Water Resources of the Basin and Range Carbonate Aquifer System in White Pine County Nevada, and adjacent areas in Nevada and Utah

Alan Welch, ahwelch@usgs.gov

BARCAS Study

or

BARCASS

Joint White Pine and Millard County Commission Meeting, Baker, Nevada

May 23, 2006

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Overview

- Legislative authorities
- BARCASS study approach
- BARCASS products
- Future program vision

BARCASS

- Present study mandated by Lincoln County Conservation, Recreation, and Development Act of 2004 (short title) PL108-424
- Funding of $6 million provided by amendments to SNPLMA within Act
- Draft Report for Public Comment– June 1, 2007
- Final Report – December 1, 2007

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BARCASS is not:

- An Environmental Impact Study.

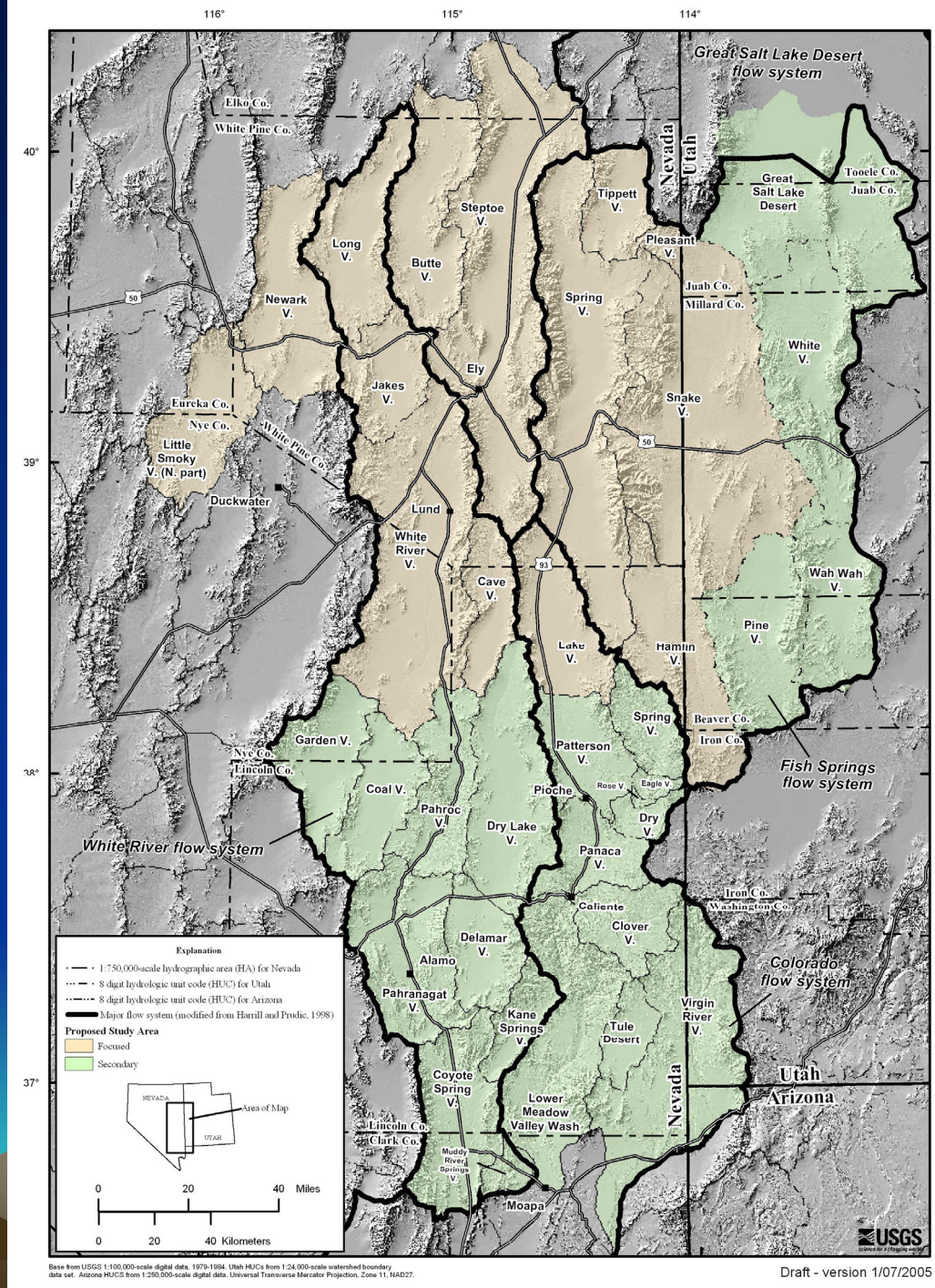
BARCASS will not:

- Produce a calibrated transient ground-water flow model.
- Directly address ground-water development or water resource sustainability issues.

Lincoln County Land Act

- "(1) IN GENERAL – The Secretary, acting through the United States Geological Survey, the Desert Research Institute, and a designee from the State of Utah shall conduct a study to investigate ground water quantity, quality, and flow characteristics in the deep carbonate and alluvial aquifers of White Pine County, Nevada, and any groundwater basins that are located in White Pine County, Nevada, or Lincoln County, Nevada, and adjacent areas in Utah".

BARCASS Study Area



Base from USGS 1:100,000-scale digital data, 1979-1984. Utah HUCs from 1:24,000-scale watershed boundary data set. Arizona HUCS from 1:250,000-scale digital data. Universal Transverse Mercator Projection, Zone 11, NAD27.

Draft - version 1/07/2005

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Lincoln County Land Act

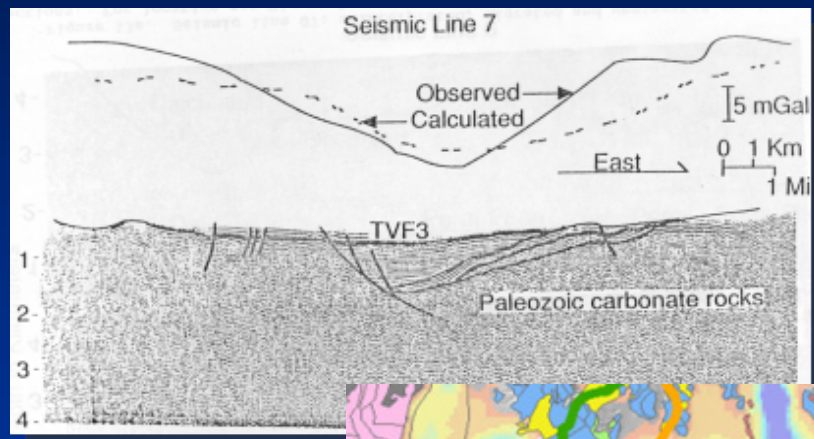
- "The study shall–
  (A) focus on a review of existing data and may include new data;
  (B) determine the approximate volume of water stored in the aquifers in those areas;
  (C) determine the discharge and recharge characteristics of each aquifer system;
  (D) determine the hydrogeologic and other controls that govern the discharge and recharge of each aquifer system; and
  (E) develop maps at consistent scale depicting aquifer systems and the recharge and discharge areas of such systems."

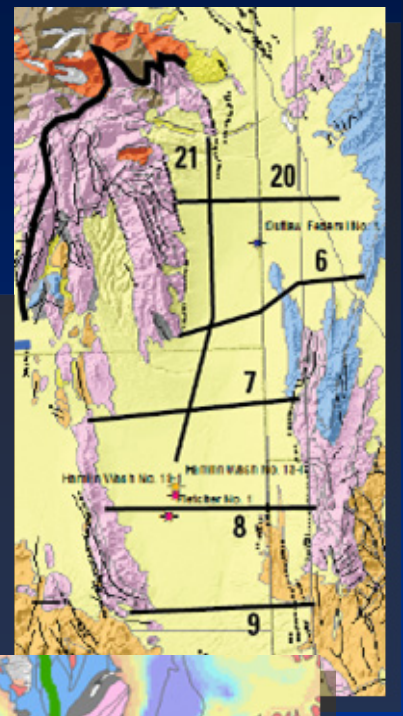
BARCASS work packages

- Geology/Geohydrology
- Recharge/Discharge
- Ground-Water Flow
- Geochemistry
- Data Integration
- Synthesis and Evaluation (Report Production)

