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Optimizing Hydrology Site Characterization in Support of New Reactor Licensing at the Nuclear Regulatory Commission

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Outline

- What does the NRC regulate?
- Location of Projected New Nuclear Power Reactors
- Hydrologic Safety Review
- Hydrologic Environmental Review
- Data Requirements for Hydrologic Review
- Modeling in Hydrologic Safety Reviews
- Uncertainties
- Minimizing Uncertainties

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The NRC Regulates:

- Nuclear reactors - commercial power reactors, research and test reactors, new reactor designs;
- Nuclear materials - nuclear reactor fuel, radioactive materials for medical, industrial and academic use;
- Nuclear waste – transportation, storage and disposal of nuclear material and waste, decommissioning of nuclear facilities; and
- Nuclear security – physical security of nuclear facilities and materials from sabotage or attacks.

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Location of Projected New Nuclear Power Reactors

(as of October 2009)

*Review Suspended

**Review Partially Suspended

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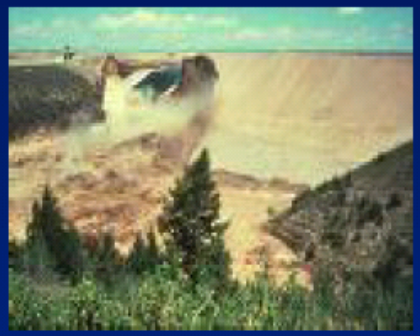
Safety Review Areas

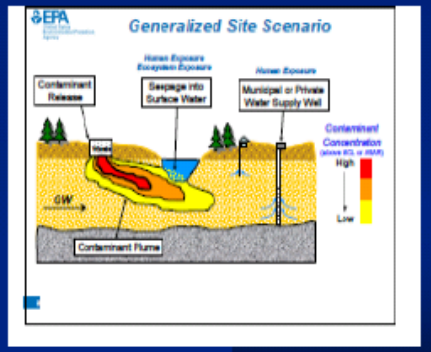










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Hydrologic Review Areas

- ✓ Review the applicant's Final Safety Analysis Report (FSAR) and then develop and publish the Safety Evaluation Report (SER)
- ➢ Hydrologic safety review focuses on the safe operation of the plant and suitability of the site under extreme hydrologic conditions
- ✓ Review the applicant's Environmental Report (ER) and then develop and publish the Environmental Impact Statement (EIS).
- ➢ Hydrologic environmental review addresses the impacts of constructing and operating the nuclear power plant on the environment.

Hydrologic Safety Review - continued

Hydrologic Issues and Review Procedures described in
Section 2.4 of the Standard Review Plan (SRP) (NUREG-0800):

- 2.4.1 Hydrologic Description
- 2.4.2 Floods
- 2.4.3 Probable Maximum Flood (PMF) on Streams and Rivers
- 2.4.4 Potential Dam Failures
- 2.4.5 Probable Maximum Surge and Seiche Flooding
- 2.4.6 Probable Maximum Tsunami Hazards
- 2.4.7 Ice Effects
- 2.4.8 Cooling Water Canals and Reservoirs
- 2.4.9 Channel Diversions
- 2.4.10 Flooding Protection Requirements
- 2.4.11 Low Water Considerations
- 2.4.12 Groundwater
- 2.4.13 Accidental Releases of Radioactive Liquid Effluents in Ground and Surface Waters
- 2.4.14 Technical Specifications and Emergency Operation Requirements

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Hydrologic Safety Review – Principal Outcomes

- ✓ Estimation of Design Basis Flood (DBF) that will be compared with the Design Control Document (DCD) to determine safety.
- ✓ Estimation of local intense precipitation to determine potential for site flooding and adequacy of drainage designs and systems.
- ✓ Determination of flooding protection requirements based on flooding analyses.
- ✓ Analysis of local and regional groundwater flow.
- ✓ Analysis of radionuclide transport and determination of compliance for Effluent Concentration Limits (ECLs) at a point of compliance for an unrestricted water source.
- ✓ Review of monitoring program for compliance with a regulation that governs minimization of contamination.

