Taos Region – Stagecoach Hills hydrogeology

Stacy Timmons & Geoff Rawling

NM Bureau of Geology and Mineral Resources

New Mexico Bureau of Geology and Mineral Resources
NEW MEXICO TECH
Earth Science for the 21st Century

NEW MEXICO TECH
SCIENCE • ENGINEERING • RESEARCH UNIVERSITY

NEW MEXICO AQUIFER MAPPING & MONITORING

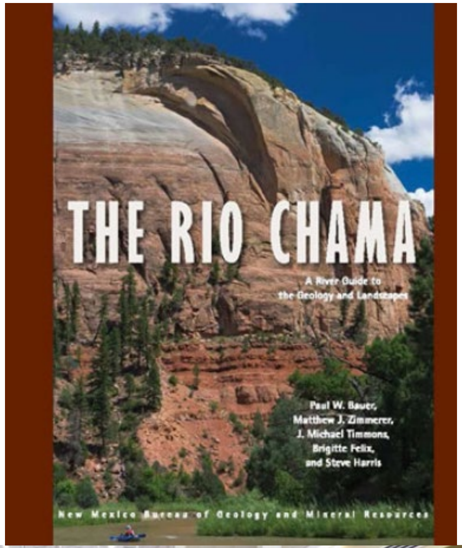
NEW MEXICO WATER DATA

NEW MEXICO WATER EDUCATION

NM Bureau of Geology
A research division of NM Tech

Non-regulatory, state geologic survey, providing science and service to NM since 1927

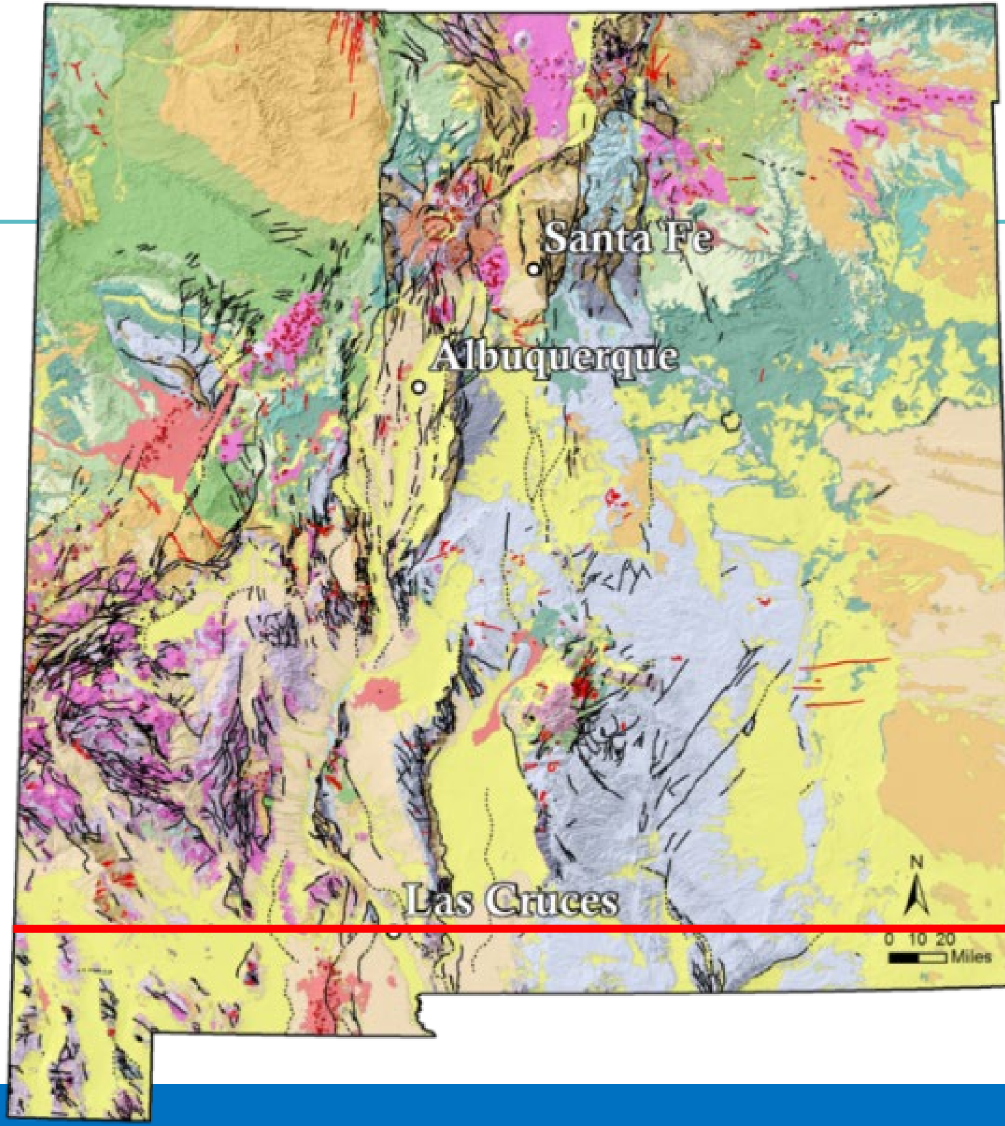
- Geologic Mapping and Hazards
- Energy
  - Oil/gas and geothermal
- Mineral Resources
- Laboratories
- Outreach and Education
- Hydrogeology / Water Programs