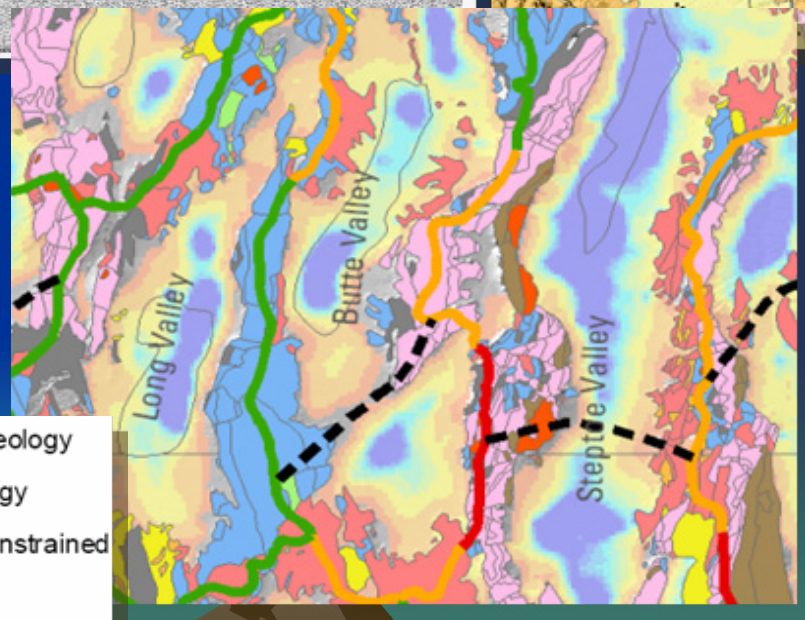
Geology/Hydrogeology

Geologic framework configuration at important interbasin areas





Overall conceptualization of geologic framework as it relates to flow



- Flow not permitted by subsurface geology
- Flow permitted by subsurface geology
- Flow possible; boundary not well constrained
- Intrabasin bedrock high

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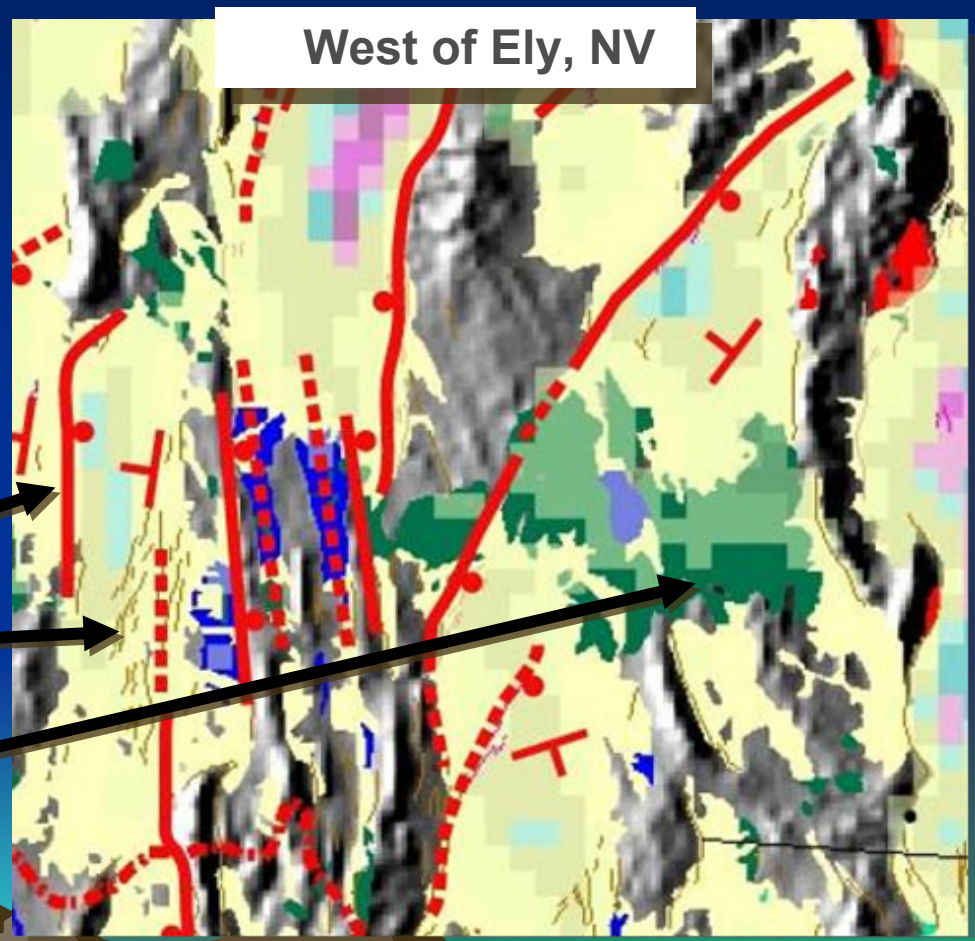
Sedimentary basin studies

- Basin-by-basin analysis of subsurface stratigraphy and structure in basins, based on
  - **Age of sediments**
  - **Presence of volcanic rocks**
  - **Faults affecting young sediments**
  - **Thickness of basin fill**



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Preliminary data from Alan Wallace, USGS

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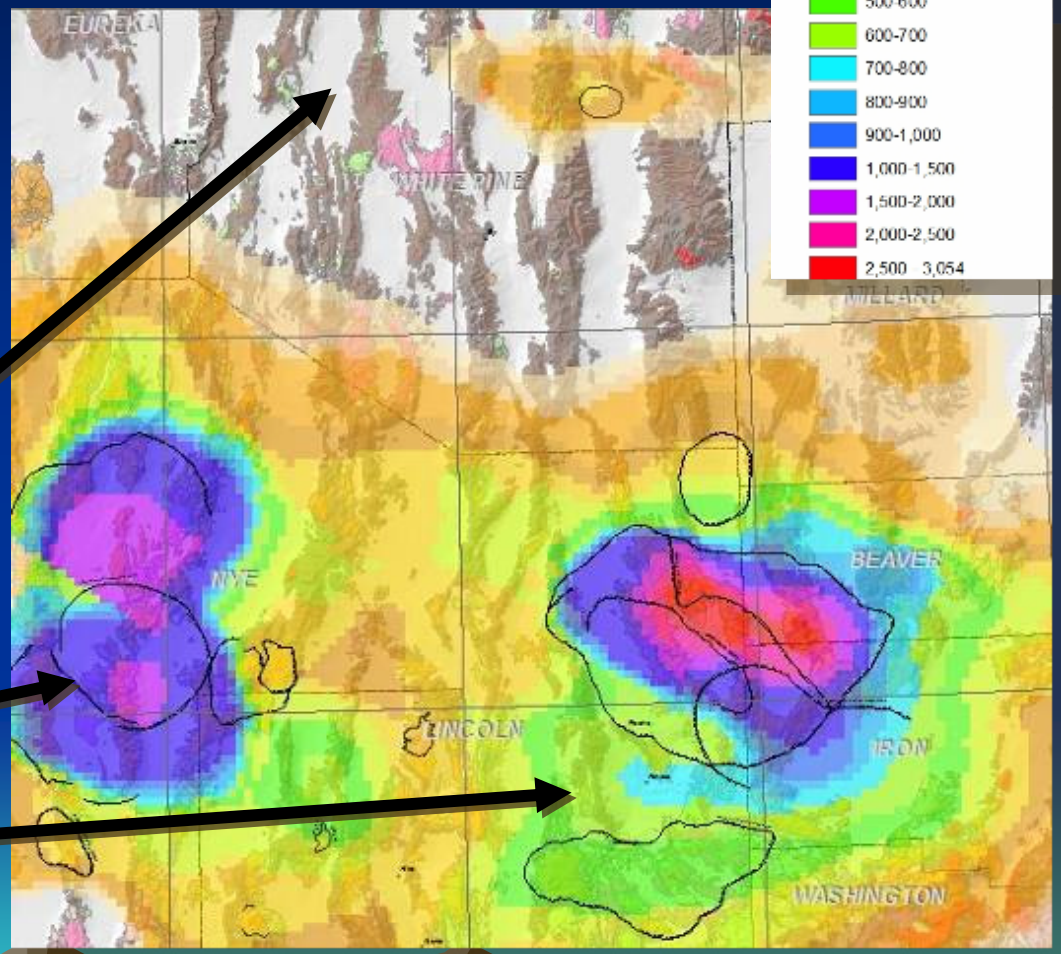
Volcanic rock studies

Construction of a thickness map of volcanic rocks

- Defines basins with sedimentary vs. volcanic basin fill
- Defines calderas
- Basins with different hydrologic properties



