Death Valley Regional Groundwater Flow System

Presented to:
U.S. Nuclear Waste Technical Review Board Panel on the Natural System

Presented by:
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Water Resources Discipline

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Team Project

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- Joan Blainey (AZ)
- Claudia Faunt (CA)
- Mary Hill (NRP)
- Randy Laczniak (NV)
- Carma San Juan (YMP)
- Don Sweetkind (GD)

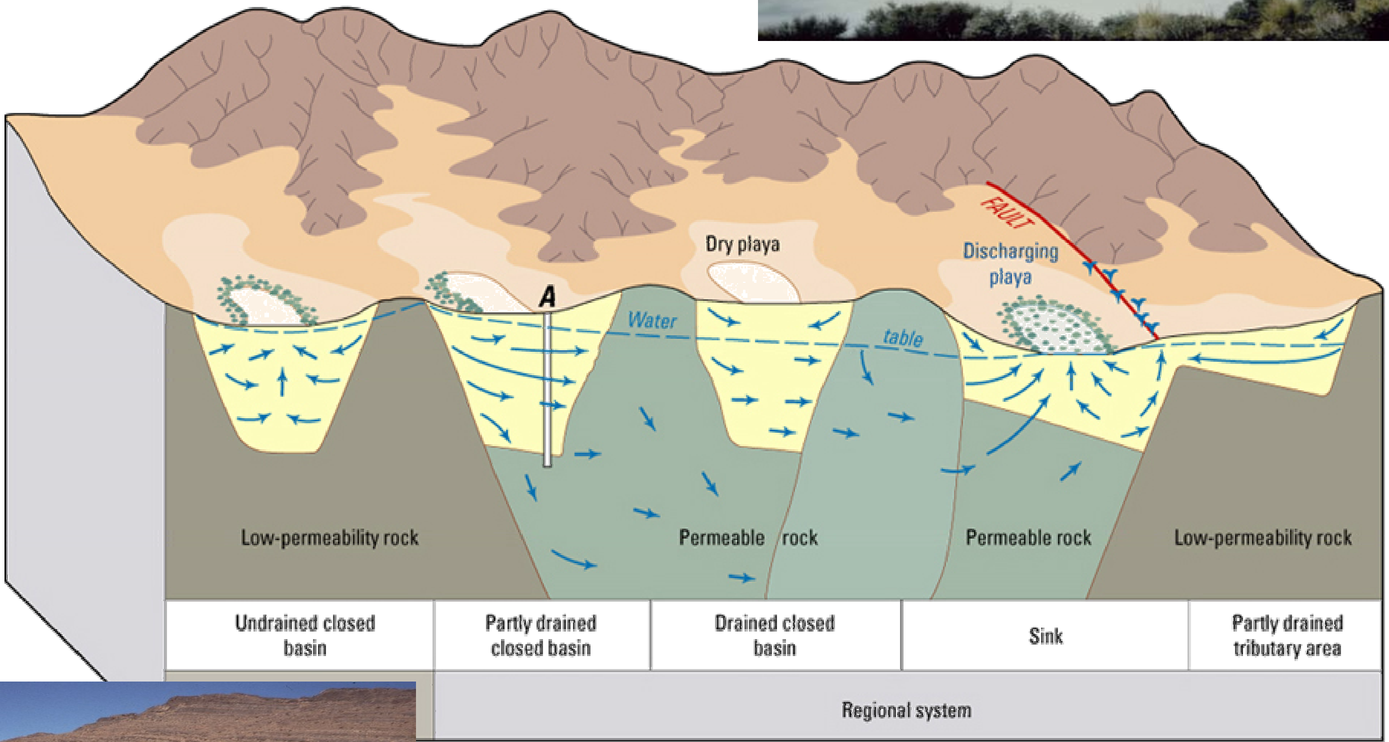
Topics of Discussion

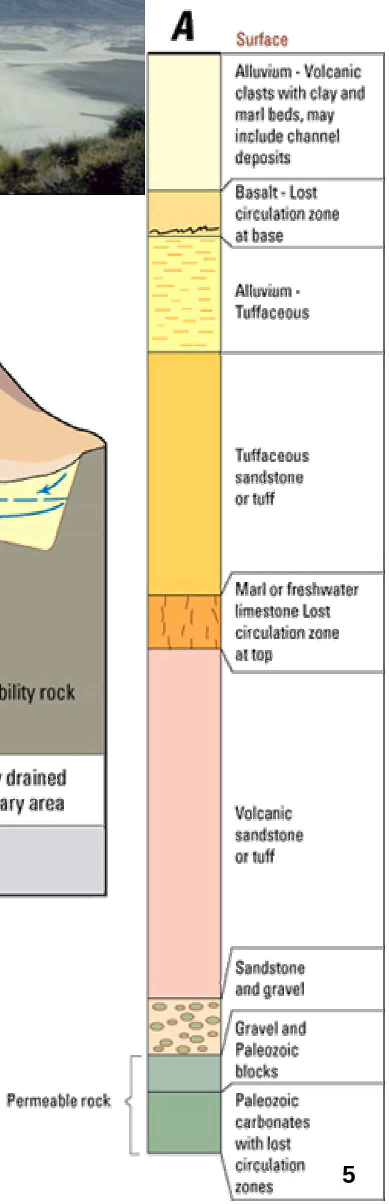
- Overview and conceptual model
- Geologic emphasis
- Tasks
- Groundwater flow model description
- Fluxes to site-scale Yucca Mountain Project (YMP) model
- Report outline, knowledge exchange, and potential future work
- Questions and discussion

Death Valley Regional Flow Model Area

- Large area with complex geology
- Potential high-level nuclear waste repository, Yucca Mountain, Nevada
- Groundwater flow paths from Nevada Test Site
- Update of previous modeling efforts
- Constructed using MODFLOW-2000
- Time period 1913-1998

Conceptual Model(s) of Groundwater Flow System





Geology is Half the Equation

KA = Q/(dh/dl)