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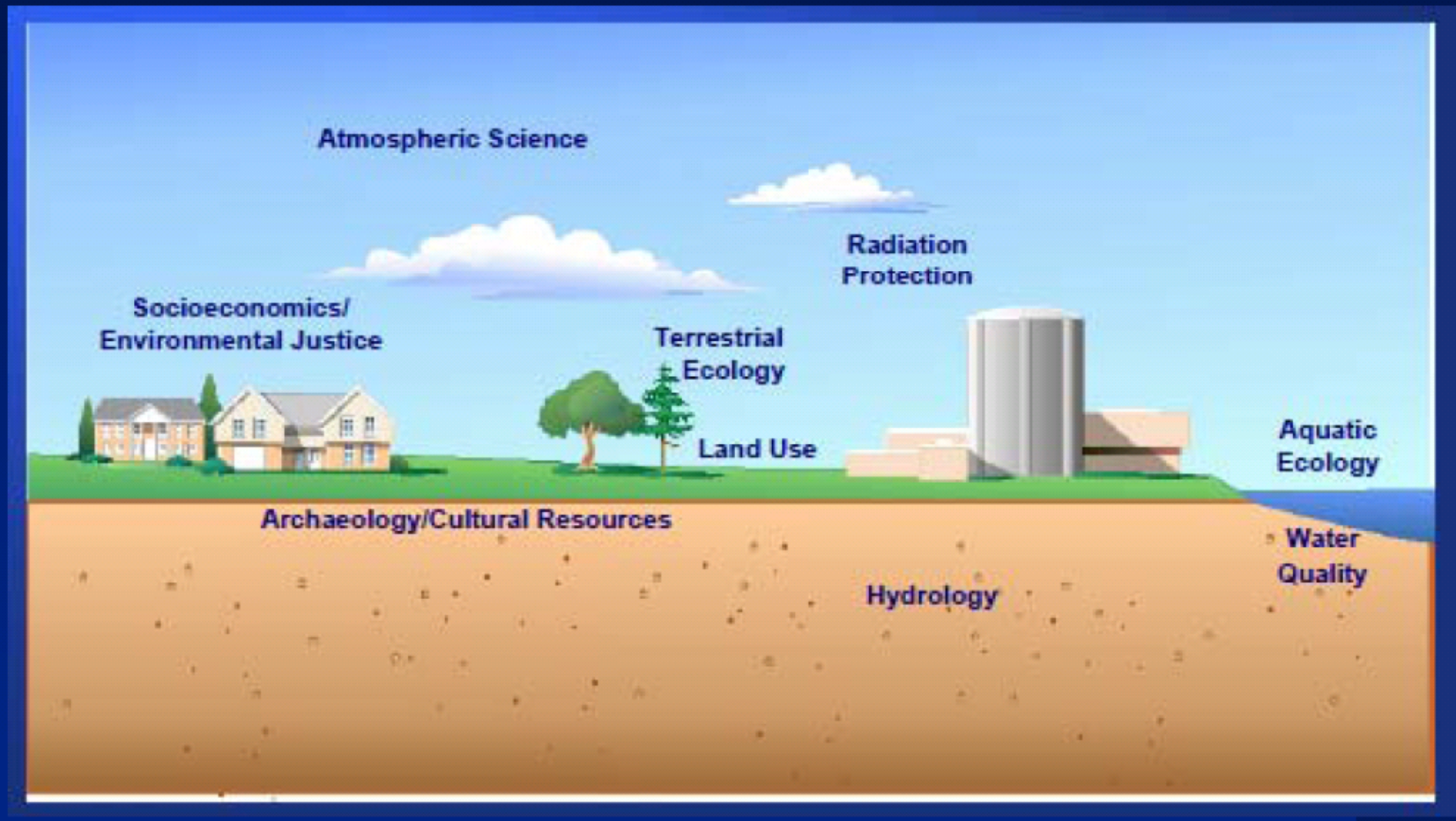
Environmental Review Areas



Hydrologic Environmental Review

Hydrologic issues and review procedures described in Environmental Standard Review Plan (ESRP) (NUREG-1555):