Basin with little volcanic component

Calderas

Colors represent thickness of volcanic rocks

Preliminary data from Ed du Bray and Don Sweetkind, USGS

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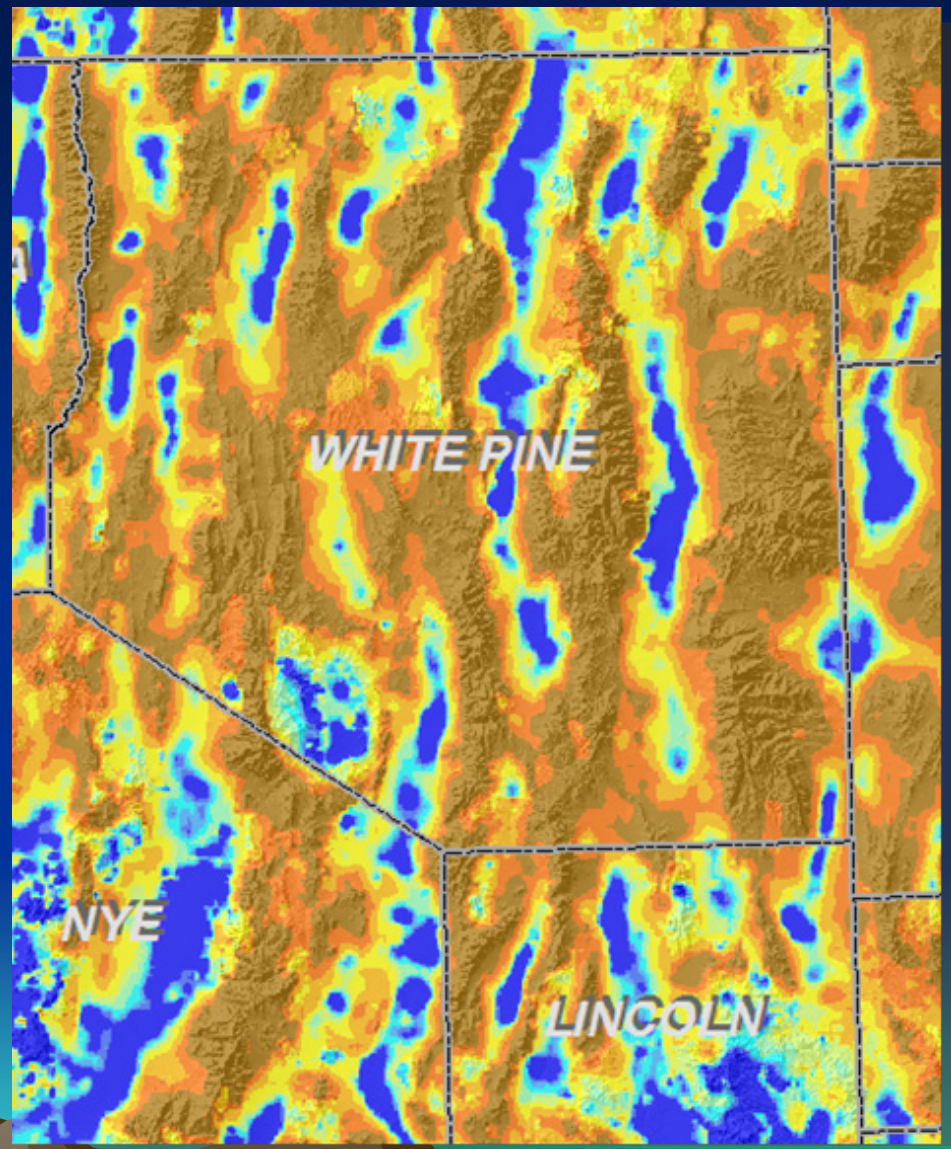
Gravity data – thickness of basin fill

- Gravity data are used to compute basin shape and depth
- Over 500 new gravity stations
- In places, a 50% volumetric increase in basin size
- Currently being refined by comparison to seismic and other data



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Preliminary data from Janet Tilden and David Ponce, USGS; data collection partly funded by SNWA

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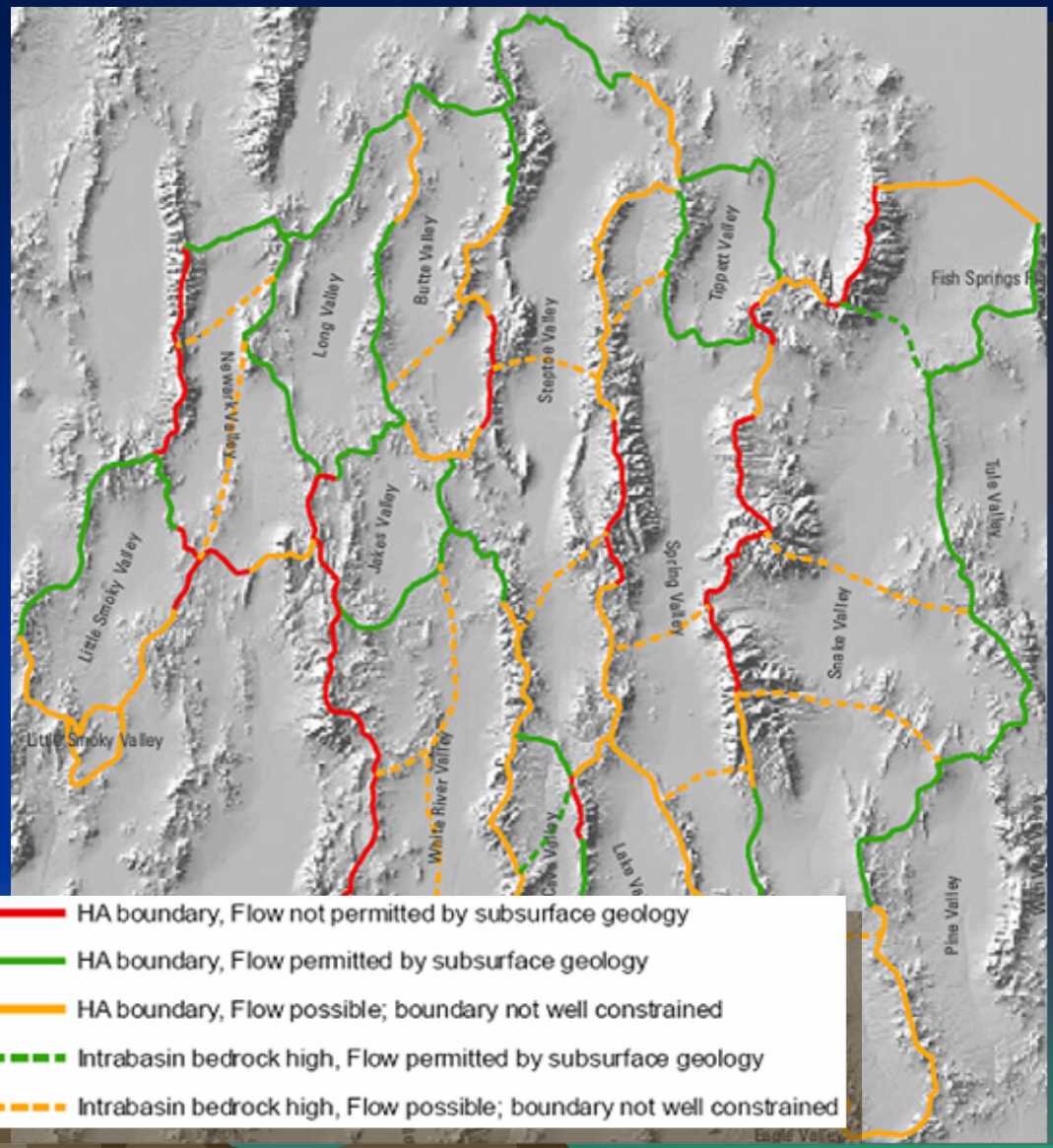
Attribution of HA boundaries

- Potential for flow across HA boundary based on subsurface geologic framework
- Geophysically defined interbasin divides
- Component of water budget calculations

Code	Description
1	Impermeable bedrock at depth
2	Thick permeable Pz carbonates at depth
3	Thick Chainman shale present
4	Pluton present
5	Thick volcanic rocks, variable flow properties
6	Thick basin fill at boundary
7	Thick impermeable basin fill at boundary
8	Permeable rocks overlie shallow detachment
9	Thin Chainman shale present at depth
10	Structural disruption may allow flow



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Preliminary data from Don Sweetkind, USGS

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Recharge/Discharge

- Well inventory, pumpage estimates
- Spring inventory, spring flow on important springs (Fish Springs – Utah)
- Remote sensing – Thematic Mapper
- Vegetation mapping
- ET measurement

