

# AQUIFER MAPPING PROGRAM: STATUS REPORT OCTOBER 2015

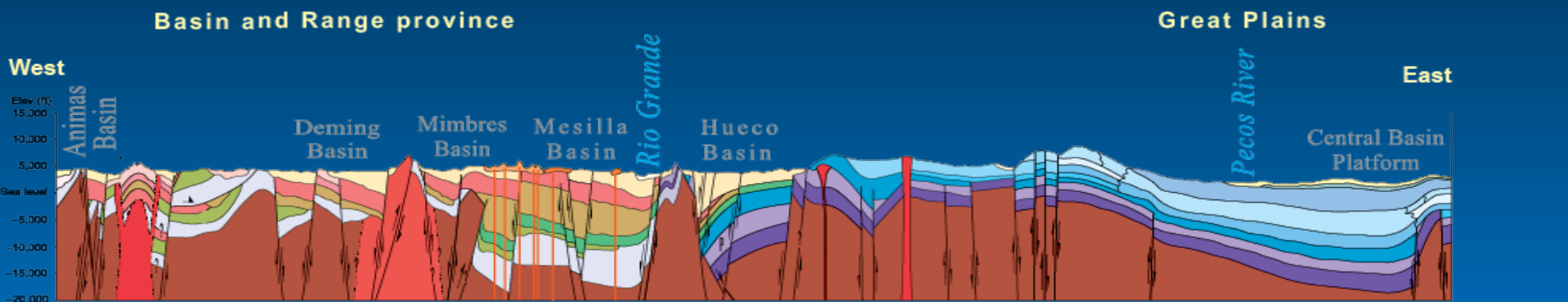
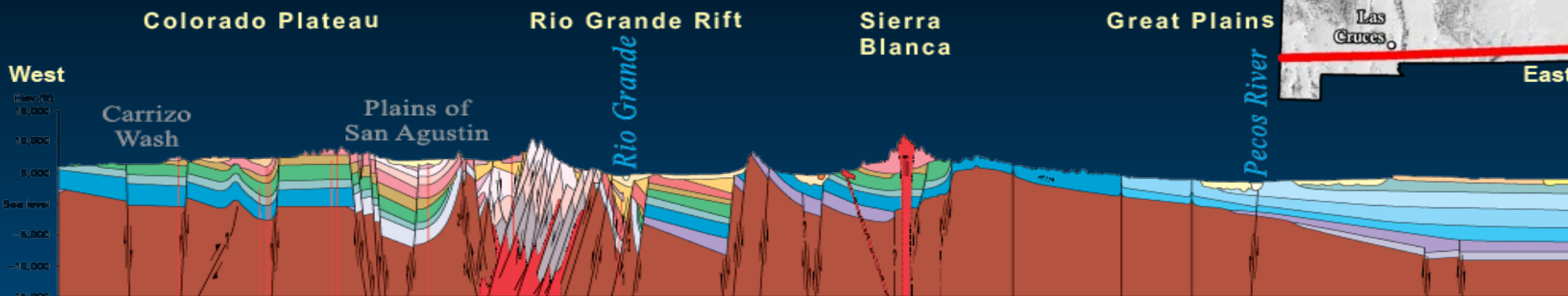


Stacy Timmons

Hydrogeologist, Aquifer Mapping Program Manager



# Geology in the sub-surface is also a challenge



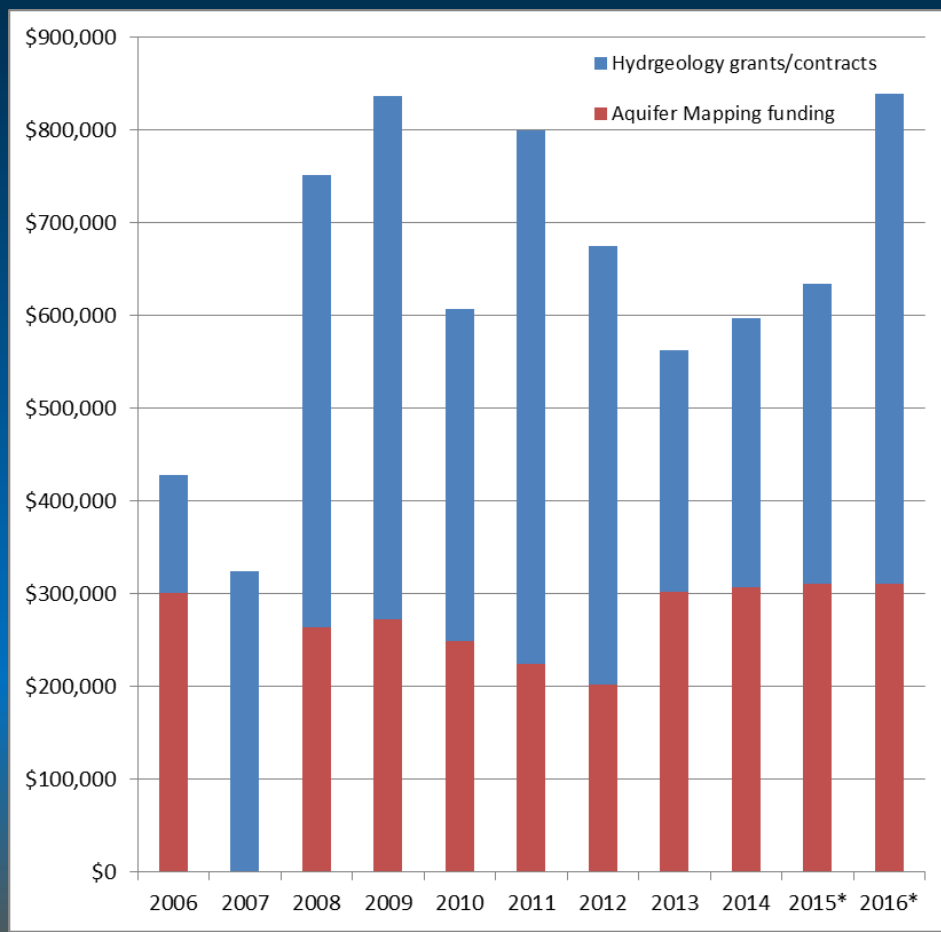
Large vertical exaggeration!