- 2.0 Environmental Description
  - 2.3 Water
- 3.0 Plant Description
  - 3.3 Plant Water Use
- 4.0 Environmental Impacts of Construction
  - 4.2 Water-Related Impacts
- 5.0 Environmental Impacts of Station Operation
  - 5.2 Water-Related Impacts
  - 5.3 Cooling System Impacts
- 6.0 Environmental Measurements and Monitoring Programs
  - 6.3 Hydrological Monitoring
- 9.0 Alternatives to the Proposed Action
  - 9.3 Site Selection Process

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Hydrologic Environmental Review – Major Outcomes

- ✓ Analysis of thermal, chemical and radionuclide pollutant discharges into water bodies and compliance with NPDES.
- ✓ Determination of environmental impacts on water and hydrology such as alterations (reservoirs, canals, etc), construction (buildings, roads, etc), withdrawal (surface water and groundwater pumping).
- ✓ Implementation of monitoring programs.
- ✓ Interface with aquatic and terrestrial ecology.
- ✓ Consideration of water related factors in analysis of alternatives (water is considered as a major criteria in the alternative site selection).

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Data Requirements for Hydrologic Review

- Hydrologic safety and environmental reviews require large amounts of data.
- QA level 1 water quantity and quality data.
- Quantitative and qualitative data.
- Data sources include:
  - Applicant and other reliable sources such as USGS, NWS, NOAA, USACE, EPA
- Data types include:
  - Spatially-referenced data for watersheds
  - Temporal data for river flow and groundwater
  - Derived data from estimates
  - Model input for example watershed runoff, groundwater flow, thermal plume

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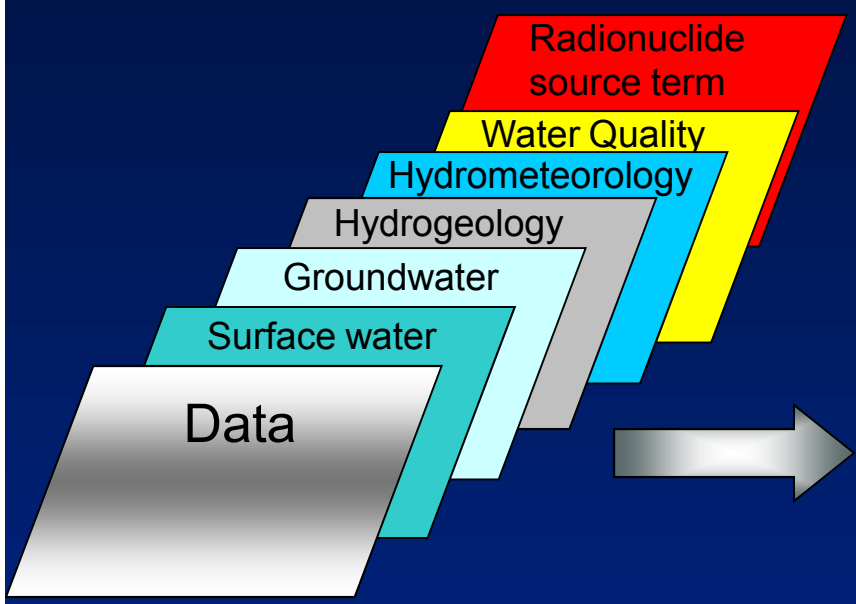
Optimizing Data and Processes



Conceptual Site Model (CSM)

Confirmatory Site Audits

Bounding Analyses

Hierarchical Approach

Design Basis Flood (CSM)

Groundwater level and pathways

Precipitation depth and local drainage

Radionuclide effluent concentration

Environmental impact on hydrology

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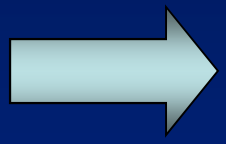
Example: Optimization of Information for Radionuclide Transport Analysis

- Physiographic information
- Features, Events and Processes
- Geophysical Surveys
- Local and site specific hydrogeology and sources
- Water level measurements
- Post-construction modeled water level
- Source term characterization
- Conceptual Site Model



- Rock types and properties
- Description of major aquifer types
- Hydrogeologic information
- Hydrogeology and local aquifers
- Drainages and divides
- Well logs and characterization
- Cross-sections
- Aquifer properties n, n_e, K
- Hydraulic gradient
- Groundwater flow velocity
- Pathways for transport analysis

