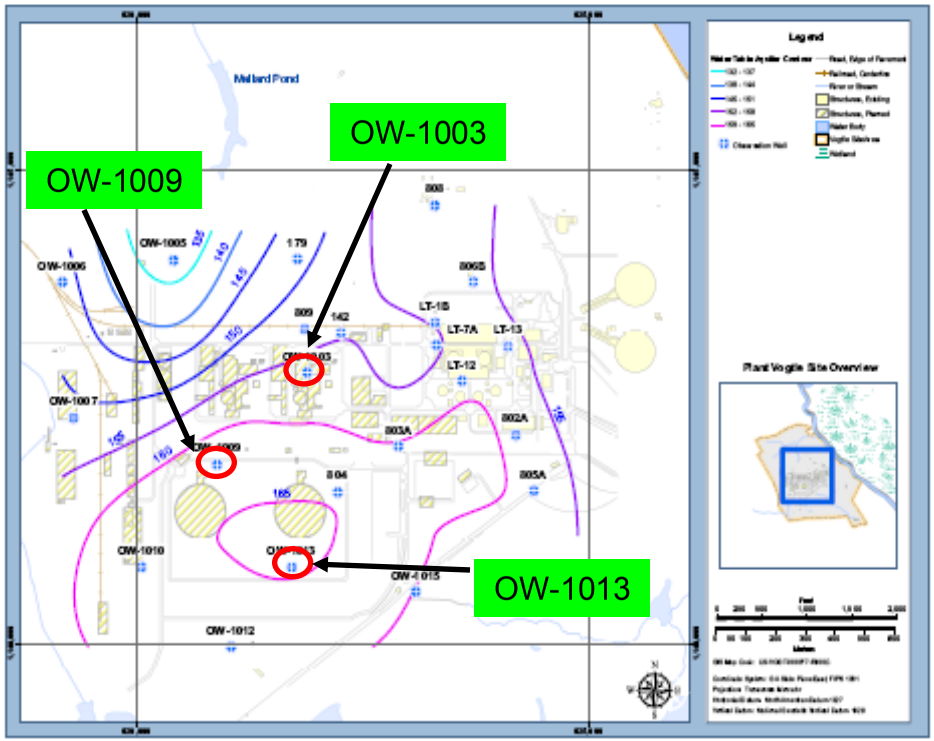


Pre-Construction Hydraulic Head; Comparison of Modeled vs. Measured

<u>Pre-Construction Model Results</u>
Max Value, Cooling Towers = 166.8 ft MSL
Max Value, Powerblock = 162.8 ft MSL
Applicant values 166.9 and 162.9 ft MSL
(Figure source: run 721 w/ corrected drains)

<u>Observed March 2006 Hydraulic Head</u>
Max Value = 165.31 ft MSL at OW-1013
Value = 163.01 ft MSL at OW-1009
Value = 156.43 ft MSL at OW-1003