## Nebraska



# Aquifer Mapping Program: Addressing quantity, quality and distribution of groundwater

- Aquifer Mapping Program started in 2006 – as an RPSP
- Funding has varied and been supplemented by grants/contracts
- We use in-house expertise in geology, hydrology, geochemistry, and geophysics



*The purpose of this program is to provide scientific data and interpretations on the quantity, quality, and distribution of the state's aquifers to a diverse group of water agencies and stakeholders in order to support informed decision making and increase public education and awareness on critical water issues.*

# PARTNERS AND USERS

- Academic Institutions: NMT, UNM, NMSU, Highlands
- State Agencies: NMOSE/NMISC, NM EMNRD, NMED
- Federal Agencies & National Laboratories: US Geological Survey, Los Alamos NL, Sandia NL, US Bureau of Indian Affairs, US Fish & Wildlife Service, US Bureau of Land Management, US Forest Service, NASA
- Counties, Municipalities, Irrigation Districts, Water Utilities: Sandoval, Taos, Otero, Lincoln, Bernalillo, Albuquerque, Santa Fe, Socorro, Catron, Sierra, Town of Taos, City of Santa Fe, Village of Magdalena, City of Truth or Consequences
- Tribes: Taos, Picuris, Santo Domingo, Tesuque, Sandia, Isleta, Santa Ana, etc.
- Soil & Water Conservation Districts: Otero, Taos, Northeastern
- Public
- Consultants



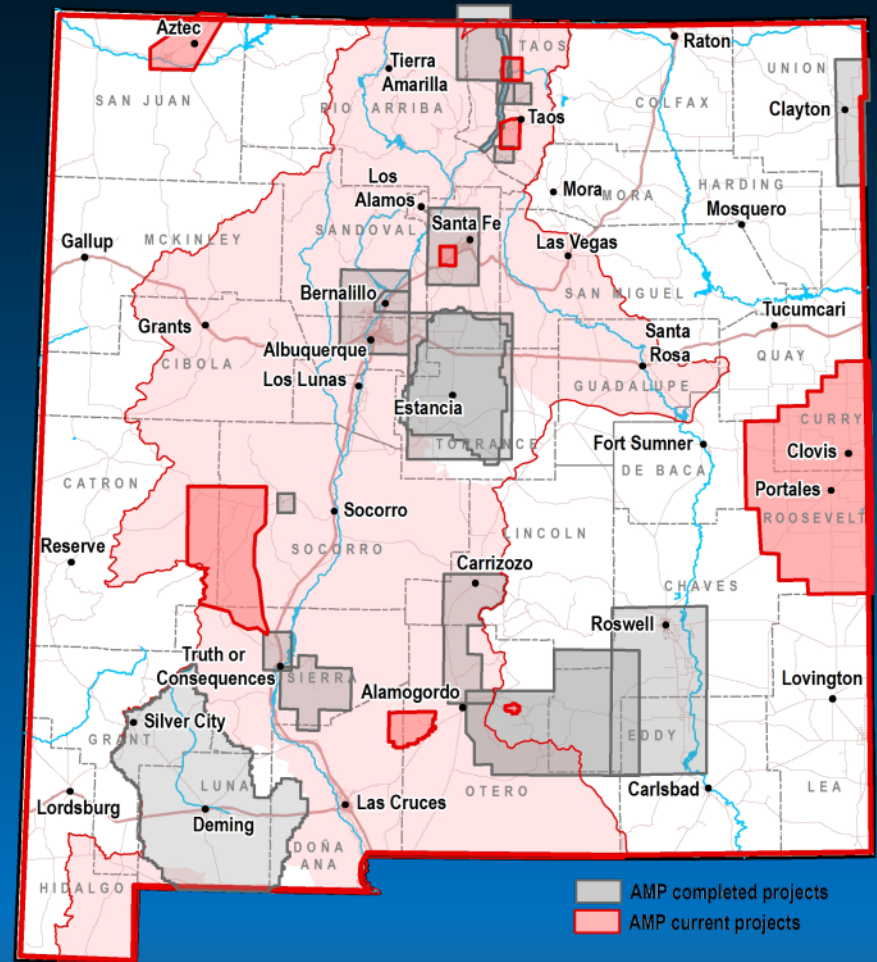
# EACH PROJECT IS UNIQUE

## Recently completed projects

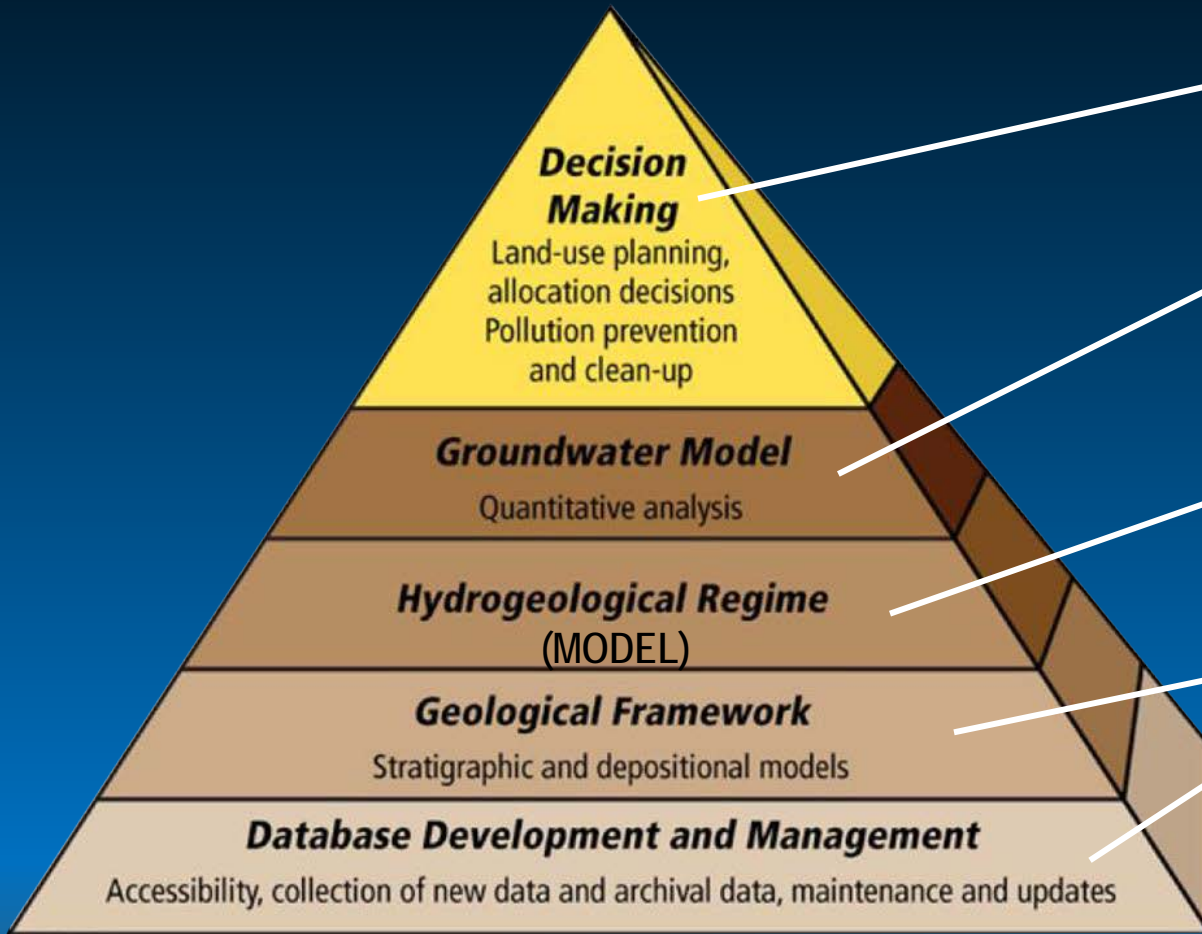
- Union County (NESWCD, Healy, Bureau)
- Eastern Tularosa Basin (OSWCD)
- Sacramento Mountains (OSWCD)