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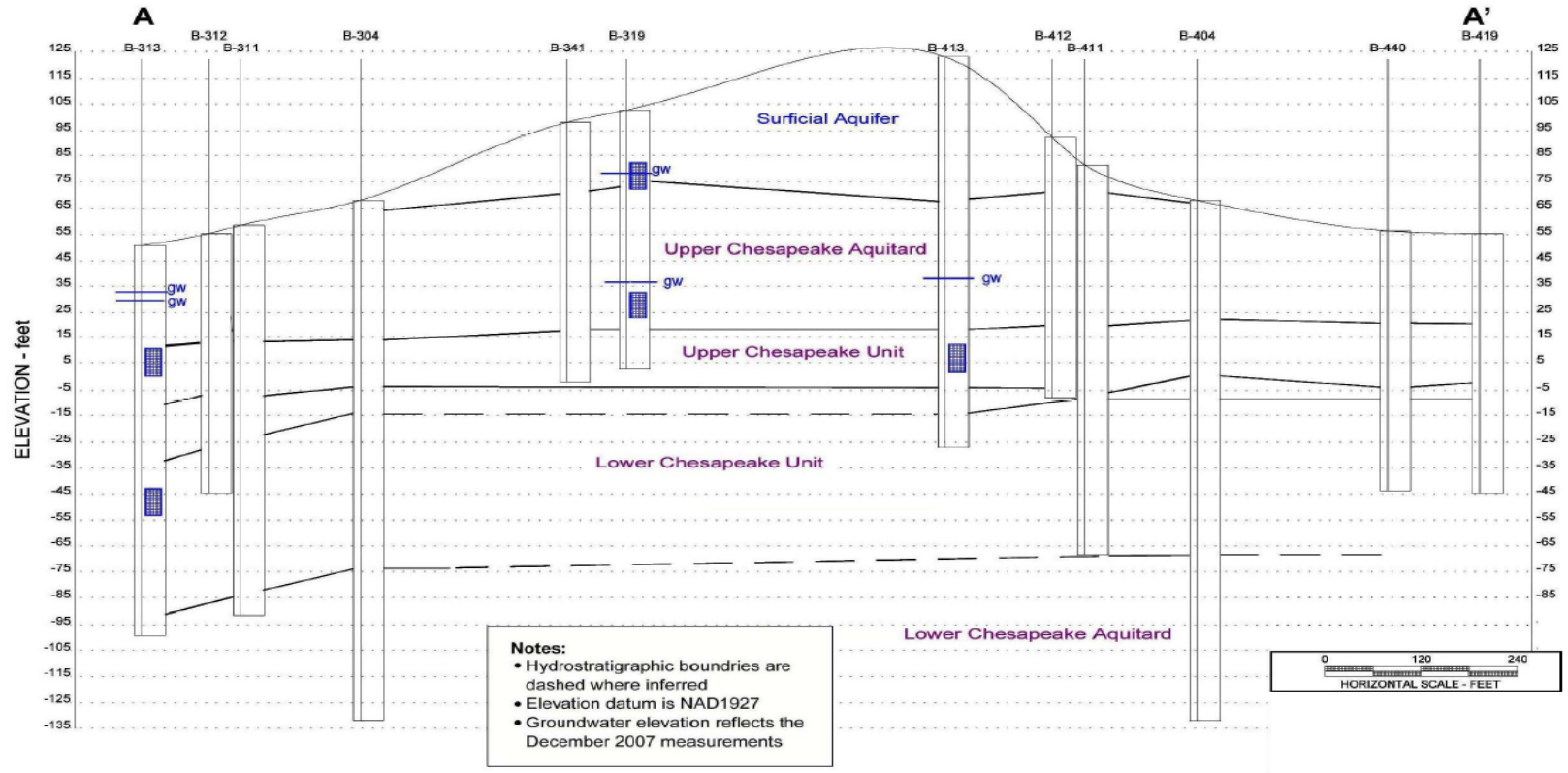
Cross Section Data for Groundwater Analysis