Aquifer Mapping and Monitoring Program

- We are the only non-regulatory state agency engaged in this specialized, multidisciplinary water science and research
- New Mexico's geology is complex, and so are the aquifers
- Many aquifers and regions have not been fully characterized

NEW MEXICO
AQUIFER MAPPING
& MONITORING



Aquifer Mapping and Monitoring Program

What We Do

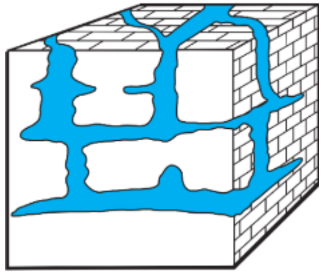
- We analyze the quantity, quality, and distribution of groundwater within aquifers by integrating geological, geophysical, hydrological, and chemical data
- Our work supports communities, agencies, policymakers, and managers in making informed, science-driven decisions on water resources
- We work with funding and support from state, federal, local and philanthropic sources

All together, our team currently has over 250 years of experience!

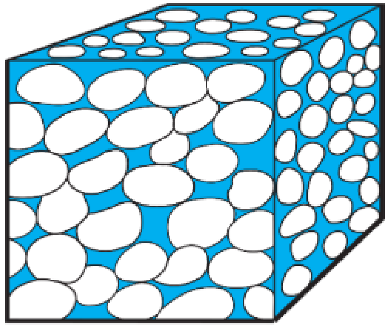
NEW MEXICO AQUIFER MAPPING & MONITORING

Groundwater Basics

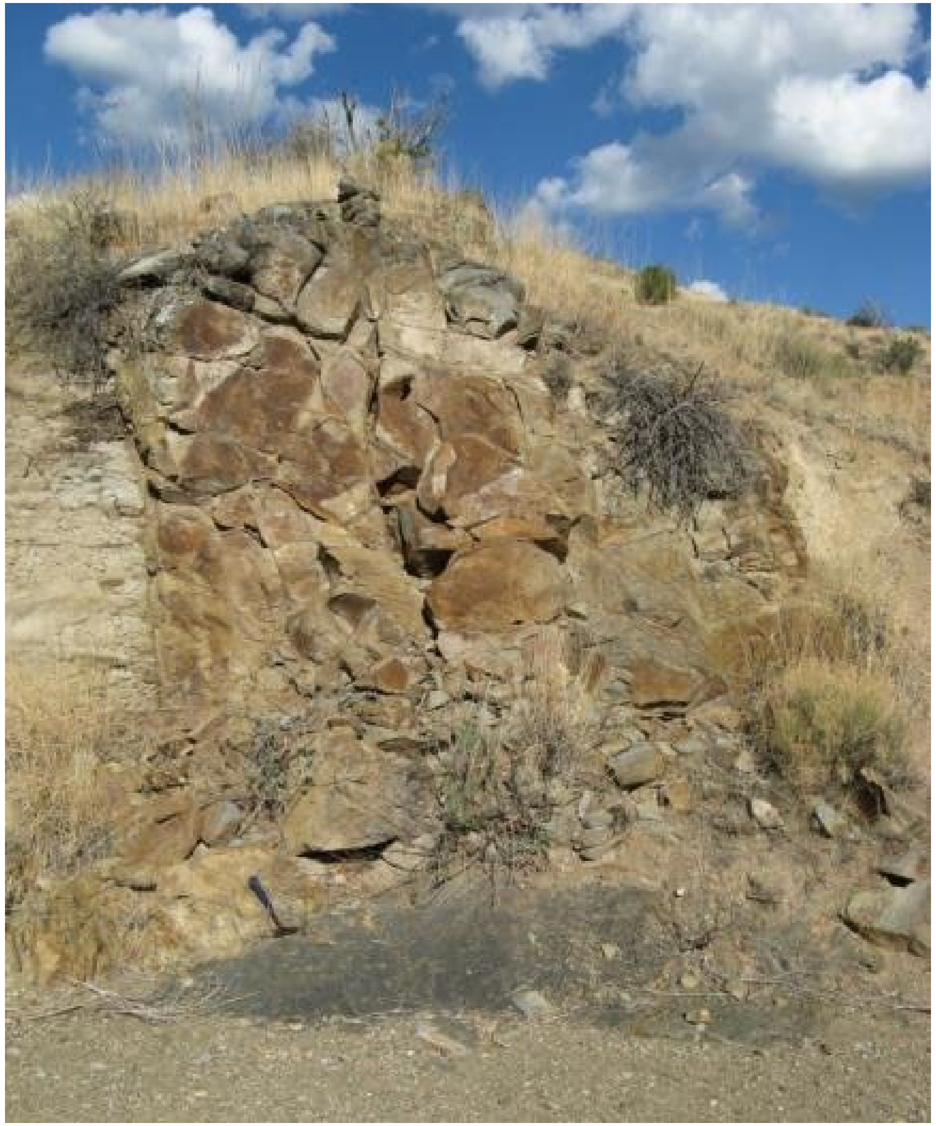
- Aquifers are rocks that can contain or transmit groundwater
- Unlike rivers and lakes, groundwater is hidden from direct observation making quantification more difficult
- Changes and impacts to groundwater take time to observe
- Recharge to groundwater is typically MUCH slower than the it is extracted by pumping
- Deeper formations are typically tighter (poor production) and may have higher mineral content (brackish/saline, or contaminants)