## Current projects

- Curry – Roosevelt Counties (NMED)
- Animas River aquifer (pending)
- Statewide recharge and water level changes (WRII)
- San Agustin Plains (Bureau)
- Small projects in Taos, Questa, La Cienega, White Sands National Monument



# INFORMATION FOR BETTER DECISION MAKING



- Using a solid knowledge foundation to educate decision makers
- Build numerical model(s) to test hypotheses and forecast future conditions
- Build conceptual models of the system
- Build a solid geologic model
- Build a solid foundation with ongoing data collection

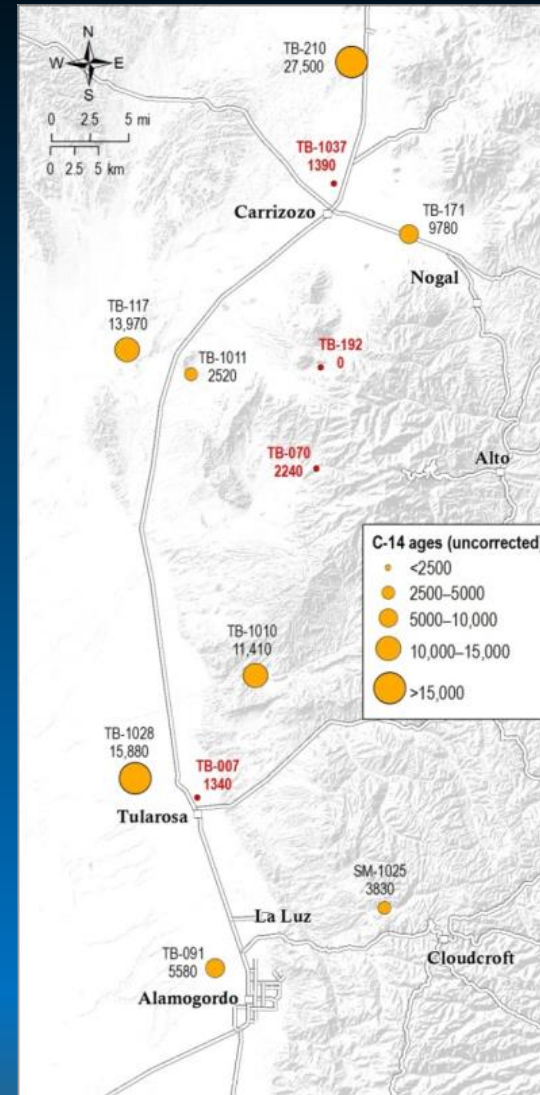
(Council of Canadian Academies, 2009)

# THE FOUNDATION OF OUR SCIENCE: DATA COLLECTION

- Groundwater level monitoring
- Water quality sampling
- Water age-dating
- Geothermal groundwater assessment
- Streamflow measurements