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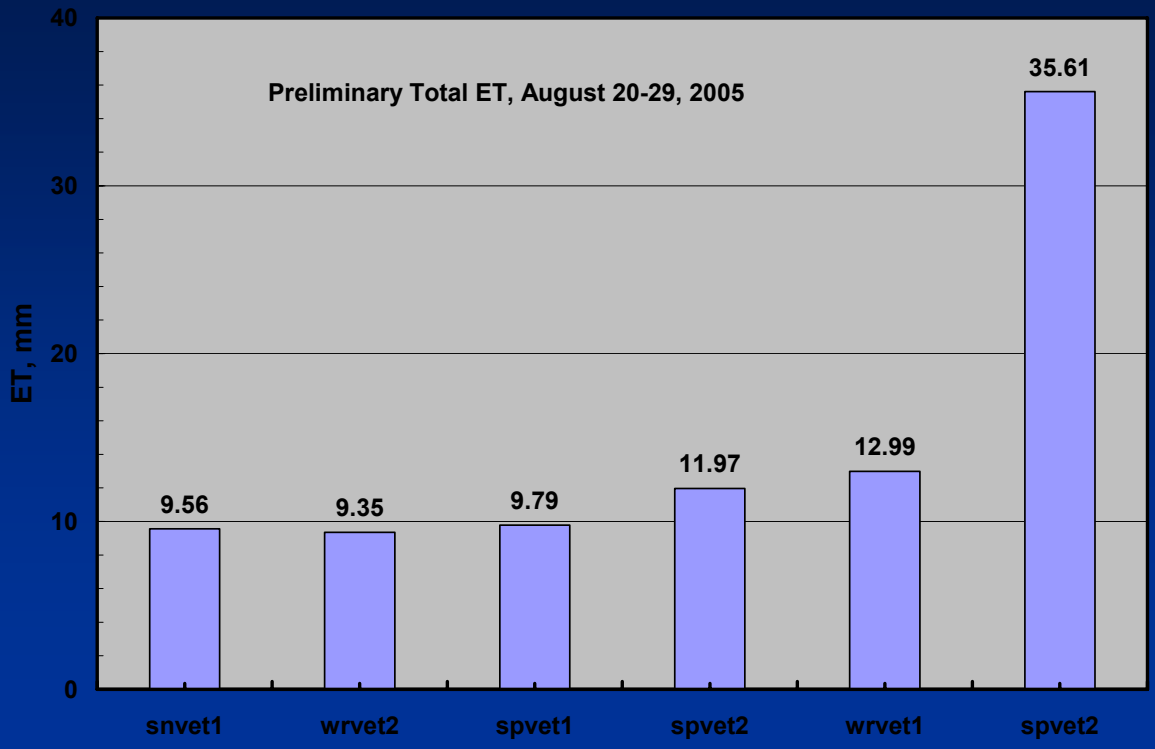
Discharge



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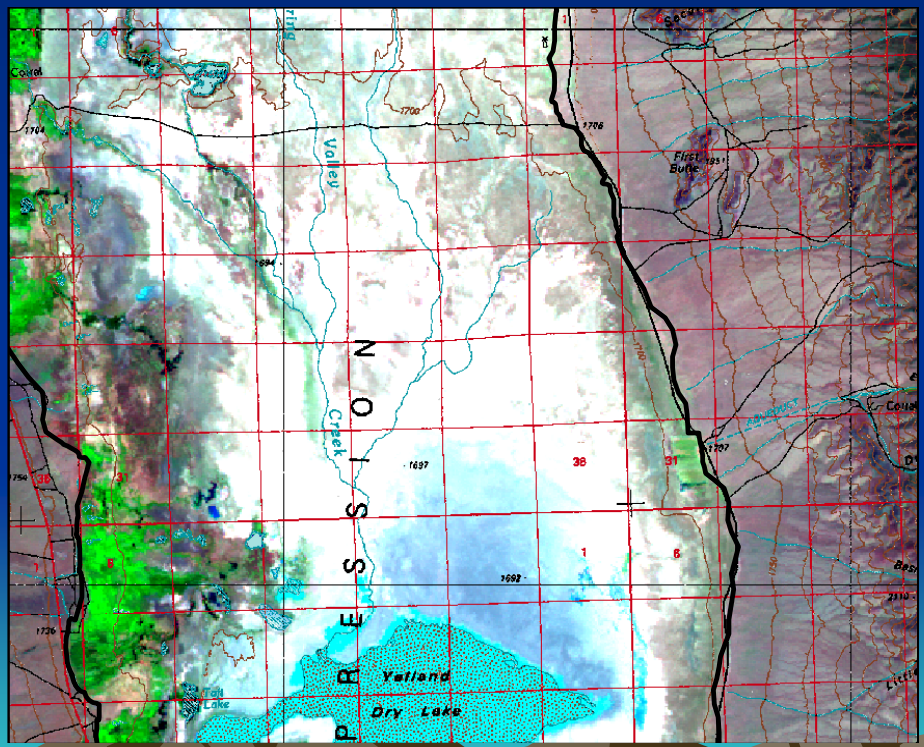
ET Area - Preliminary ET unit delineation

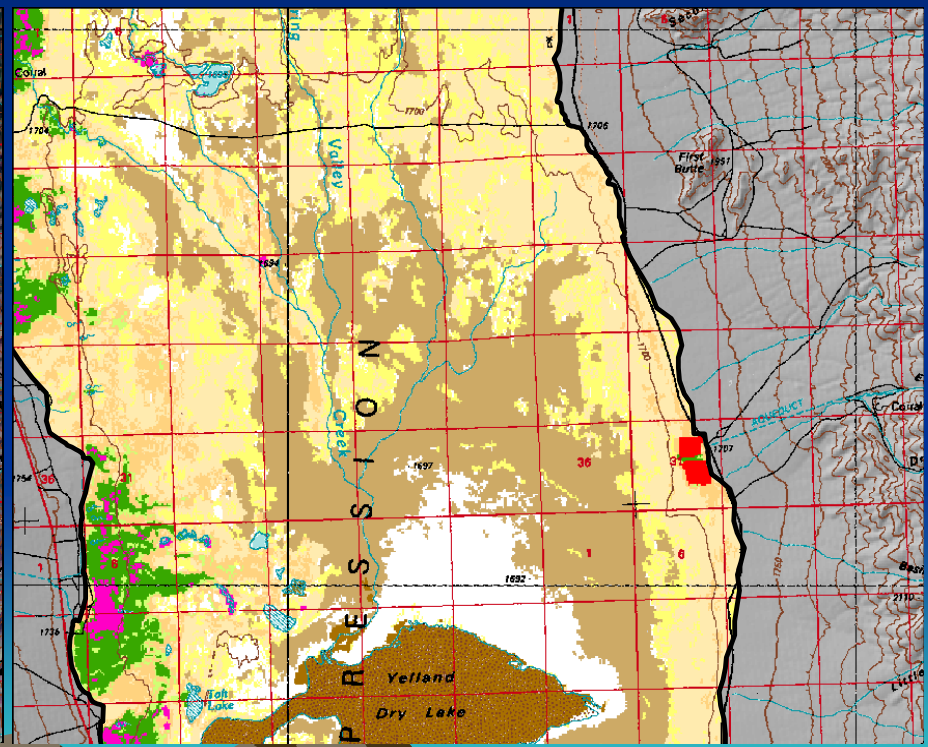
- ET units are areas of phreatophytic vegetation grouped by similar vegetation and soil characteristics
- ET units are delineated by spectral analysis of Landsat TM imagery and published land-cover classifications

Northern Spring Valley area

Legend

Non phreatophyte	Mod shrub	Agriculture
Marsh	Sparse shrub	
Dense grassland	Moist soil	
Mod grassland	Open water	
Dense shrub	Playa	





Remotely-sensed false color composite

Preliminary ET-unit delineation

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ET Approach – Summing the groups

ET-UNIT AREA
(areas of similar vegetation and soil moisture delineated using multi-spectral imagery)