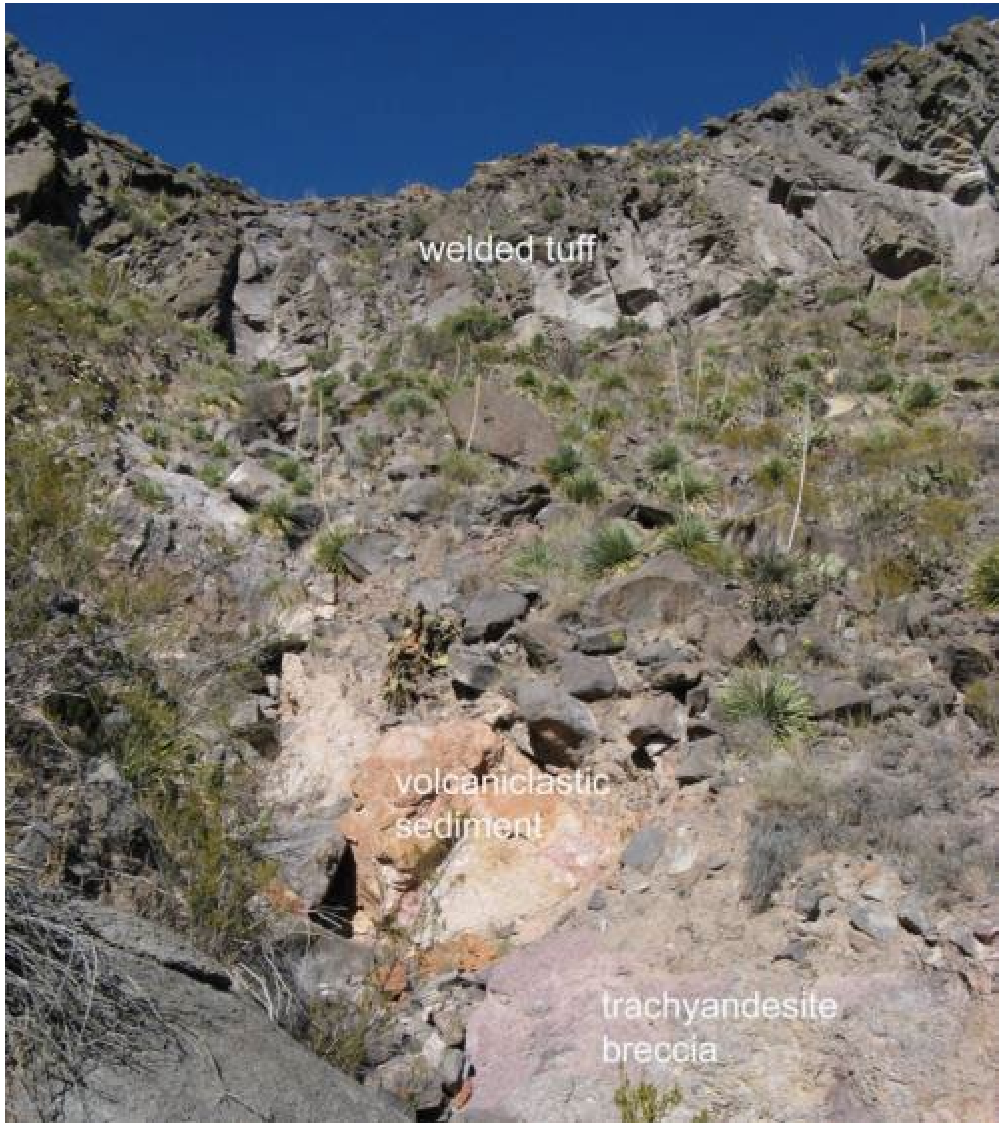


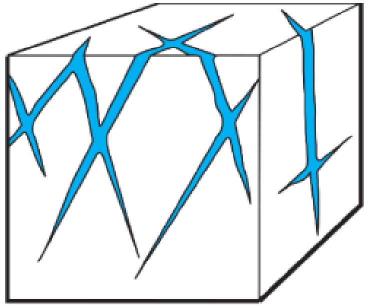
Karst aquifer (caves)



Sediment / Alluvial aquifer materials
(New Mexico’s best aquifers!)

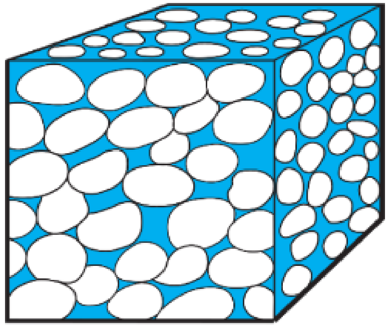


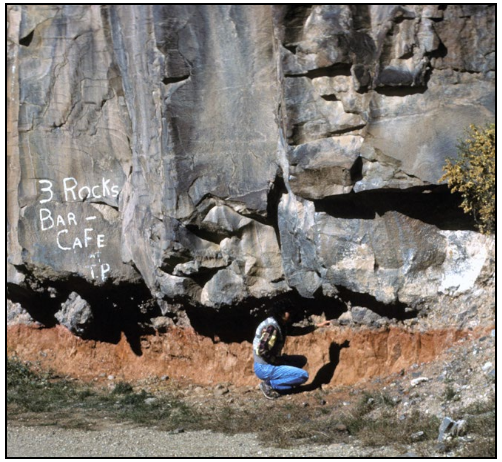


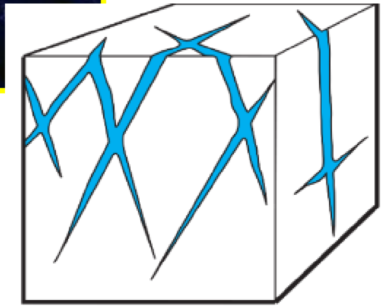


Fractured rock aquifer

The basin is filled with great thicknesses of a variety of materials.