Making measurements of groundwater levels



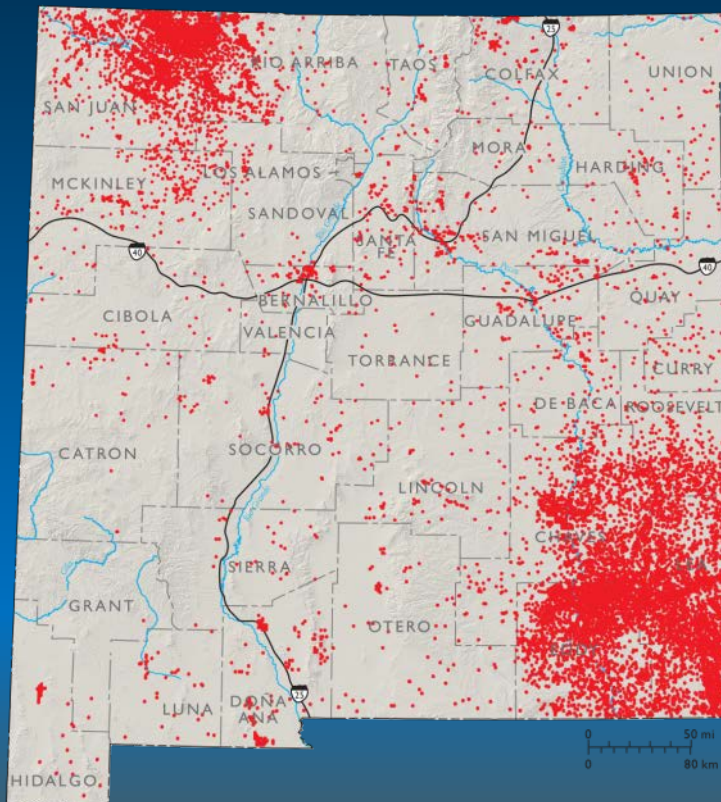
Estimates of groundwater age



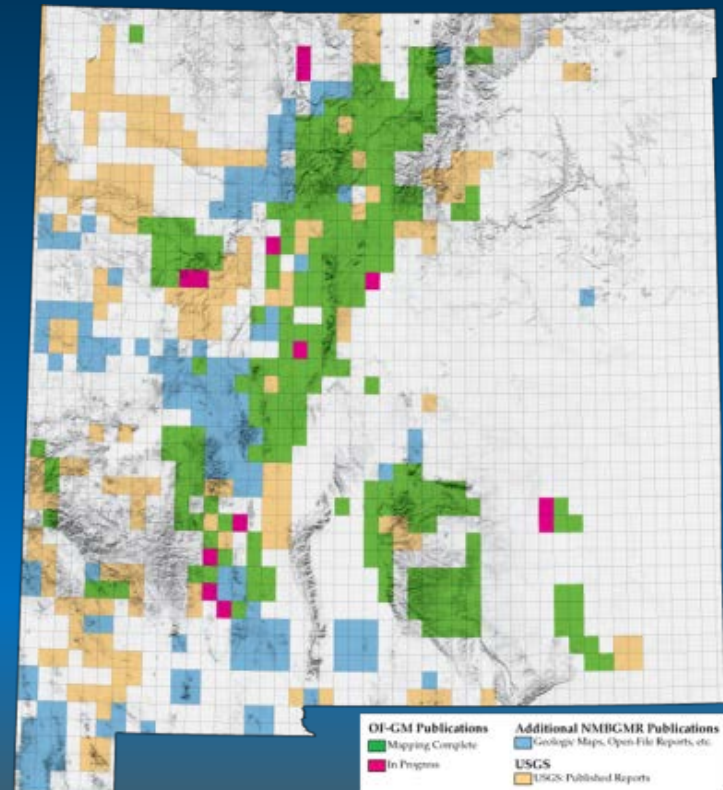
# THE FOUNDATION OF OUR SCIENCE: DATA COLLECTION

- Building on our in-house Subsurface Data and Core Library
- Utilizing detailed geologic mapping and cross sections.

Subsurface deep well core and cuttings at Bureau of Geology



Detailed geologic mapping coverage in NM



# THE FOUNDATION OF OUR SCIENCE: DATA COLLECTION

We are using new techniques to address new Mexico's water issues

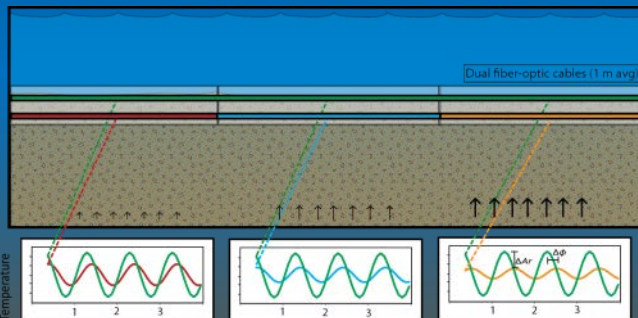
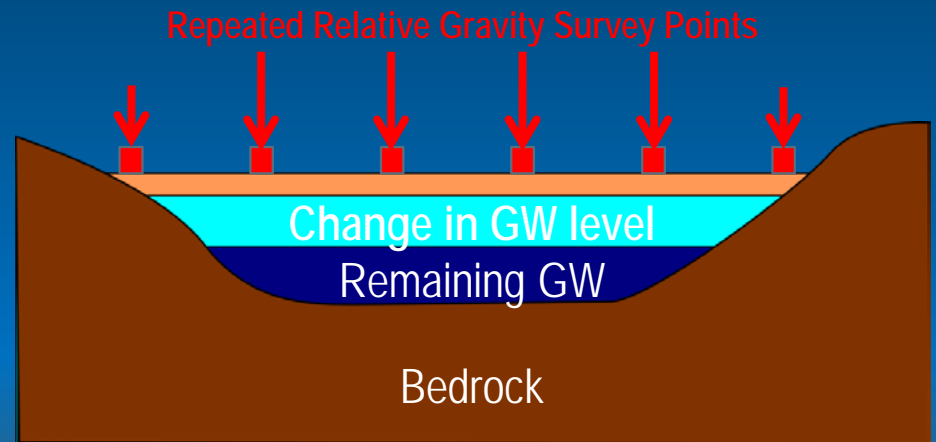
- Temperature cables (DTS) to address recharge
- Gravity to address groundwater storage changes