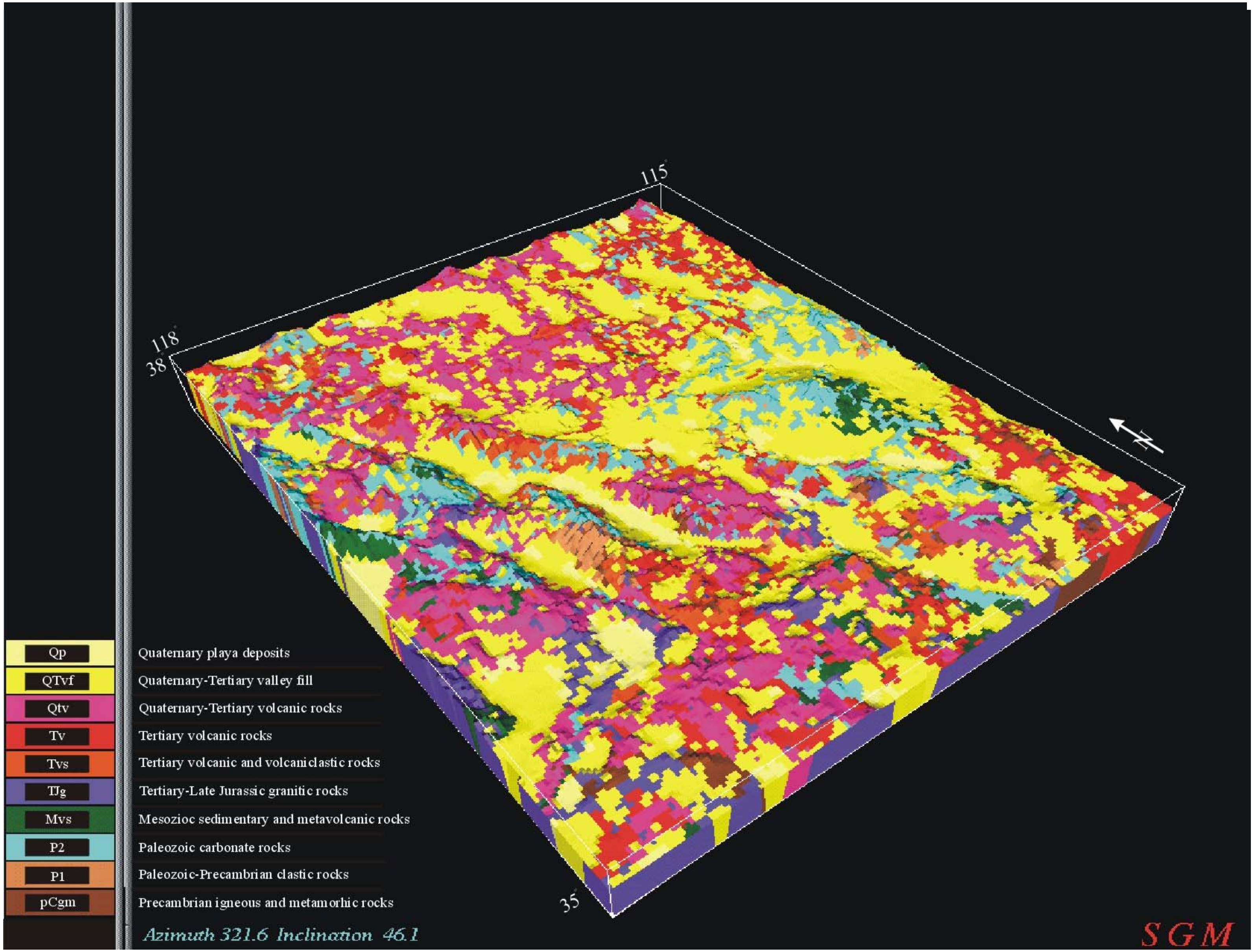
- **Framework**
  - Unit geometry/truncation
  - Location of high K zones
  - Groundwater barriers
  - Heterogeneity/anisotropy
  - Actually doesn't provide K

Q/(dh/dl) = KA

- **Hydrology**
  - Model observations (hydraulic heads and discharge rates)
  - Weighting/error factors for calibration
  - Constrains K

Comprehensive Geologic Interpretation in Support of the Regional Flow Model

- Synthesis of geologic maps
- Interpretation of regional tectonics
- Regional geologic cross-sections
- Geophysical interpretations
- Stratigraphic analysis of tertiary basins
- Hydrologic significance of structural and stratigraphic elements



Preliminary

Does Complex Geology Demand a Complex Flow Model?

- **Ultimately depends on flow model**
  - **Availability of hydrologic data**
  - **Justified level of geologic detail**
- **Need to understand regional framework**
  - **Cross-section interpretations**
  - **Representation of structural zones**
- **Complexity is required in Death Valley region**
  - **Scale of geologic features**
  - **Previous modeling experience**