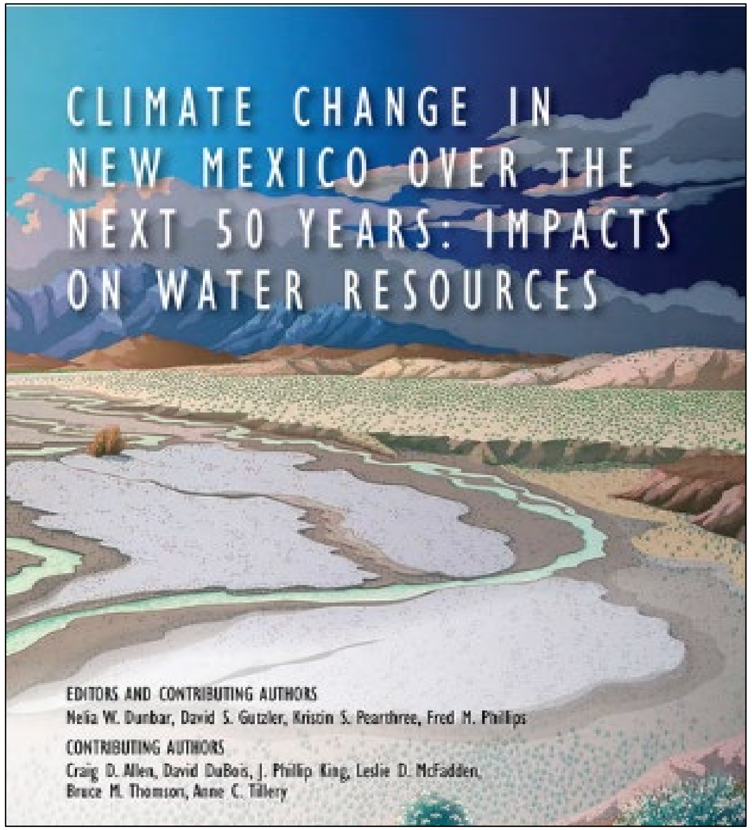




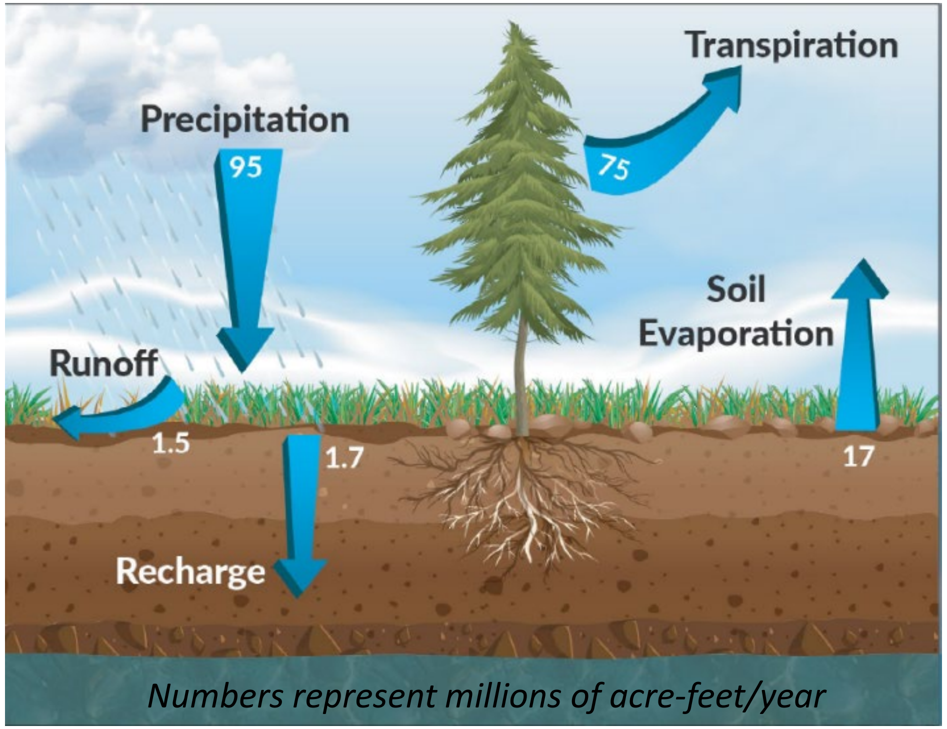


These materials are important for ground water studies.