Making gravity measurements



DTS cables in river

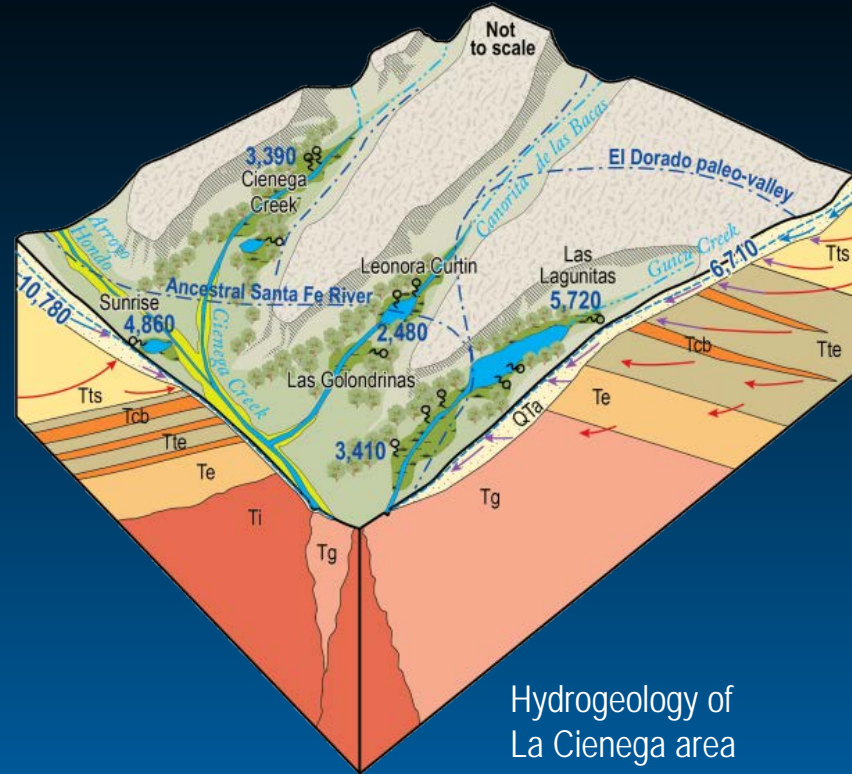
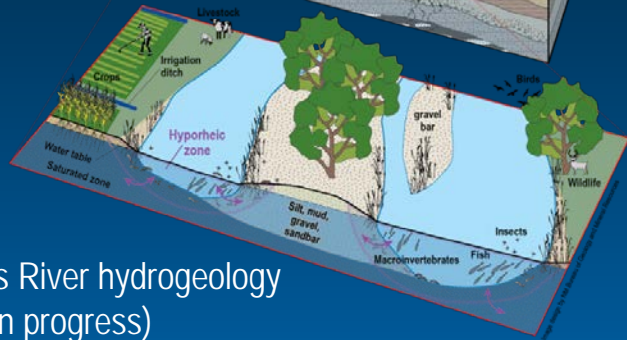




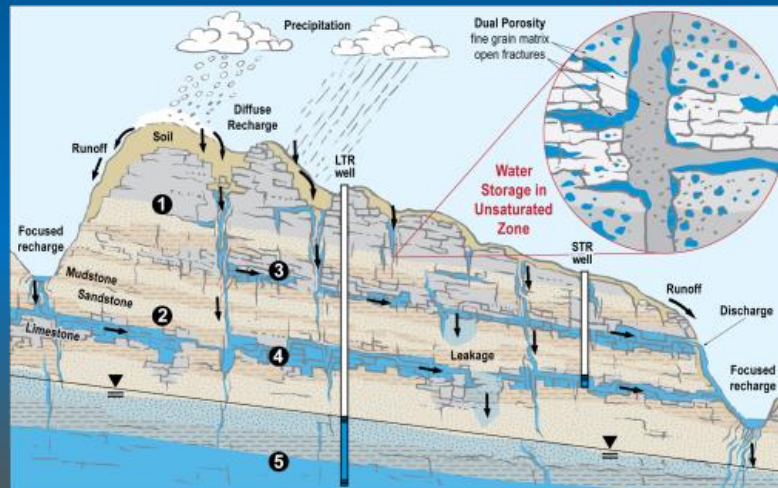
# BUILDING THE CONCEPTUAL MODELS



Animas River hydrogeology  
(work in progress)