Cross-Section A-A' Through Proposed Unit 3 Power Block Area

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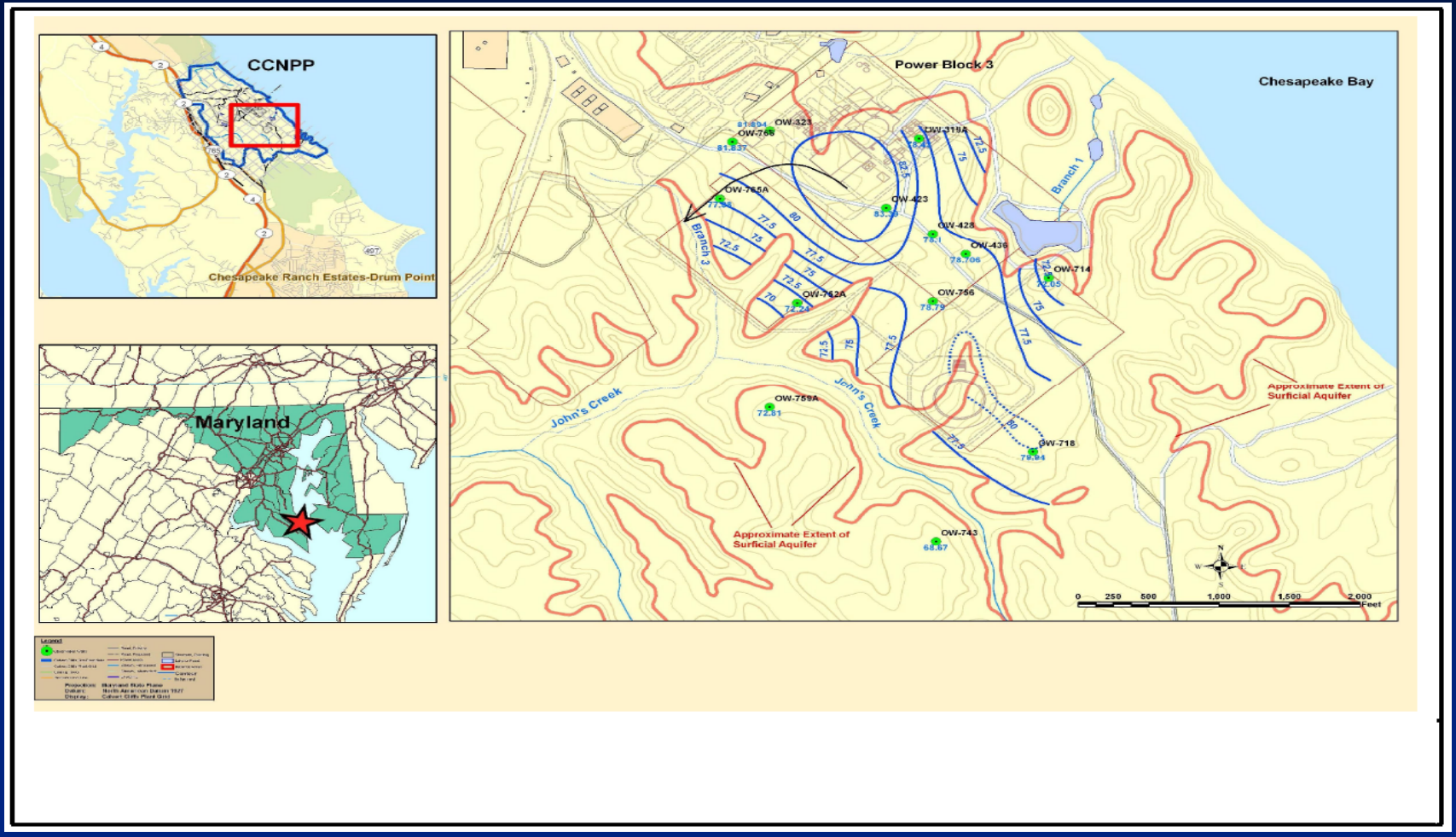
Pre-construction Groundwater Map



Water Table Elevation Map and Groundwater Flow Direction for the Surficial Aquifer, July 2006