Water in New Mexico is becoming increasingly scarce



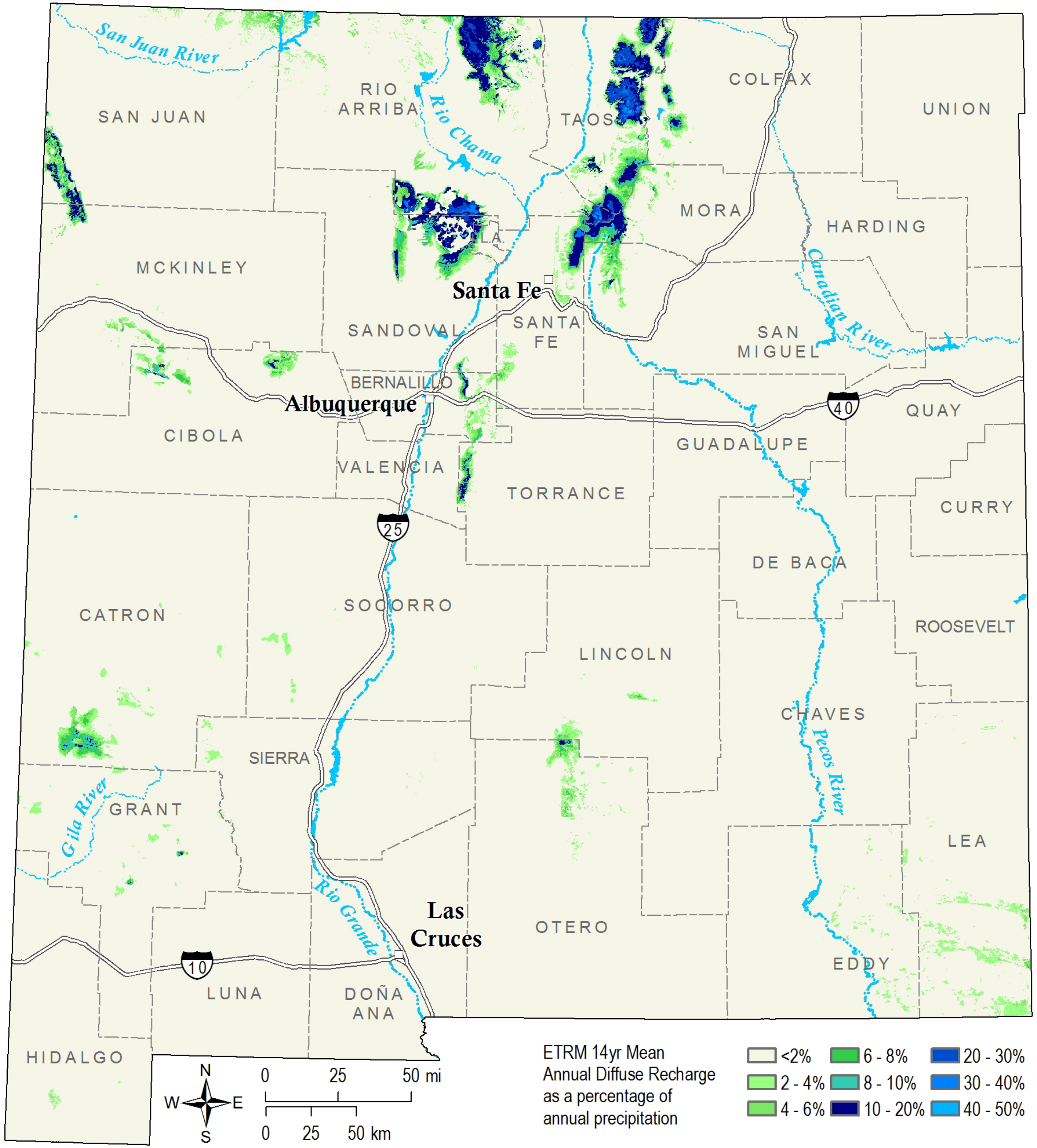
- Average temperatures warming 5-7°F over next 50 years
- Increasing aridity
- 25-30% reduction in surface water
- Increasing demand on groundwater
- Increasing wildfire
- Increasing sedimentation
- Degraded water quality
- And more…