Hydrogeology of  
La Cienega area



Sacramento  
Mountains  
hydrogeology

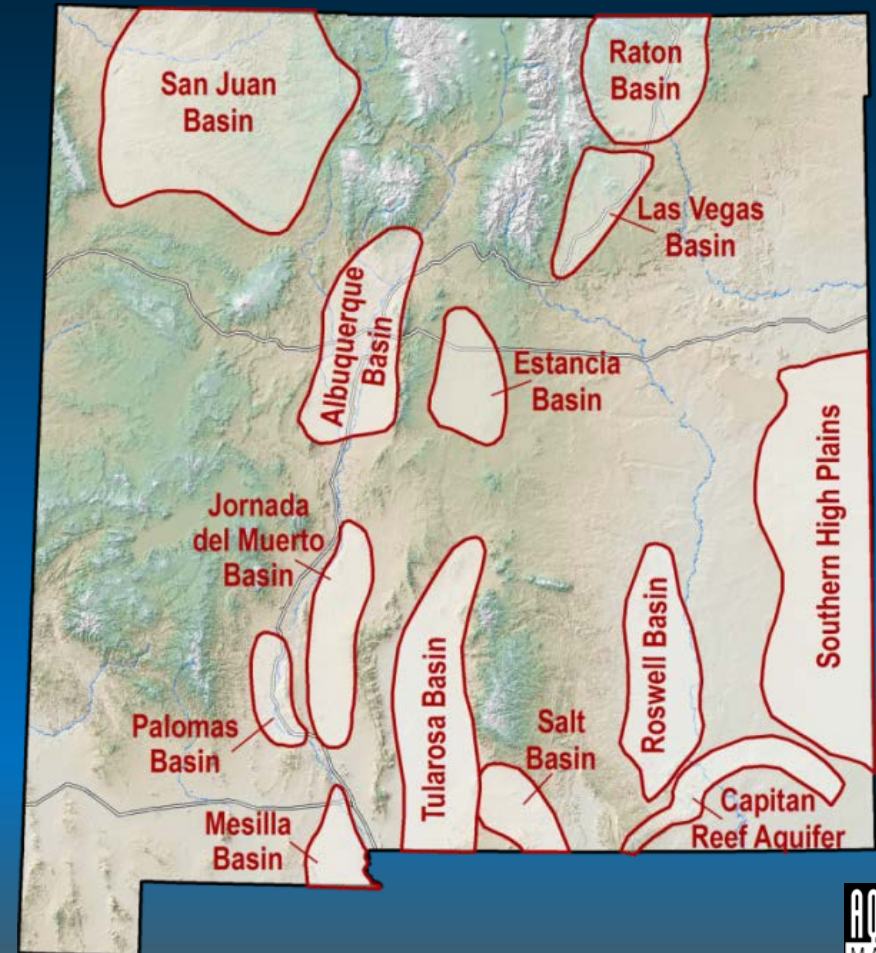
# AQUIFER MAPPING PROGRAM

Addressing quantity, quality and distribution of groundwater

## OUR STATEWIDE PROJECTS THIS YEAR

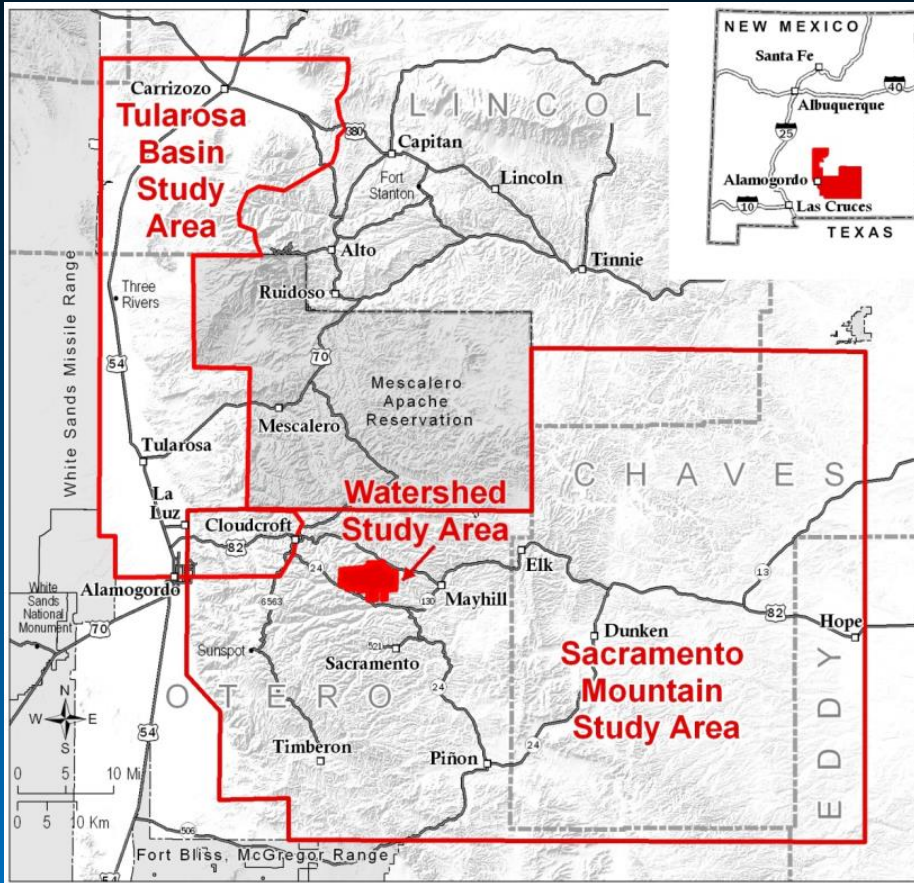
1. Digitize and compile legacy water data
2. Water quality characterization
  - NMED funding (pending) for fresh and brackish water
  - Interactive web map products
3. WRI-funded research projects
  - Statewide recharge
  - Groundwater storage changes

Potential brackish water basins





# EXAMPLES OF RECENT WORK



Project started in 2005

Funding grew from \$200K to over \$2.3 million in funding over 10-year study

- Capital outlay to OSWCD
- Additional funds from ISC, USFS, and USGS (NCGMP)

## Regions of study:

- Southern Sacramento Mountains
- Eastern Tularosa Basin
- Watershed Study on Effects of Tree Thinning

# The Southern Sacramento Mountains Hydrogeology Study



Geoffrey Rawling  
Hydrogeologist



# Southern Sacramento Mountains study



- Water source for the Roswell Artesian Basin
- Where does groundwater recharge occur?
- When does groundwater recharge occur?
- How much recharge occurs?



# Methods

- I. Geologic mapping
- II. Water level monitoring
- III. Spring, well, and surface water sampling
- IV. Precipitation sampling
- V. Streamflow measurement
- VI. Analysis of rock fractures
- VII. Soil surveys