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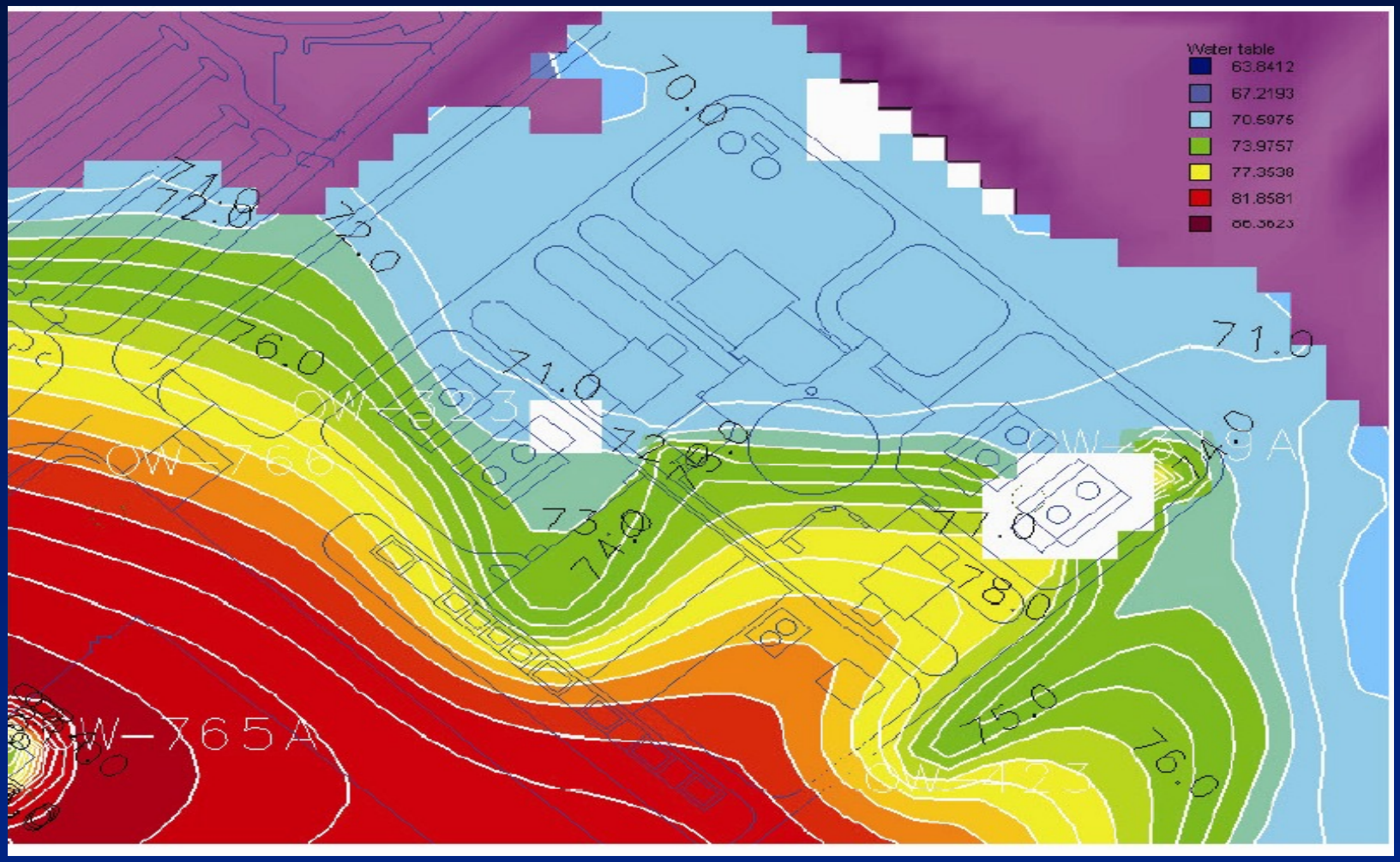
Post-Construction Modeled Groundwater Level



Modeled Post-Construction Elevation of the Surficial Aquifer Water Table Around Power Block 3

- Contours in feet
- Water table is below the base of surficial aquifer in cells colored white