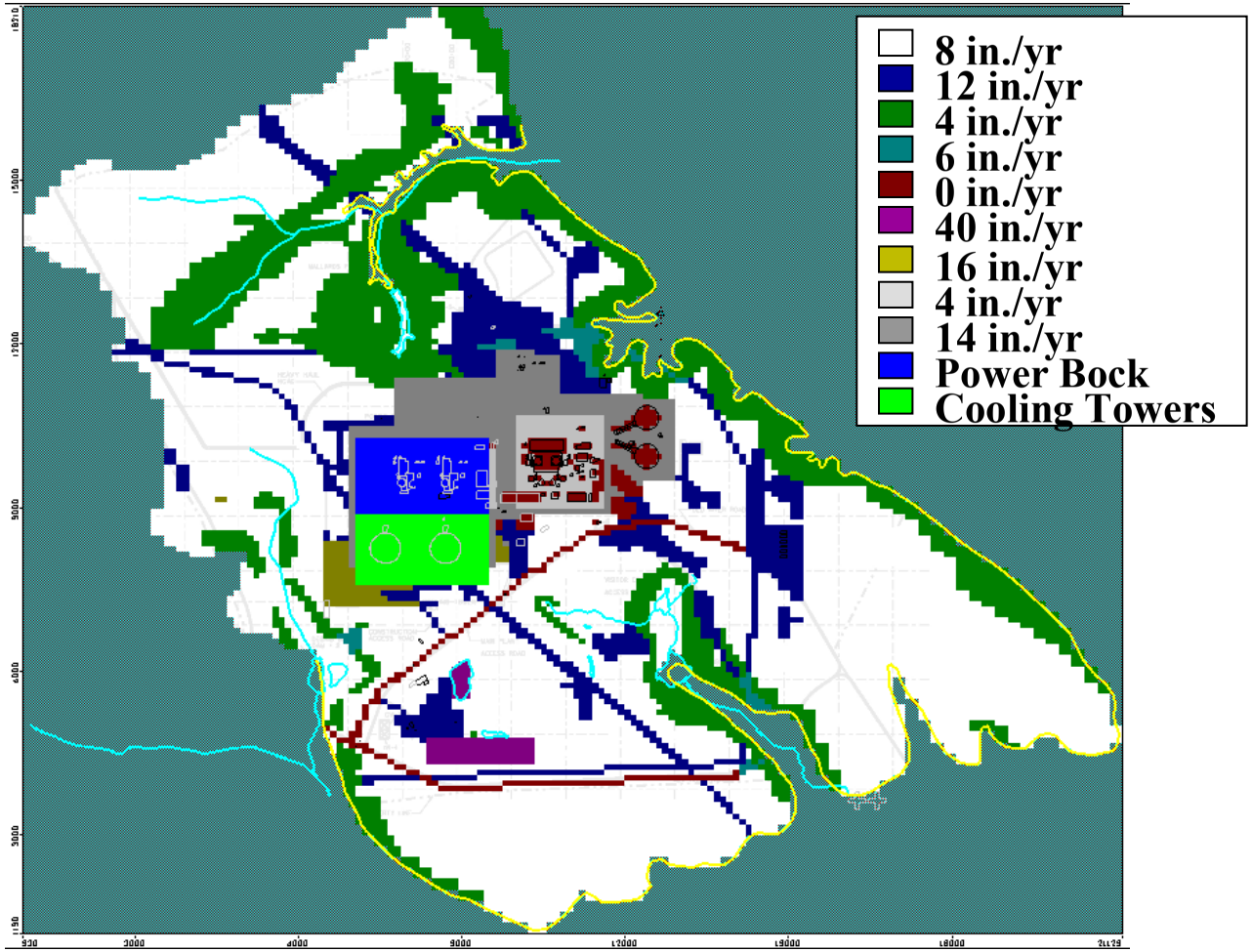
Post Construction: A Matrix of Recharge Rates; Evaluation of Transport towards Daniels Branch

√ = simulation completed; recharge to cooling area ≥ that to powerblock area
(mean annual precipitation 44 to 48 in/year)

Power Block / Cooling Tower	**High** (½ × Avg. Annual Precipitation)	**Plausible** (⅛ × Avg. Annual Precipitation)	**Low** (Zero)
High (½ × Avg. Annual Precipitation)	√	√	√
Plausible (¼ × Avg. Annual Precipitation)		√	√
Low (Zero)			√

Post Construction: Powerblock & Cooling Tower Recharge Zones

Source: Simulation run 721pc, (i.e., run 721 post-construction)