Tasks

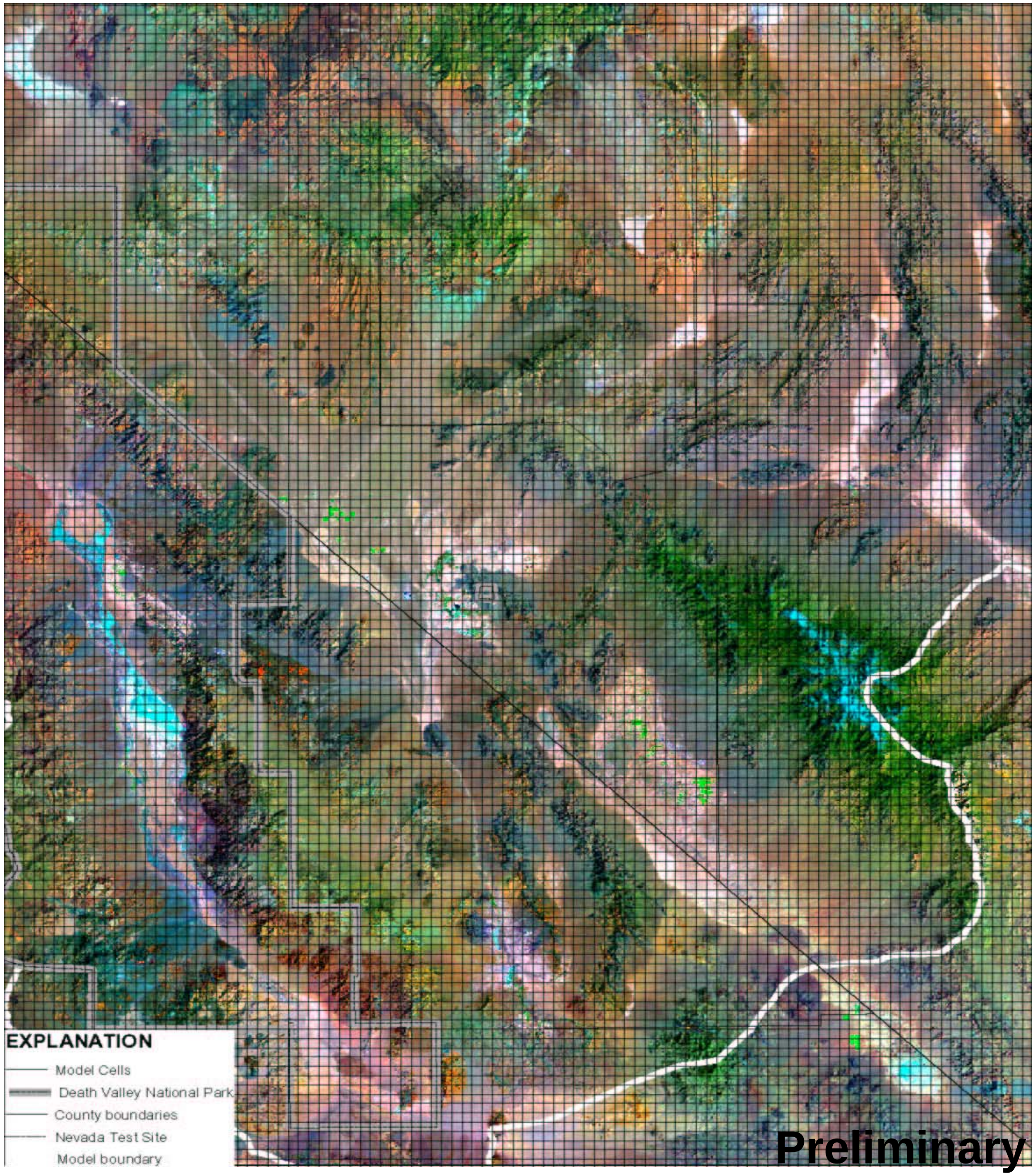
1. **Complete transient model and report**
   - **Status reports (various dates)**
   - **Report to review (September 30, 2003)**
   - **Report completed (September 30, 2004)**
2. **Model enhancements (various deliverables)**
   - **Additions to MODFLOW (HUF, depth decay)**
   - **Model consistency**
   - **Predictive capability**
   - **Decision analysis**

Report Outline

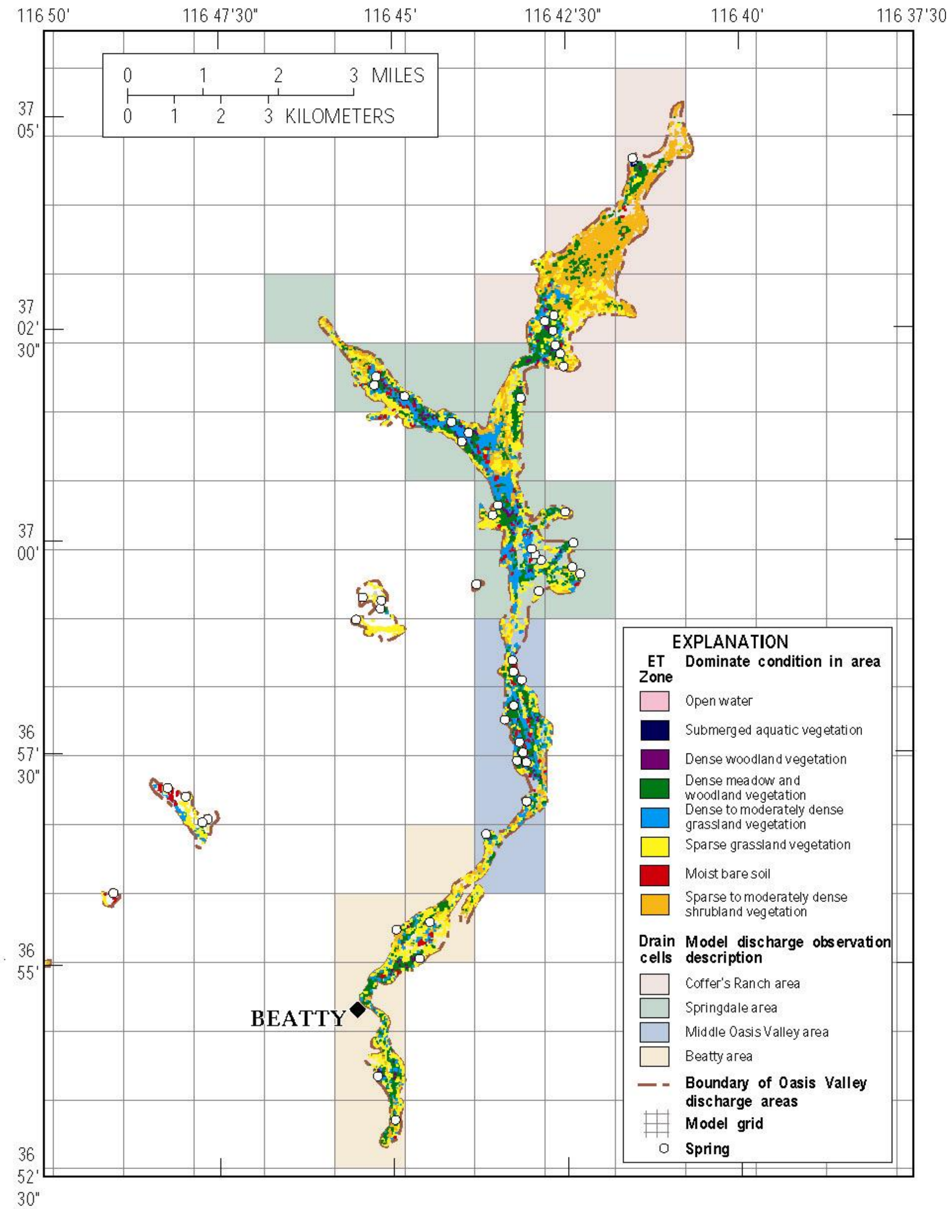
- **Edited by Belcher**
- **Part A: Introduction (Belcher)**
- **Part B: Conceptual model of the regional geology and hydrogeology (by Sweetkind, Faunt, and Belcher)**
- **Part C: Conceptual model of the regional hydrology (by Faunt, D'Agnese, and O'Brien)**
- **Part D: Hydrogeologic evaluations (by San Juan)**
- **Part E: Hydrogeologic framework model (by Faunt, Sweetkind, and Belcher)**
- **Part F: Numerical model of groundwater flow (by Faunt, Hill, Blainey, O'Brien, and D'Agnese)**
- **Appendices: Databases and data sources (Bedinger and Harrill)**