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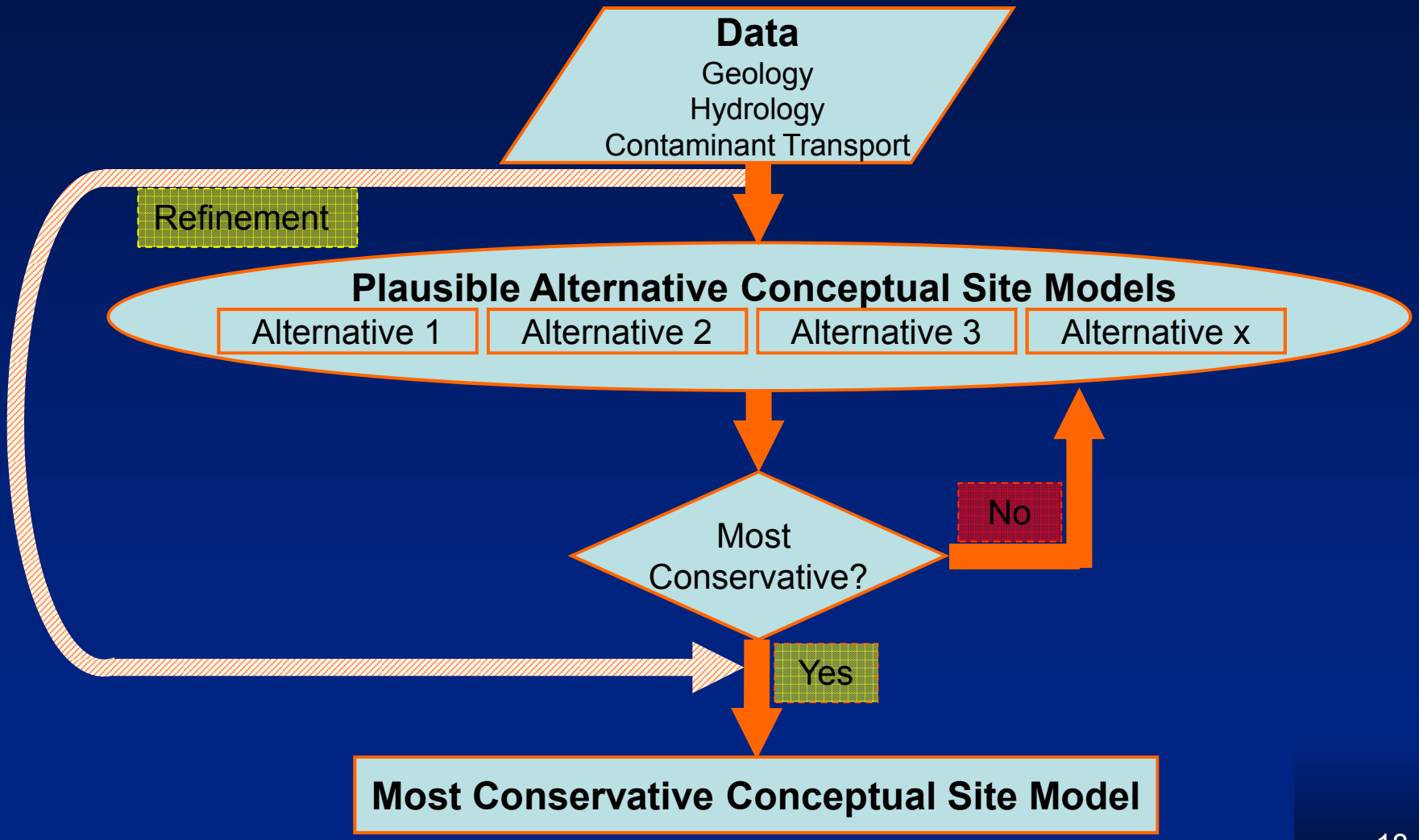
Conservative Conceptual Site Model for Radionuclide Transport Analysis