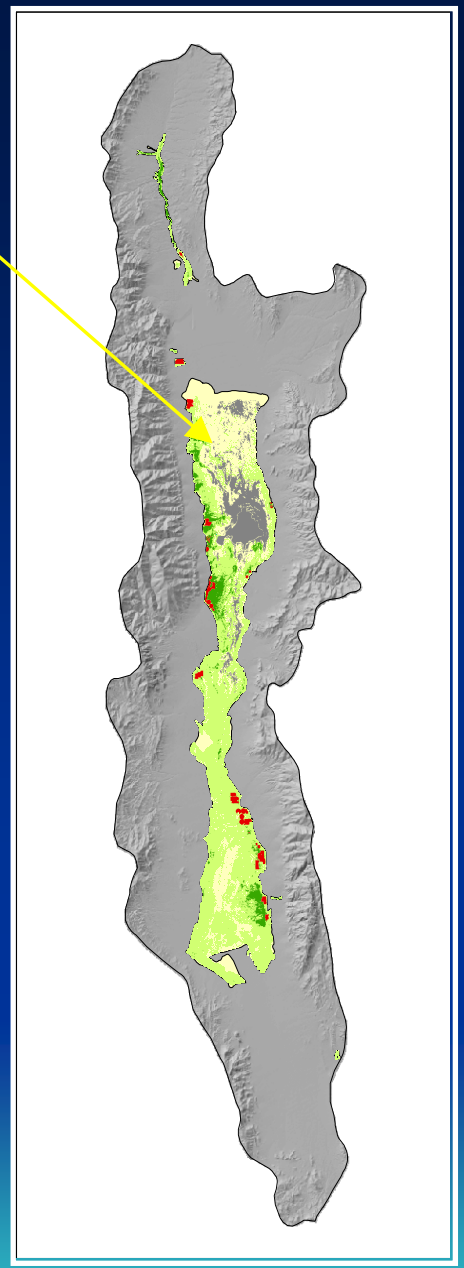
X

"AVERAGE" ET RATE
(estimated from locally made measurements and reported data)

–

PRECIP. RATE

= MEAN ANNUAL GROUND-WATER DISCHARGE



SPRING VALLEY					
ET Unit	Area (acres)	ET Rate (ft/yr)	ET (acre-ft/yr)	Precip. Rate (ft/yr)	Ground-Water Discharge (acre-ft/year)
Open Water	39	7.5	290	0.8	259
Low Density Shrubs	66,600	1	66,600	0.8	13,320
Moderate Density Shrubs	71,120	1.5	106,680	0.8	49,784
High Density Meadow Grass and Marsh	10,754	3.25	34,949	0.8	26,346
Playa	19,650	0.8	15,720	0.8	0
Agriculture	4,103	0	0	0	0
Total			227,955		89,709

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Preliminary data from Randy Laczniak and Mike Moreo

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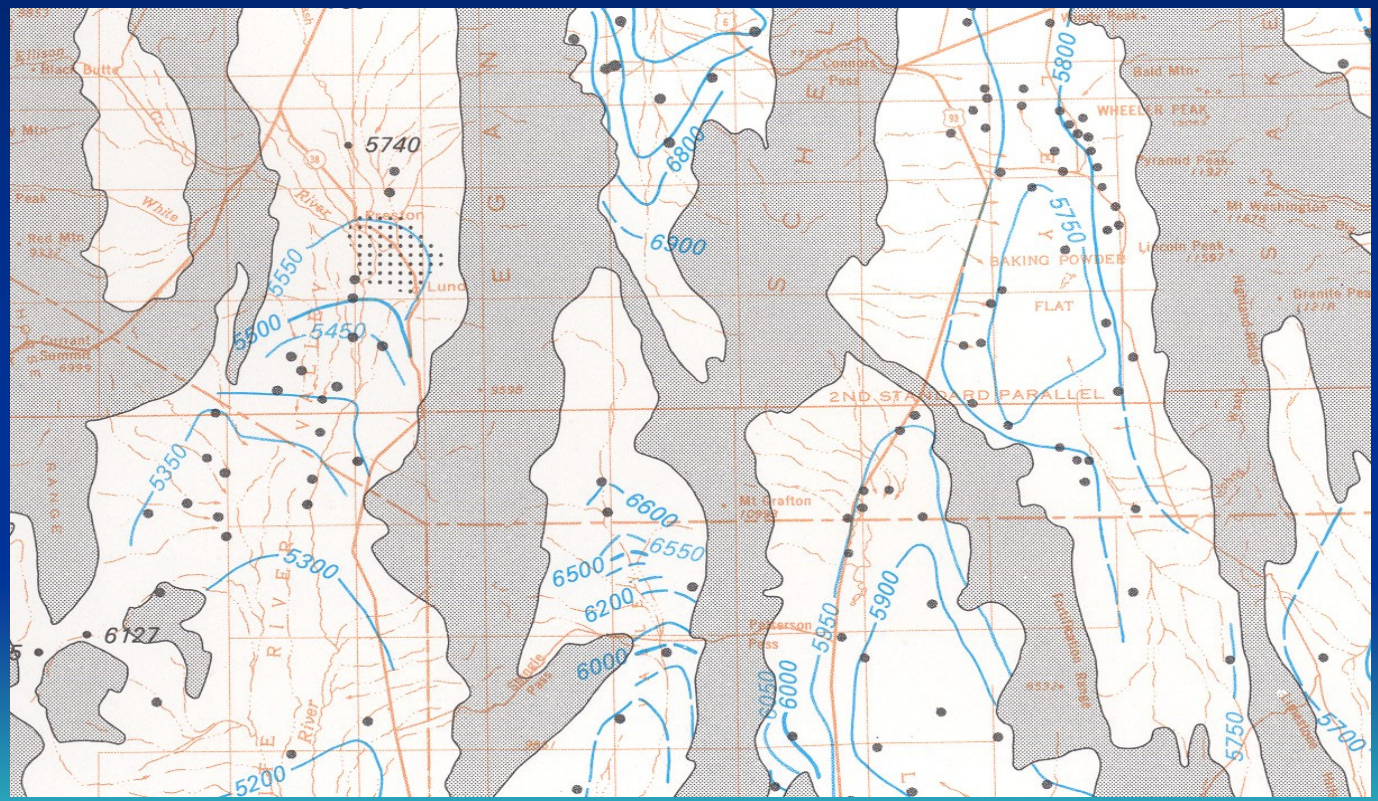
Ground Water Flow

- Ground-water level network



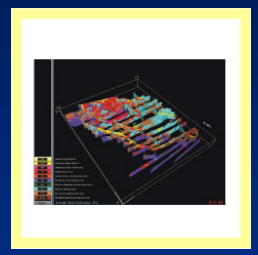
Geochemistry

- General ground-water quality in basins
- Reduce uncertainty of other BARCASS tasks on discharge, recharge, and ground-water flow:
    - Hydraulic connection and volume of ground-water discharge between selected basins
    - Recharge rates
    - Direction of ground-water flow

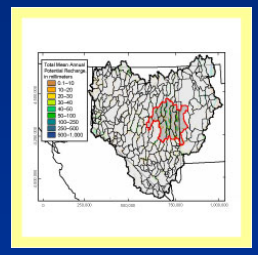
Synthesis and Evaluation

Conceptual 'Model'

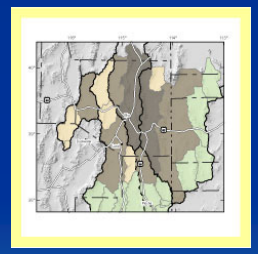
- **Hydrogeologic framework model of geology**
- **Series of maps showing recharge, discharge, and ground-water flow**