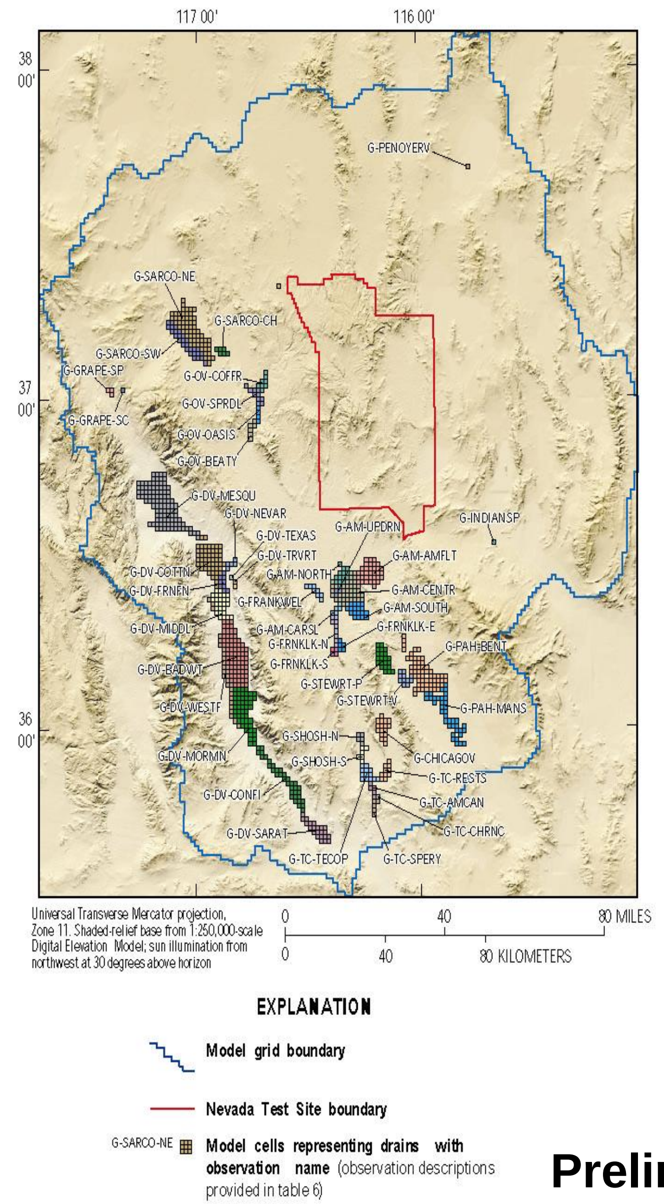
Model Discretization

- 1500 m grid cell spacing
  - 194 rows
  - 160 columns
- 16 layers (top layer > 50 m thick and is convertible), remaining layers follow water table at uniform thickness per layer and get thicker with depth
- Discharge represented by drains
- Recharge based on infiltration model
- Transient simulation (1913-1998)
- First stress period is steady state and replaces 2002 model