Precipitation collector

Streamflow measurement

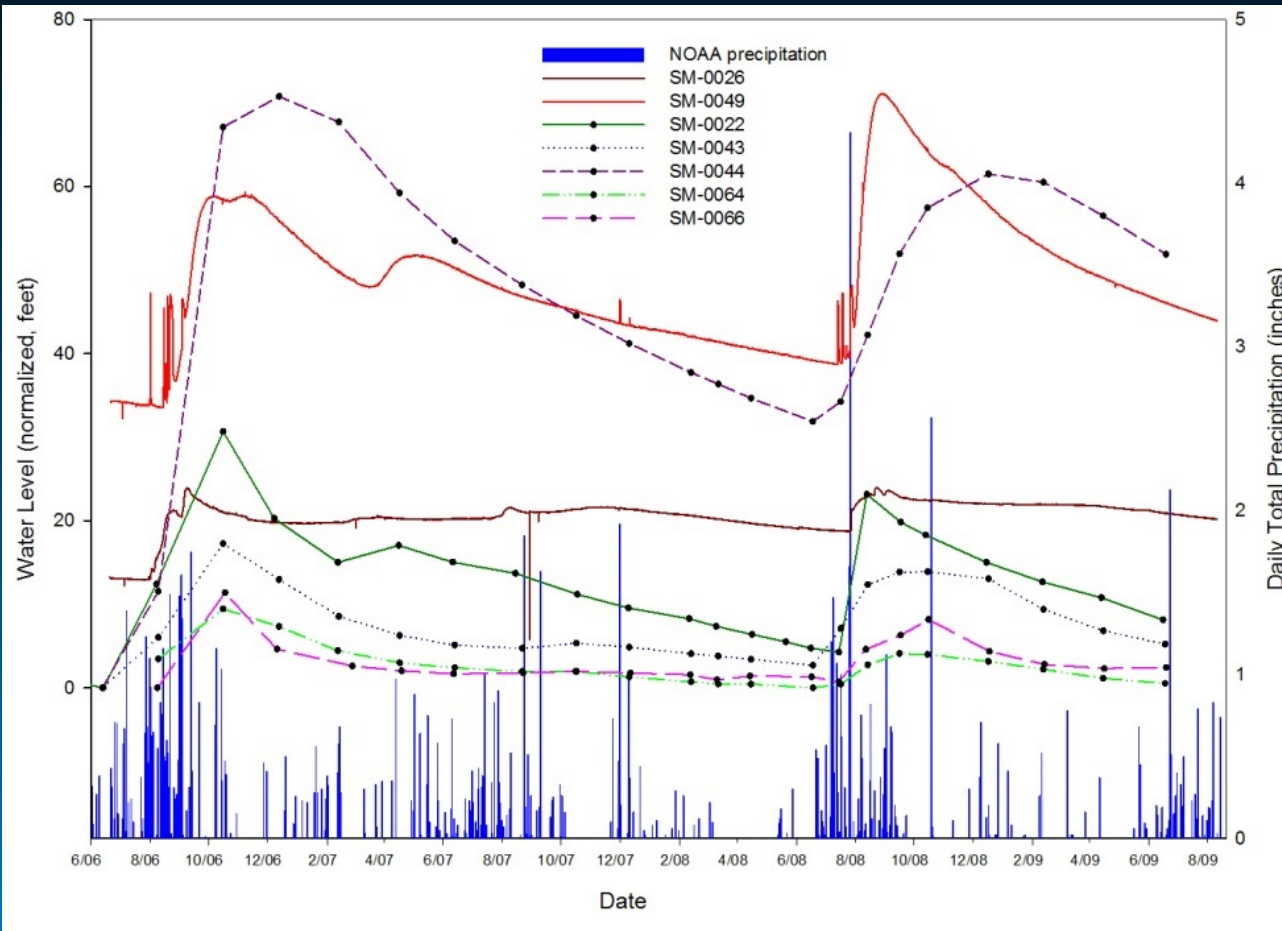


Sampling springs



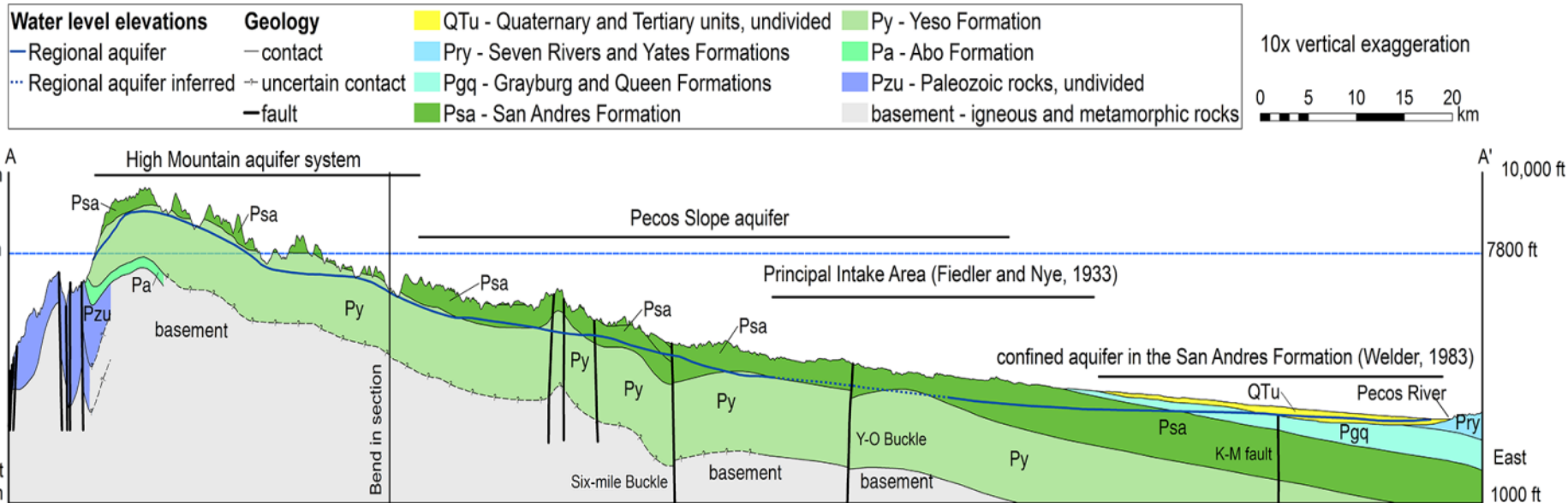


# Water levels and precipitation



- Data collection from Dec 2005 to Aug 2009
- Summer 2006 and 2008, winter 2006-07 had water level rises
- Recharge raises pressure in aquifer
- 7 inch threshold for water level rise?
- Other times show level or declining water levels

# Hydrogeologic conceptual model



- Multiple, independent lines of evidence from geology, hydrology, and groundwater chemistry indicate that ~ 75% recharge occurs  $\geq 7800$  ft
- Little recharge occurs on Pecos Slope except along Rio Peñasco (during extreme monsoons?)

# Recharge to Sacramento Mountains – Roswell Artesian Basin

	Source	Recharge, af/yr	Method
1	Fiedler and Nye, 1933	$\leq 176,465$	Estimate of RAB discharge
2	Hantush, 1957	192,825	Correlation with precipitation
3	Saleem and Jacob, 1971	132,047 – 232,095	Correlation with precipitation
4	Summers, 1972	173,968	Water budget of Pecos Basin
5	Duffy et al., 1978	133,052	Darcy flow calculation
6	DBSA, 1995	175,071	Computer model calibration
7	<b>This study, recharge above 7800 ft</b>	<b>129,599</b>  <b>88,131 – 171,066</b> <b>(mean <math>\pm 1\sigma</math>)</b>	<b>CI-mass balance including canopy interception</b>

# Recharge to Sacramento Mountains

- **When?** Historically snowmelt has dominated, typical for the SW USA.
- **But**, extreme monsoon seasons (> 7 inches ? ) are important (e.g., 2006, 2008). This may important for the future with declining snowpack
- **Where?** Above 7800 feet. Much less at lower elevations and on the Pecos Slope except along the Rio Peñasco.  
During extreme monsoons?
- **How Much?** 5 - 10% of precipitation from extreme storms,  $24 \pm 8$  % averaged over the study area over several years; 88,131 – 171,066 acre-ft/year.