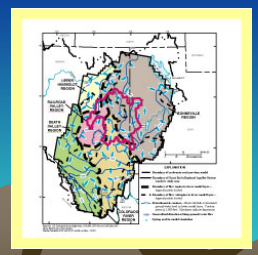
Hydrogeology



Recharge



Discharge



GW Flow

Conceptual Aquifer System

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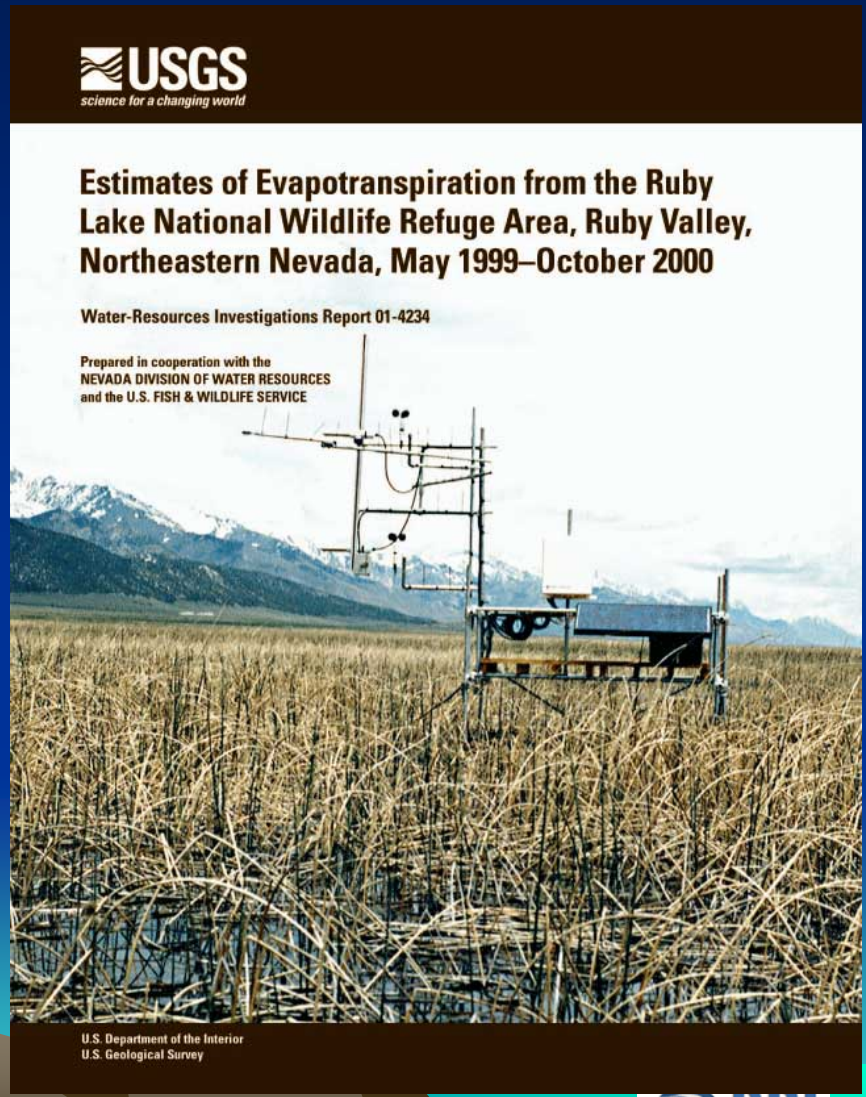
Data Synthesis and Evaluation

Report

- Document results of study
- Draft due June 2007
- Public comment period
- Final report due December 2007



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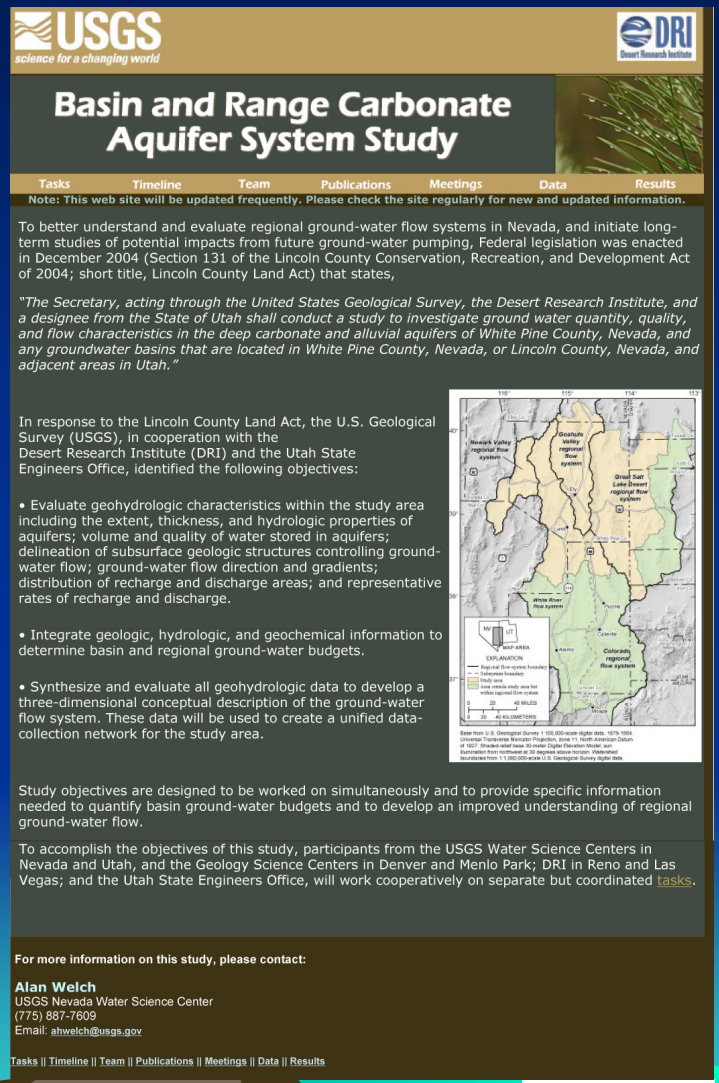
Information Dissemination

- **Web page dedicated to project**
  - Background
  - Progress
  - Quality-assured point and spatial data

  http://nevada.usgs.gov/barcass/index.htm
- **Quarterly Public Meetings**
- **Department and Congressional Briefings**
- **Scientific Meetings**



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Basin and Range Carbonate Aquifer System Study

Tasks | Timeline | Team | Publications | Meetings | Data | Results

Note: This web site will be updated frequently. Please check the site regularly for new and updated information.

To better understand and evaluate regional ground-water flow systems in Nevada, and initiate long-term studies of potential impacts from future ground-water pumping, Federal legislation was enacted in December 2004 (Section 131 of the Lincoln County Conservation, Recreation, and Development Act of 2004; short title, Lincoln County Land Act) that states,

"The Secretary, acting through the United States Geological Survey, the Desert Research Institute, and a designee from the State of Utah shall conduct a study to investigate ground water quantity, quality, and flow characteristics in the deep carbonate and alluvial aquifers of White Pine County, Nevada, and any groundwater basins that are located in White Pine County, Nevada, or Lincoln County, Nevada, and adjacent areas in Utah."

In response to the Lincoln County Land Act, the U.S. Geological Survey (USGS), in cooperation with the Desert Research Institute (DRI) and the Utah State Engineers Office, identified the following objectives:

- Evaluate geohydrologic characteristics within the study area including the extent, thickness, and hydrologic properties of aquifers; volume and quality of water stored in aquifers; delineation of subsurface geologic structures controlling ground-water flow; ground-water flow direction and gradients; distribution of recharge and discharge areas; and representative rates of recharge and discharge.
- Integrate geologic, hydrologic, and geochemical information to determine basin and regional ground-water budgets.
- Synthesize and evaluate all geohydrologic data to develop a three-dimensional conceptual description of the ground-water flow system. These data will be used to create a unified data-collection network for the study area.

Study objectives are designed to be worked on simultaneously and to provide specific information needed to quantify basin ground-water budgets and to develop an improved understanding of regional ground-water flow.

To accomplish the objectives of this study, participants from the USGS Water Science Centers in Nevada and Utah, and the Geology Science Centers in Denver and Menlo Park; DRI in Reno and Las Vegas; and the Utah State Engineers Office, will work cooperatively on separate but coordinated tasks.

For more information on this study, please contact:

Alan Welch
USGS Nevada Water Science Center
(775) 887-7609
Email: ahwelch@usgs.gov

Tasks || Timeline || Team || Publications || Meetings || Data || Results

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Improved Interpretations

- Revised interpretations of existing information based upon present (2007) understanding of Regional flow systems
- Revised hydrogeologic framework
- Revised aquifer-storage estimates
- Revised recharge and discharge estimates