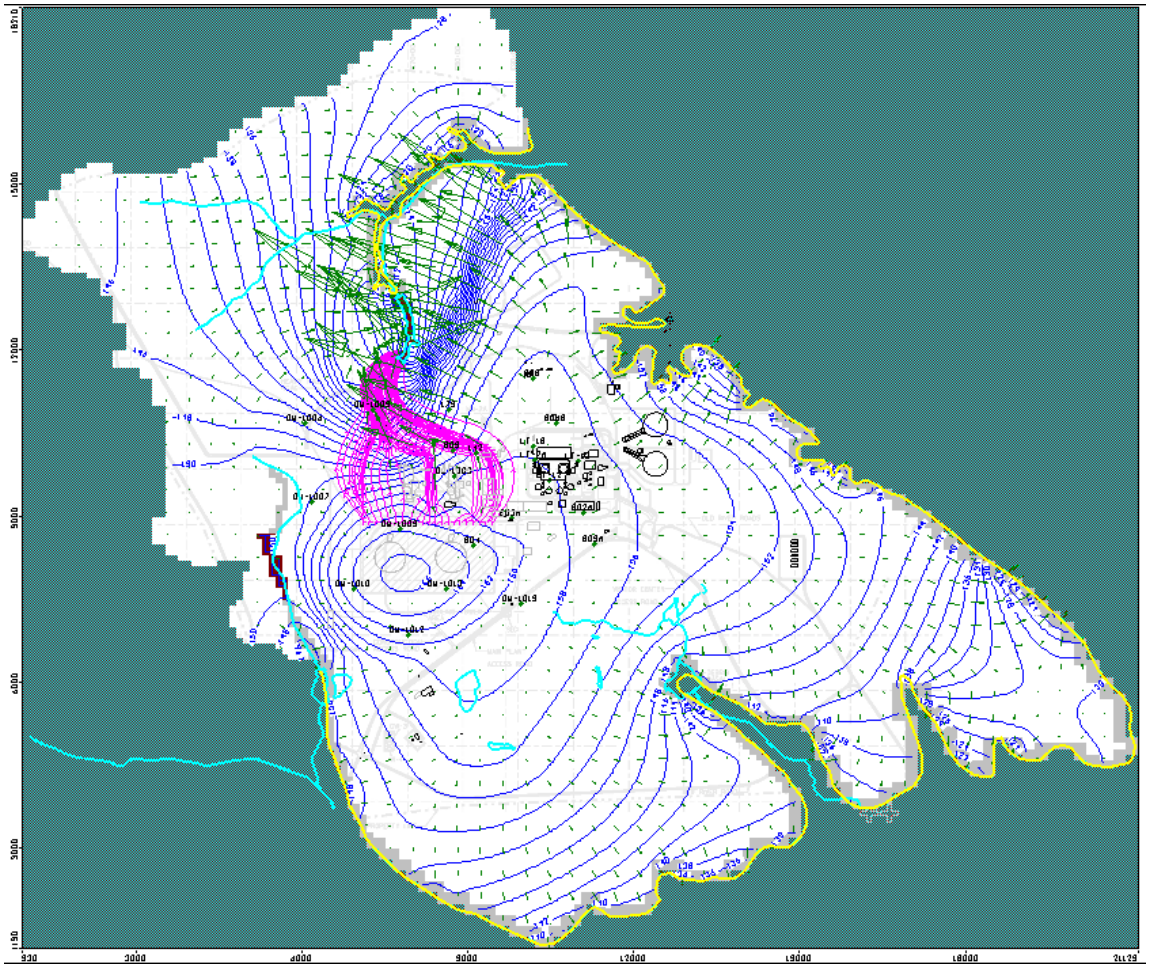
Post Construction: Hydraulic Head for Plausible/Plausible Recharge Case

Figure Source: Simulation 721pc Recharge: Plausible/Plausible (Power/Cooling)

Post-Construction Model Results

Applicant's analysis:
Max water table
Cooling Towers
166.1 ft MSL
Powerblock
162.6 ft MSL

Staff's confirmation:
Max water table
Cooling Towers
166.5 ft MSL
Powerblock
162.4 ft MSL



Assurance of Conservative Results

- Relevant pre-construction model of unconfined aquifer
  - Model (1) incorporated topography and aquifer base; (2) incorporated boundary conditions (especially drains); (3) incorporated distributions of hydraulic conductivity and recharge; (4) exhibits correspondence between measured and modeled parameters; and (5) achieves correspondence to measured hydraulic head.
  - NRC staff and SNC pre-construction models yield conservative (high) estimate of water table; therefore, post-construction results likely high (a conservatism).
- Evaluated post-construction groundwater levels
  - Applicant evaluated recharge rates at pre-construction Units 1&2 as applied to post-construction Units 3&4.
  - Staff analyzed a plausible recharge in powerblock area / plausible recharge in cooling tower area based on ⅛ and ¼ of the precipitation rate (48 in/yr) respectively, and no regions of zero recharge (a conservatism).
- Results of the analysis; post-construction water table predicted to be below 165 ft MSL.

Staff's analysis of potential groundwater impacts on the subsurface portion of safety-related SSCs

- Highest measured pre-construction water table elevation inside proposed powerblock is 157.24 ft MSL in May 2006 at OW-1003.
- Pre-construction groundwater model predicts a conservatively high water table; 162.9 ft MSL inside powerblock.
- Simulated post-construction water table inside powerblock.
  - Applicant – 162.6 ft MSL; used template of recharge rates similar to Units 1&2; structures 0 in/y, near buildings 4 in/yr, surrounding areas 14 in/yr.
  - Staff – 162.4 ft MSL; applied recharge rates w/o consideration for structures: cooling tower area 12 in/y, powerblock area 6 in/yr.
  - Both simulations suggest post-construction less than or equal to pre-construction levels.
- Therefore, the applicant's site characteristic for highest groundwater elevation of 165 ft MSL
  - Is supported by current observations and post-construction simulations.
- Furthermore, the lowest elevation of safety-related SSCs for the plant fitting within the bounding parameters in the proposed permit application is the bottom elevation of the containment building slab; 180.5 ft MSL.
- A maximum groundwater level of 165 ft MSL inside the powerblock would present no undue threat to any safety-related SSCs located there.

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