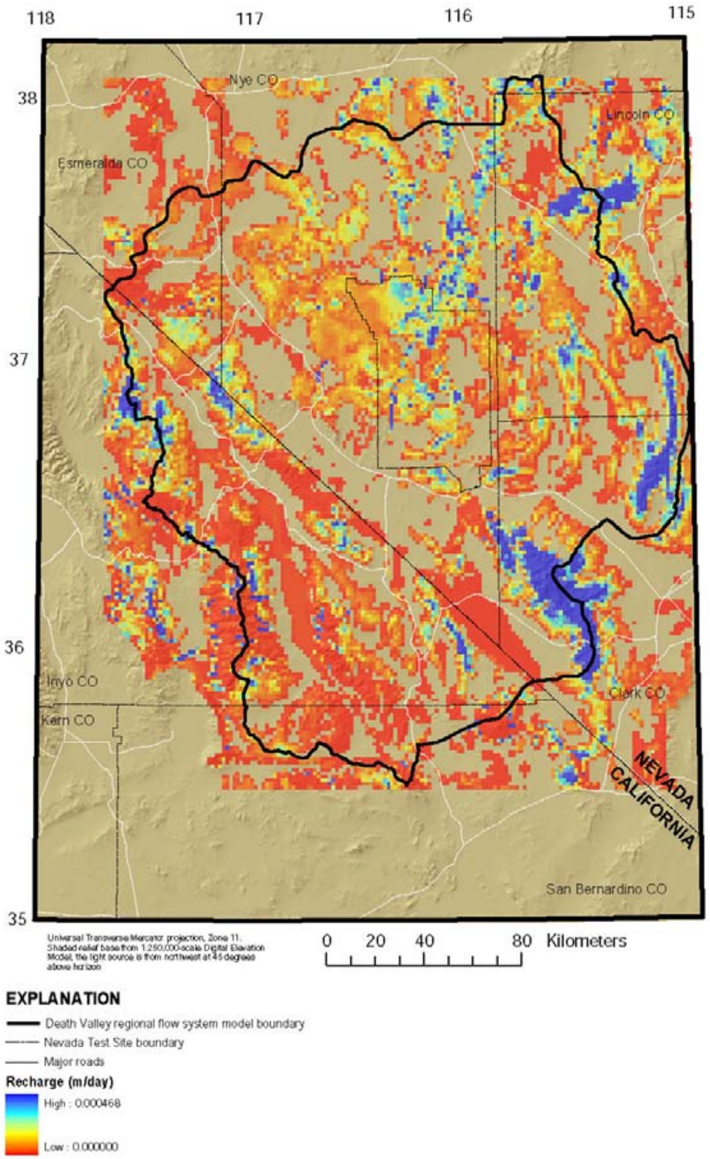
Discharge Represented by Drains

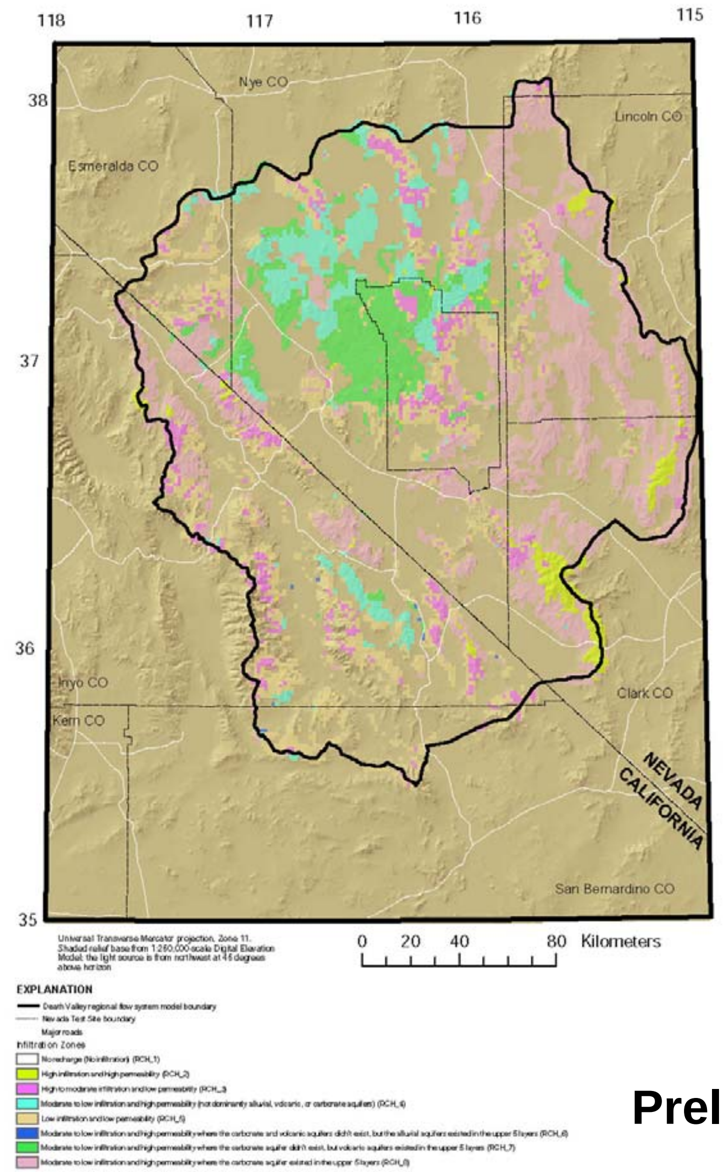




Preliminary

Recharge Based on Infiltration





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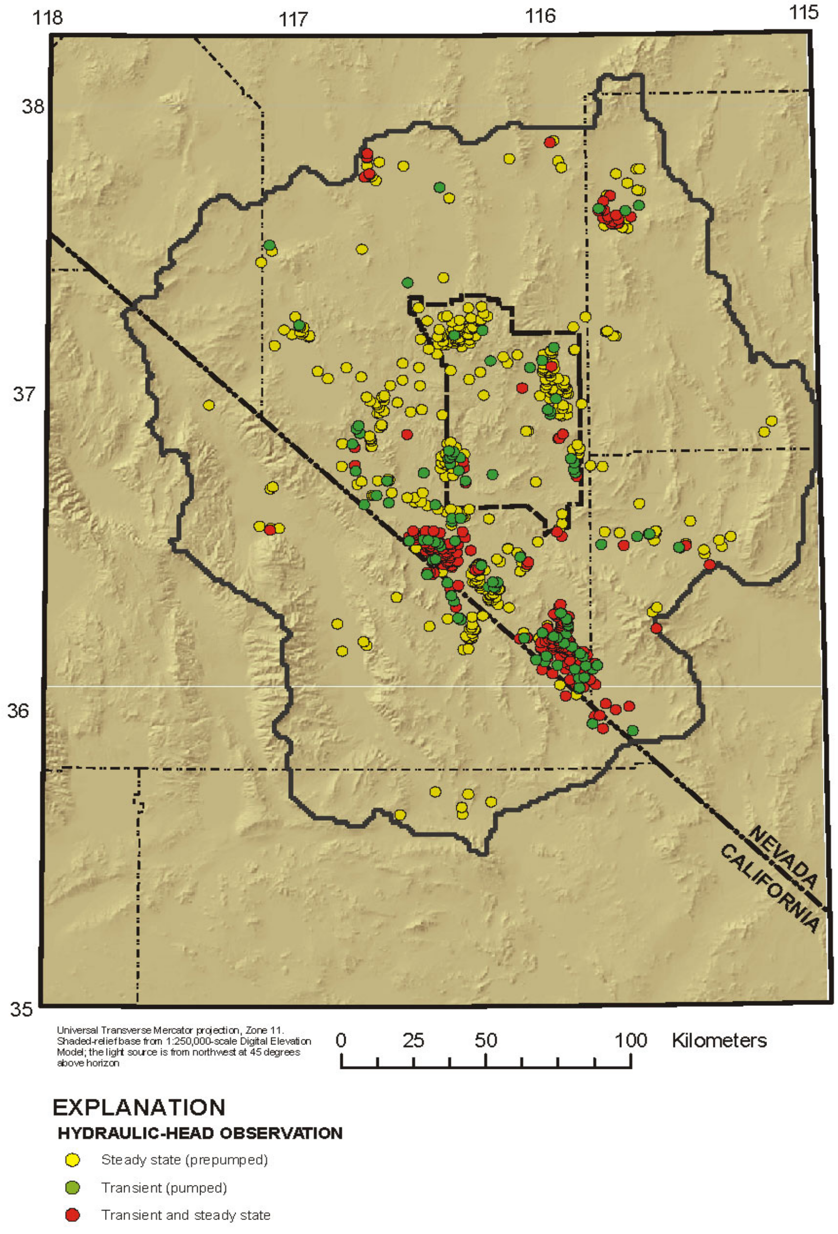
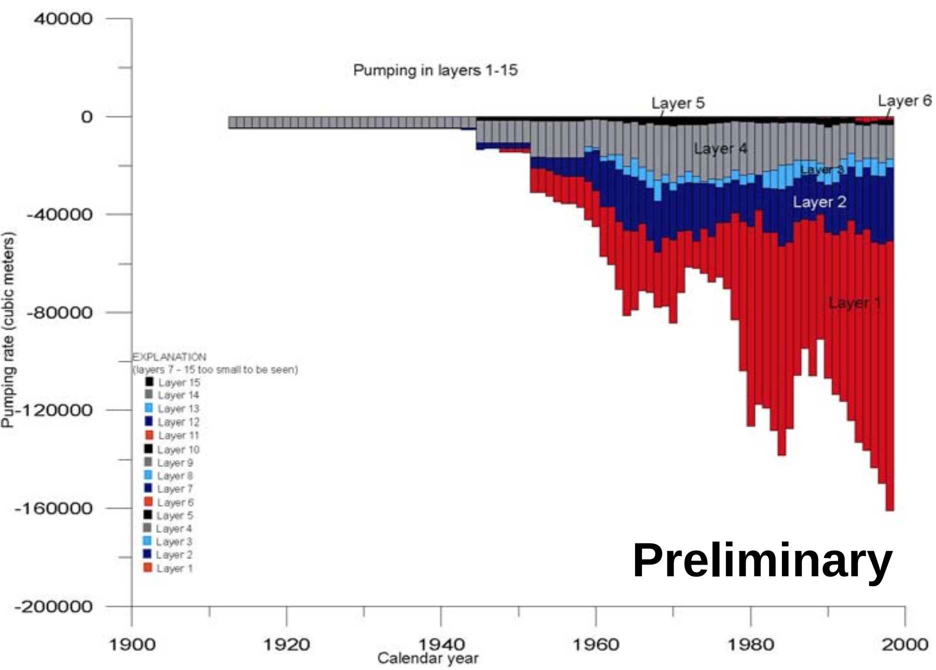
Hydraulic Head Observations