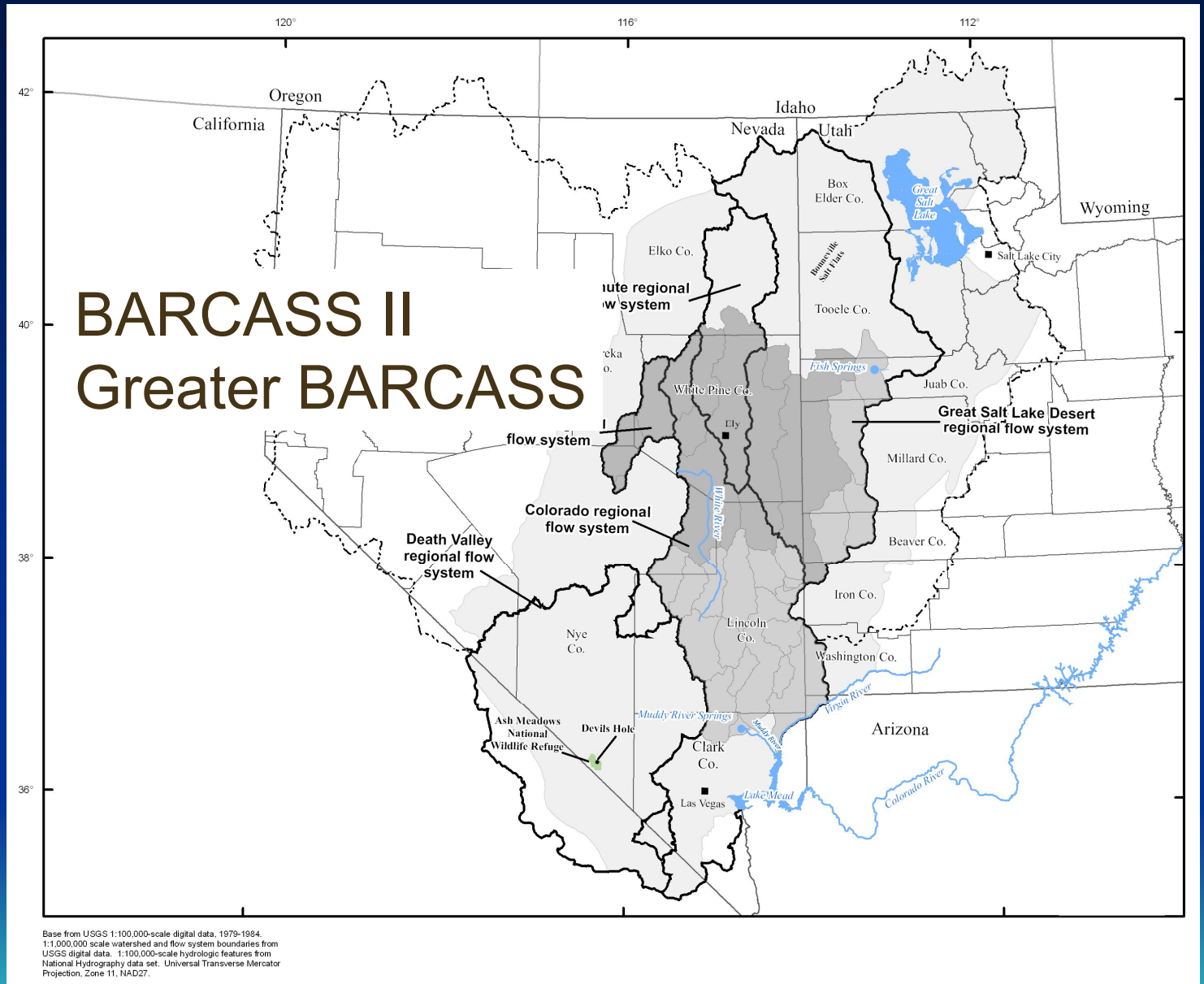
Points to Consider

- Revised water-budget estimates may not differ greatly from present estimates
- Previous work done by leading scientists of their respective period
- Revised estimates will represent application of USGS science expertise

USGS Future Program Vision

- Statewide Ground-Water Monitoring Network (within cooperative water program, many partners)
- Develop and maintain public-sector ground-water models of Colorado and Great Salt Lake Regional Flow Systems

BARCASS II
Greater BARCASS



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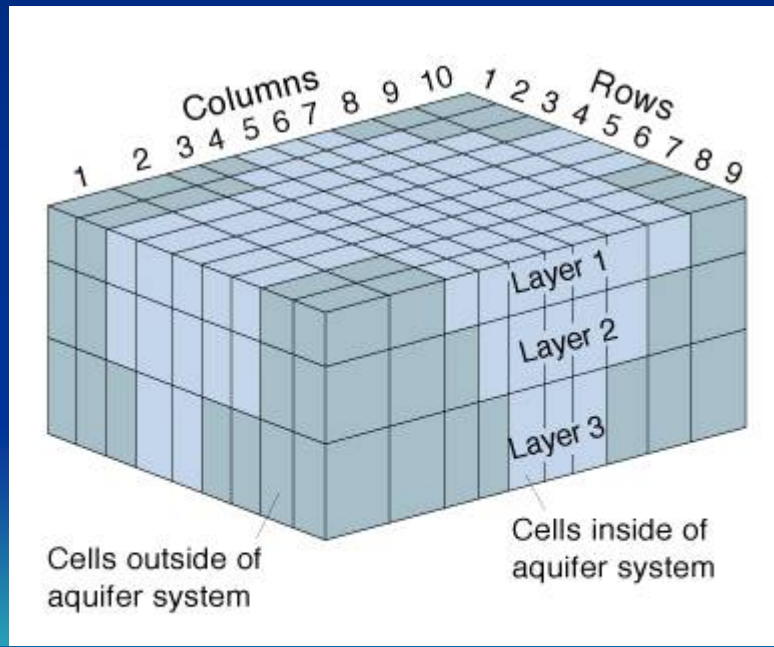
Utility of Ground-water flow Models

- Data integration
- Resource management tool
- Predictive tool
  - Impacts from pumping
    - Water levels (vegetation changes)
    - Springs
    - Flow paths

Numerical Modeling

"Slice" up volume into blocks

Solve for water entering and exiting each block



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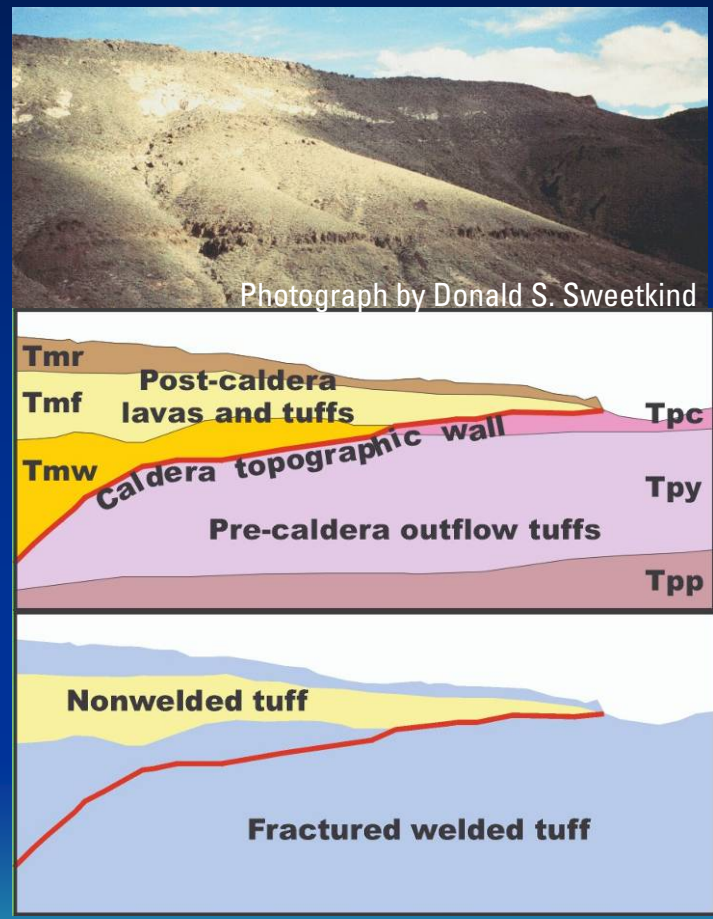
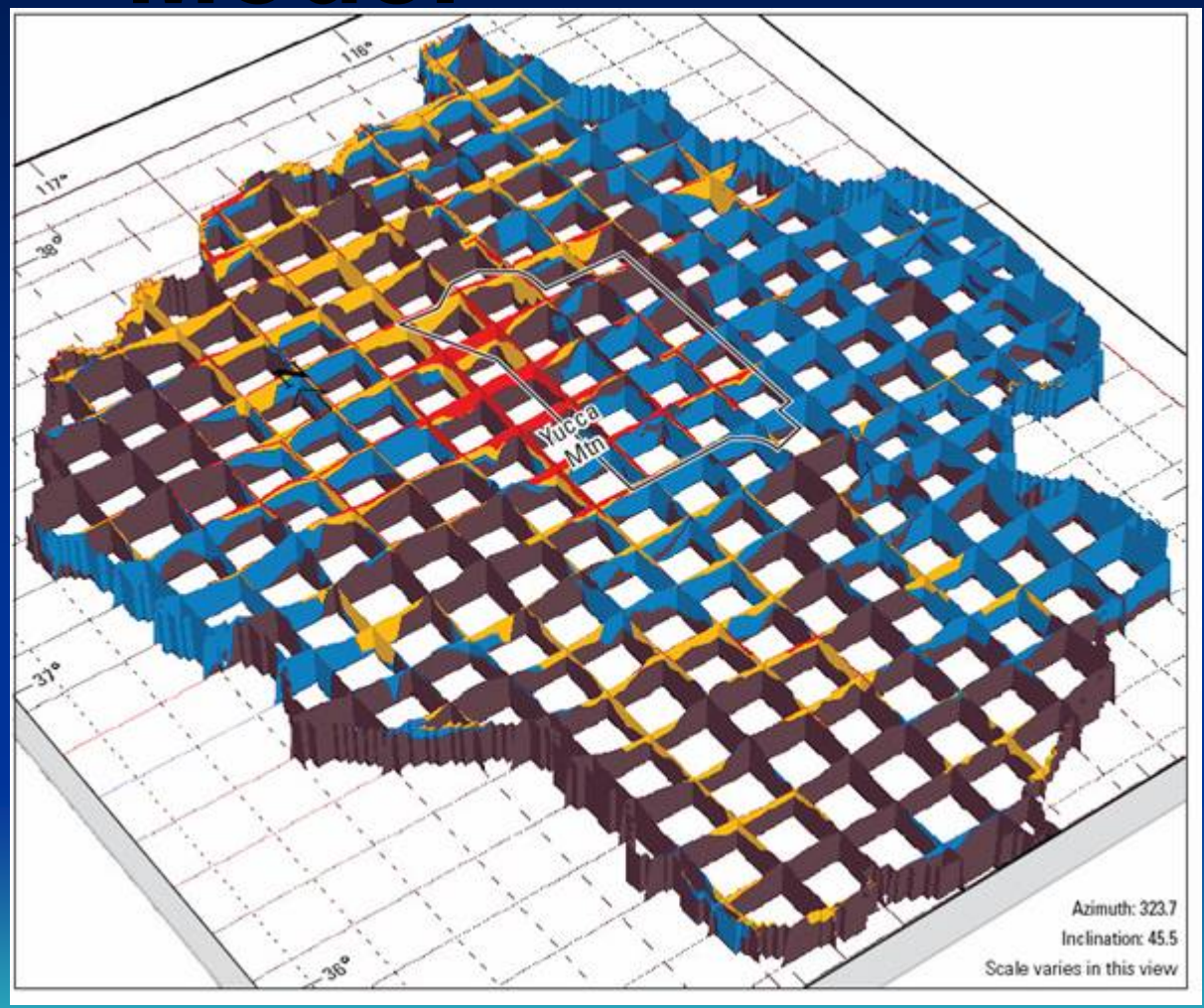
Capturing Geology