# Aquifer Mapping results in the southern Sacramento Mountains

- 1:24K and 1:100K geologic maps and cross sections
- Publicly available data on water levels, water chemistry, age dating, etc.
- Final report: NMBGMR OFR-543
- Four papers in peer-reviewed scientific journals
- Watershed study built upon this research

# SACRAMENTO MOUNTAINS WATERSHED STUDY

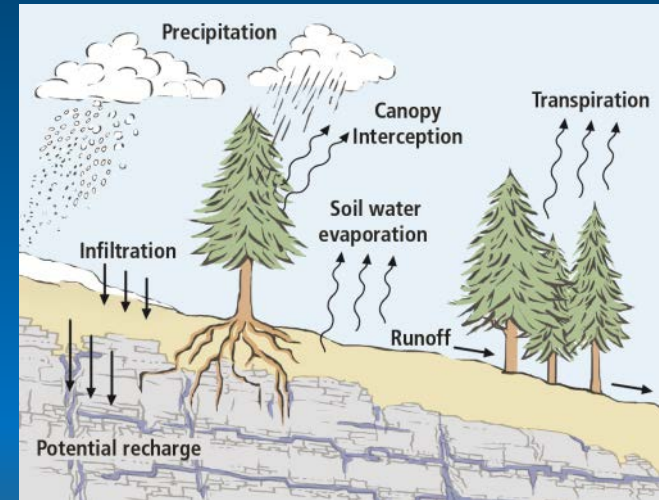
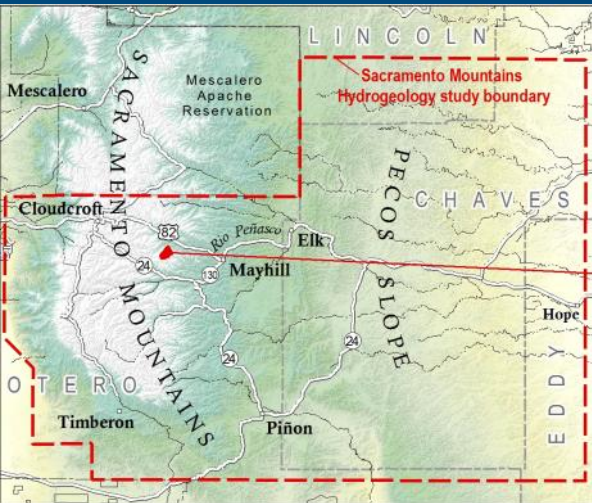


Study area

B. Talon Newton  
Hydrogeologist

Can tree thinning  
increase our water  
supply?

Soil water balance

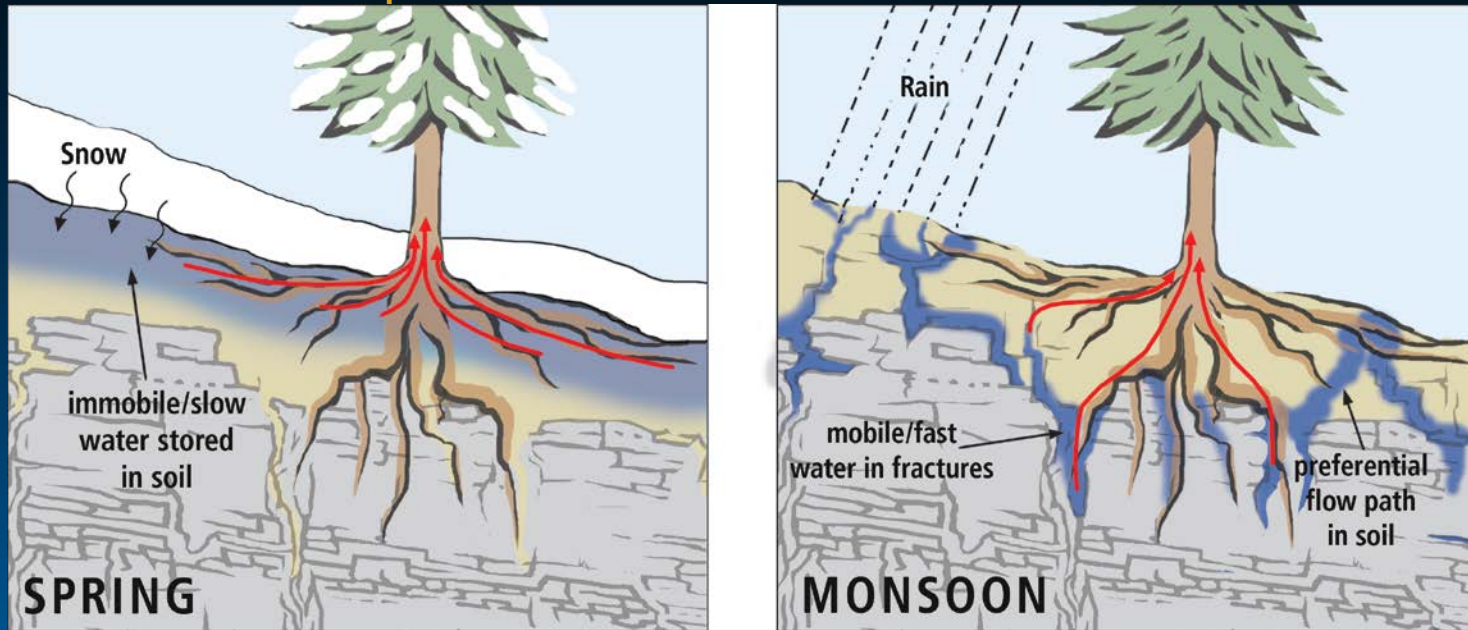


# SACRAMENTO MOUNTAINS WATERSHED STUDY

	Water Balance Component	Effects of Tree Thinning	Comments
Inputs	Rain	Large increase	For a 50% decrease in canopy density, the amount of water reaching the ground can increase by more than 100%.
	Snow	Slight increase	High sublimation losses decrease the relative increase in water that contributes to the soil water balance due to lower canopy interception.
Outouts	Evapotranspiration	Significant decrease	This effect is variable and depends on many factors.
	Runoff	No effect	Runoff in the Sacramento mountains is relatively small, and does not appear to change due to tree thinning.
	<b>Potential recharge</b>	<b>Increase</b>	<b>If preferential flow is the primary mechanism by which water makes its way past the soil column, this increase may be very significant</b>
Storage	Soil moisture	Significant increase	Average soil moisture increases, but seasonal fluctuations do not appear to change

# SACRAMENTO MOUNTAINS WATERSHED STUDY

## Preferential flow paths



## Ideal conditions for increasing water yield by thinning trees

- Above average precipitation
- Low temperatures
- Thin soils
- Geologic conditions that allow water to enter groundwater or surface water quickly



# COME VISIT US IN SOCORRO

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Geologist

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