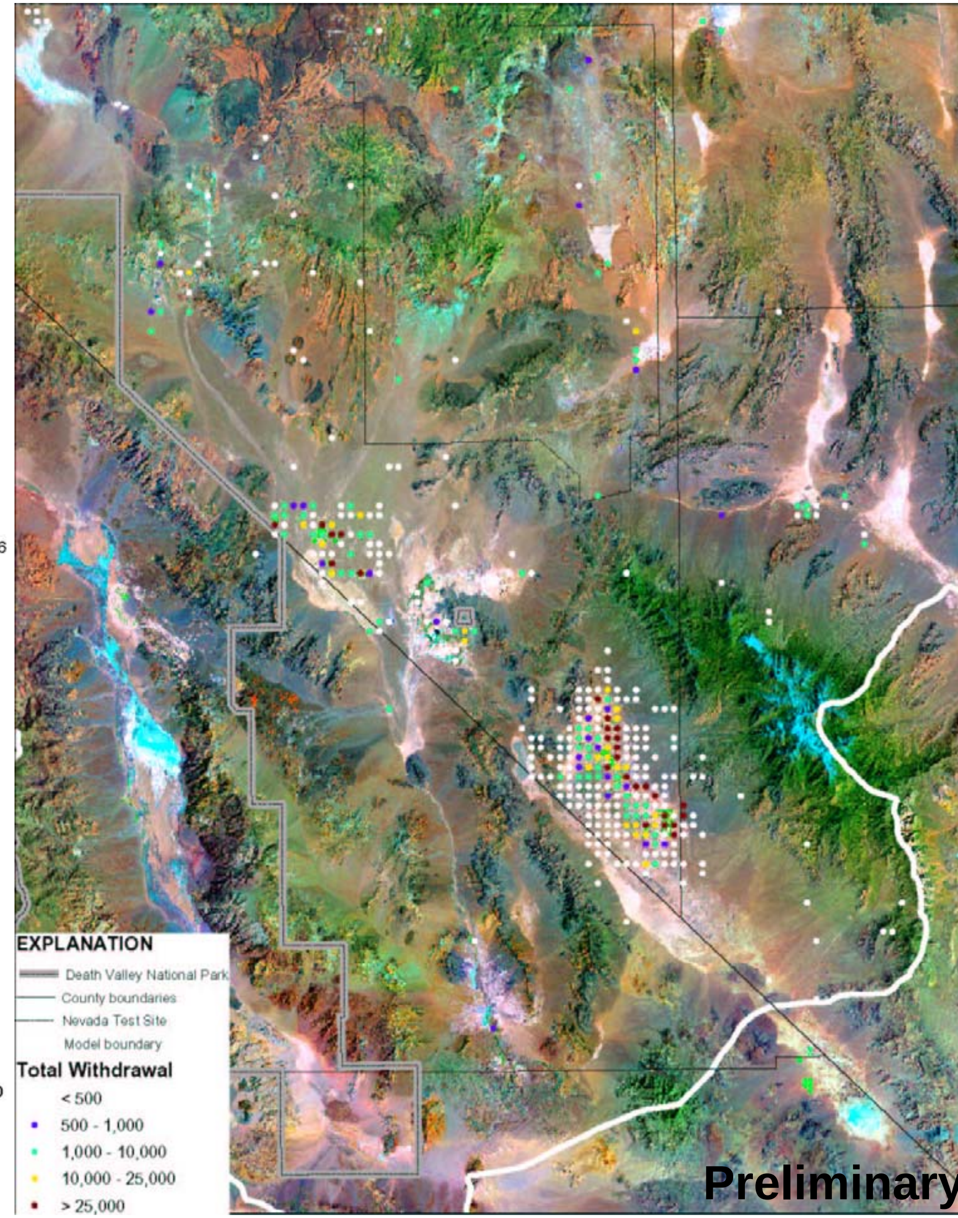


Preliminary

Transient Simulation: Pumping

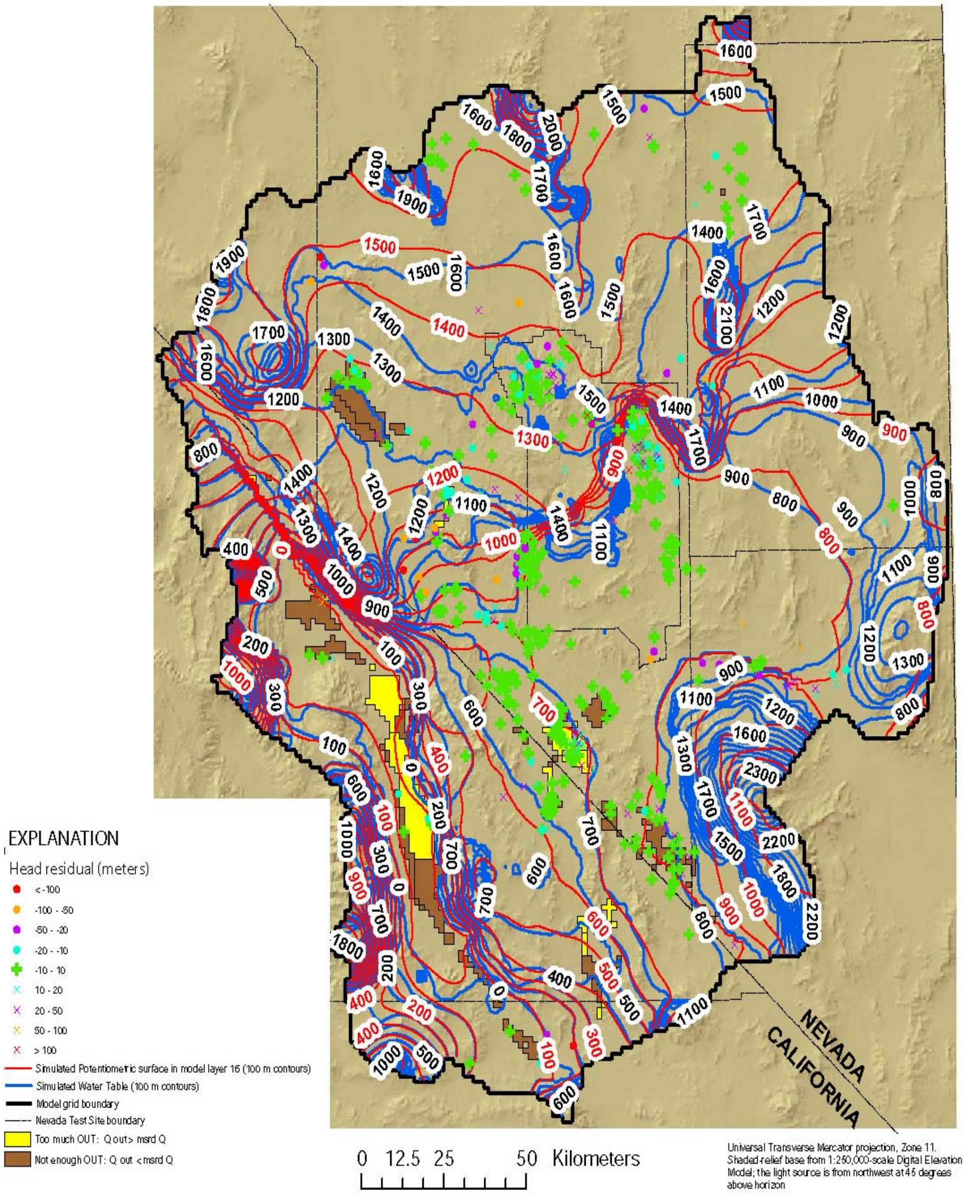
- **Distribution of simulated wells**
  - **One well combined pumpage per cell**





Residuals and Simulat

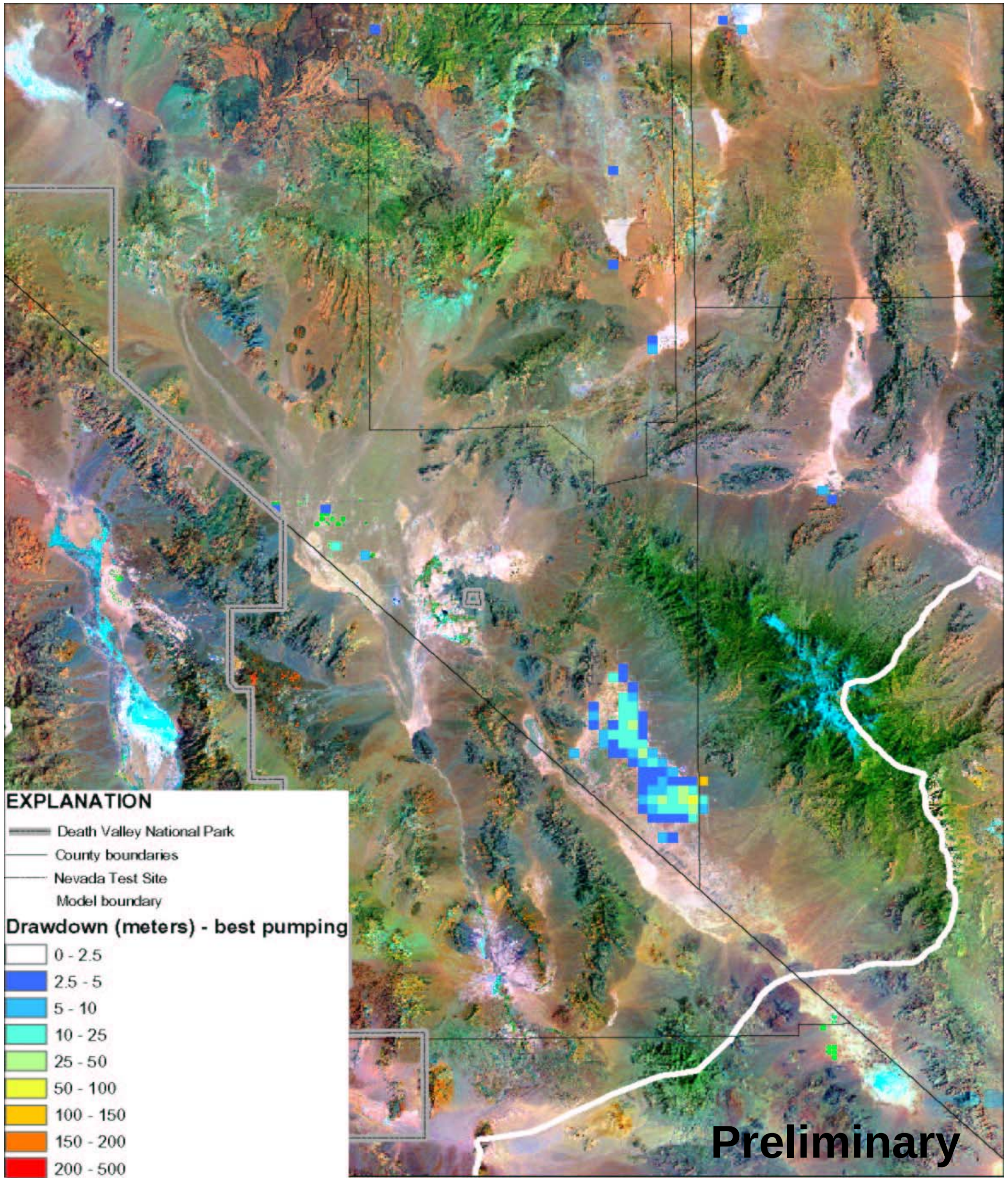
- **Validation**
  - Match discharge (ET and spring flow) rates and heads
  - Qualitative look at hydrochemist
  - Calibrated using parameter estimation
- **Comparison to 2002**
  - Better match to flows
  - More head observations
  - Quantified boundary conditions
  - Transient with convertible upper layer