- **Hydrogeologic framework model provides geometry of units**
  - Extent and thickness of units
  - Juxtaposition of units
- **Properties vary spatially**
- **Structures**
  - Conduits
  - Flow barriers



Hydrogeologic Framework Model

Death Valley
Flow System



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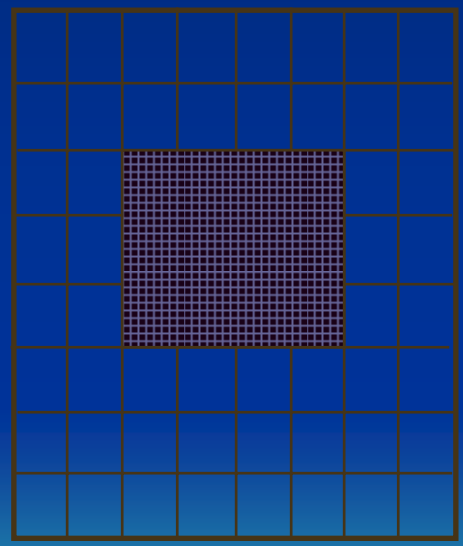
Linking Regional and Local Models

Directly embedded

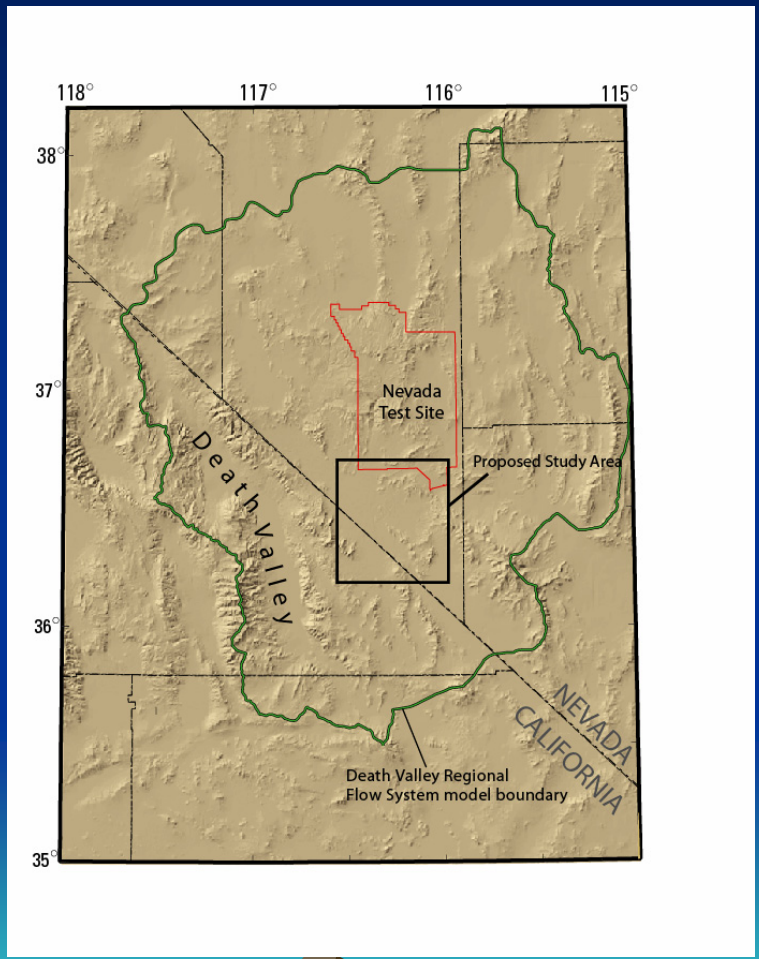
- Modify regional grid for local grid
  - Solve as a single grid
  - Integrated “co-calibration”
  - Local grid refinement

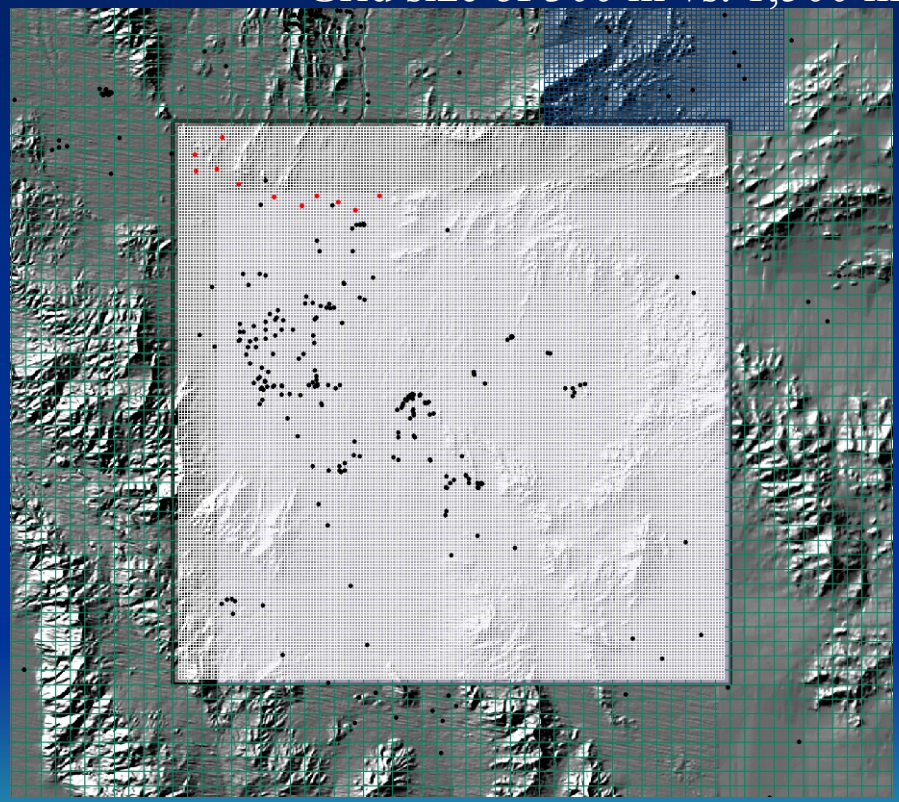


Child

Embedded Model

5:1 refinement ratio
Embedded model grid is 5 X finer than regional model
Grid size of 300 m vs. 1,500 m





USGS Regional Models

- Within public sector: available to everyone
- Infrastructure for integrating, storing and updating geologic and hydrologic information for aquifer systems
- Provide framework for embedded models required for detail or for engineering considerations

Questions?

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