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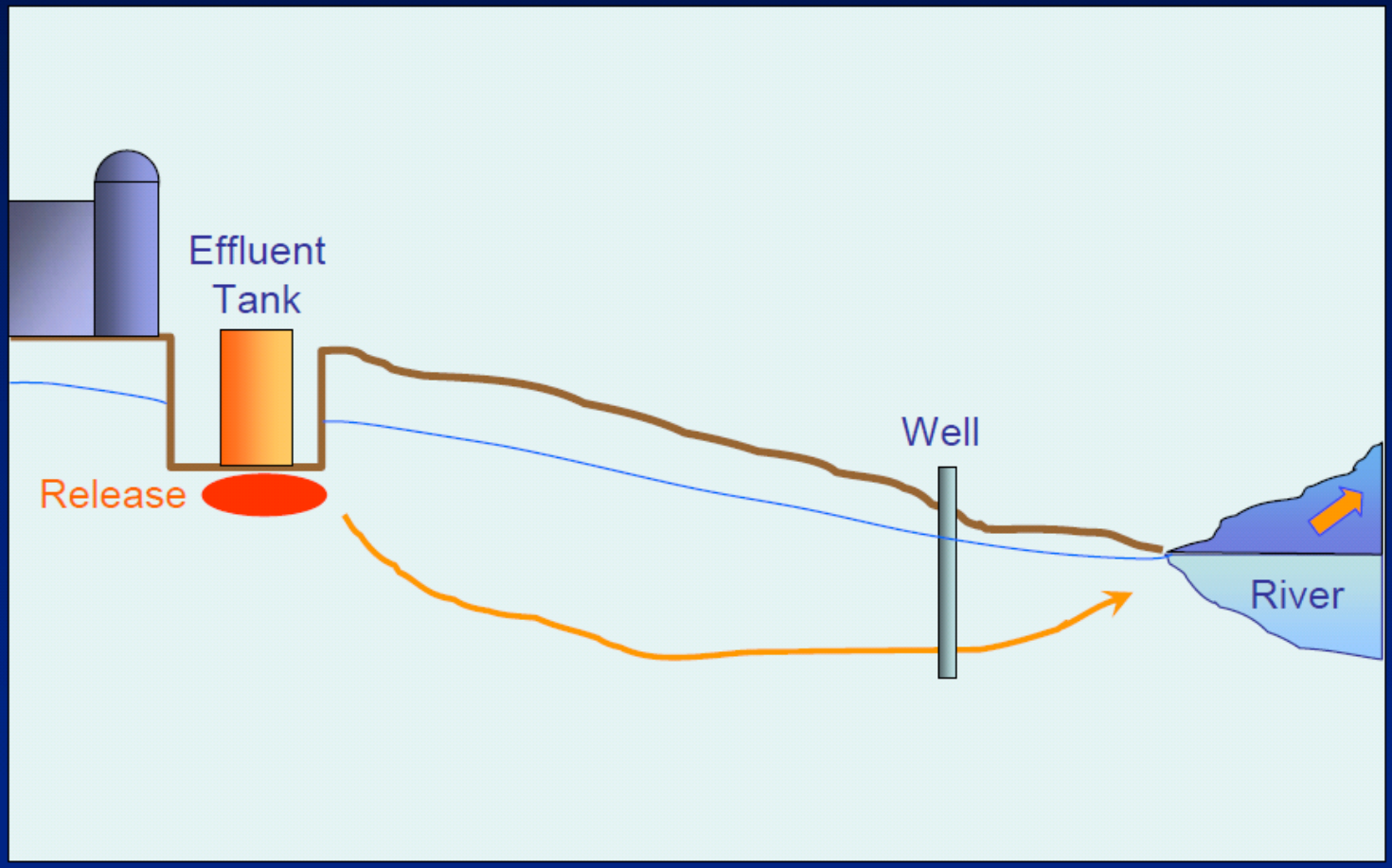
Accidental Release Scenario



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Uncertainties in Conceptual Models, Parameters & Scenarios

- Data: data gathered from different sources and at different times and scales.
- Methods: methods employed in data gathering and processing could vary. Also methods employed in analyzing a specific hydrologic process may have alternate approaches
- Models: models developed to represent specific hydrologic features, events and processes have inherent uncertainties
- Scenarios: formulated future states of the environment and human activities

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Minimizing Uncertainties

- Data Uncertainties
  - QA-QC procedures for measured and derived data.
  - Site visits
  - Data integrity tests

- Method and Model Uncertainties
  - Systematic process of review involving a series of Requests for Additional Information for risk-significant inputs and outcomes.
  - Confirmatory analyses
  - Hierarchical analyses
  - Alternate conceptual models
  - Analyzing scenarios that require considering pre- and post-construction conditions.