Preliminary

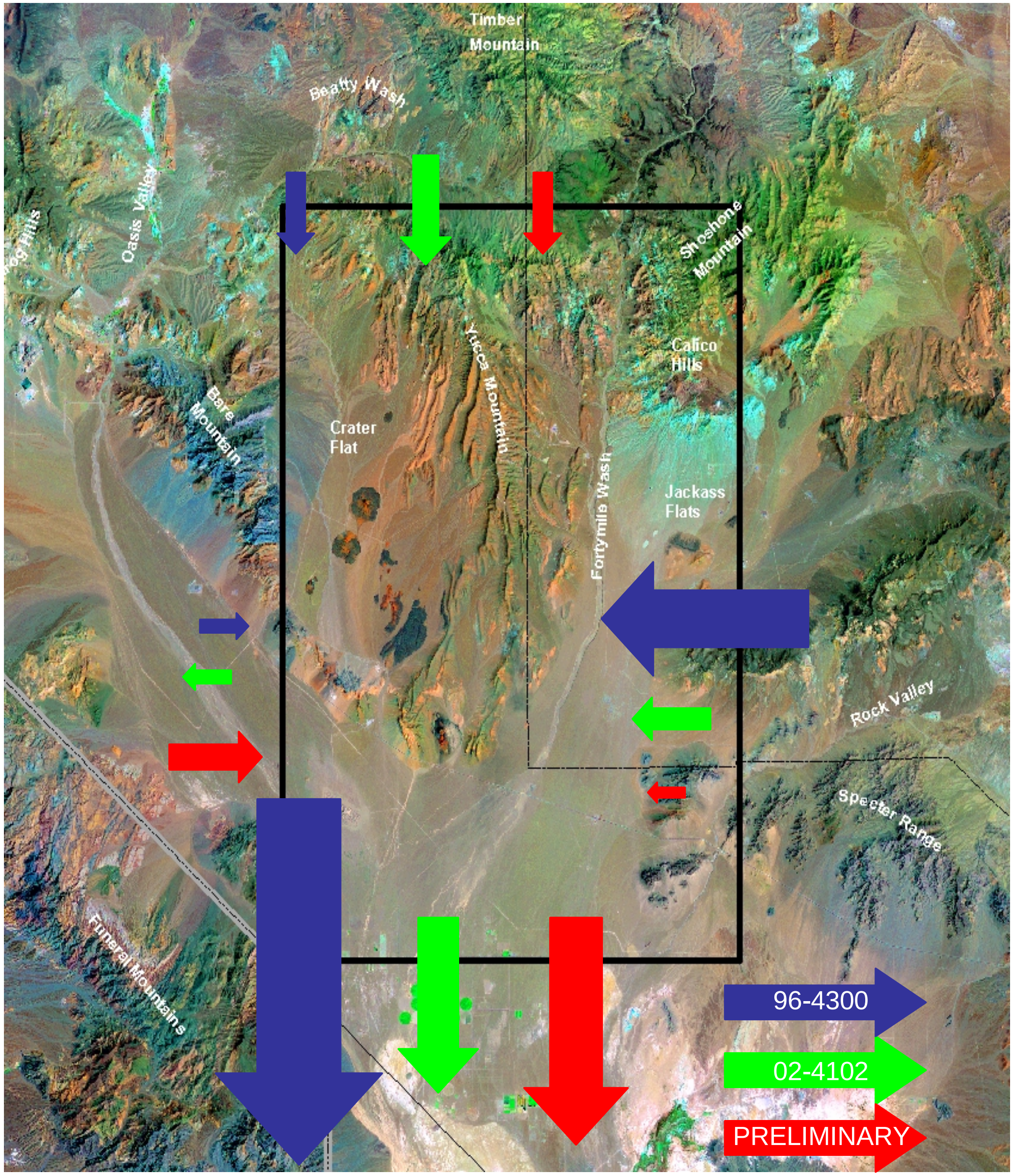
Comments

- Regional model
  - Good for answering regional questions
    - Examples:
      - Boundary conditions for site-scale models
      - Decrease in spring discharge based on pumping in region
      - Change in water levels based on pumping over time
      - Climate change
  - Need more site-specific scale model to address more detailed concerns



Fluxes to Site-Scale Yucca Mountain Project Model

	WRI 96-4300	WRI 02-4102	PRELIMINARY
NORTH	-200	-271	-196
EAST	-561	-209	-96
SOUTH	918	430	562
WEST	-119	125	-246



Knowledge Exchange
(Promised more than a model)

- Deliverable 2003: Model input and output (ASCII files, MODFLOW 2000 format)
- Proposed deliverable 2004: Integrated Knowledge System
- Transform model input and output - world coordinates, Geographic Information Systems (GIS) format
- Databases (GIS, Hydrogeologic Framework Model (HFM), Access)
- Basic analysis and visualization tools
- Proposed tasks 2004:
  - Transfer and integrate supporting databases
  - GIS - hydrology (recharge, discharge - ET, springs, wells), HFM, well, topography, imagery, geology, geophysics, base maps
  - HFM - hydrogeologic data (2-D and 3-D)
  - Access - "model-ready" head and flow data
  - Transfer and integrate analysis and visualization tools
  - Custom tools developed by U.S. Geological Survey (USGS) (ArcGIS-based)
  - 3-D model
  - Data loaded in commercial software

The Future – FY05 and On

- Use local grid refinement to facilitate coordination between regional, Yucca Mountain site, and CAU models
- Use new methods to rank the importance of potential new observations, including long-term monitoring
- Use new methods to rank the importance of new HFM data
- Evaluate the effect of HFM uncertainty on predictions