Numbers represent millions of acre-feet/year

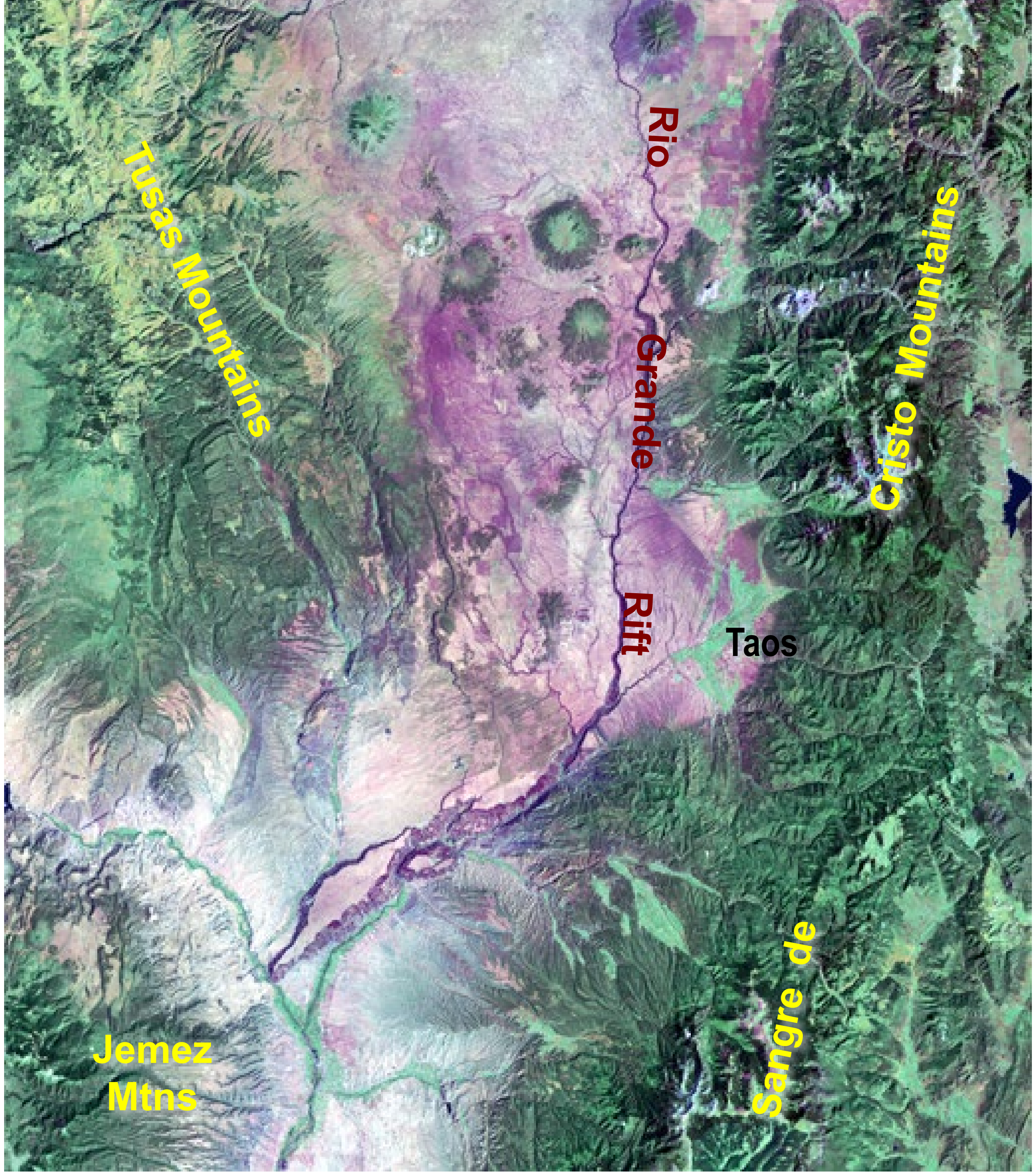
https://geoinfo.nmt.edu/ClimatePanel/report/home.html

With less surface water and increasing aridity, we expect more groundwater use and less recharge to aquifers.



New Mexico Bureau of Geology and Mineral Resources
New Mexico Tech
Earth Science for the 21st Century

NEW MEXICO TECH
SCIENCE • ENGINEERING • RESEARCH UNIVERSITY

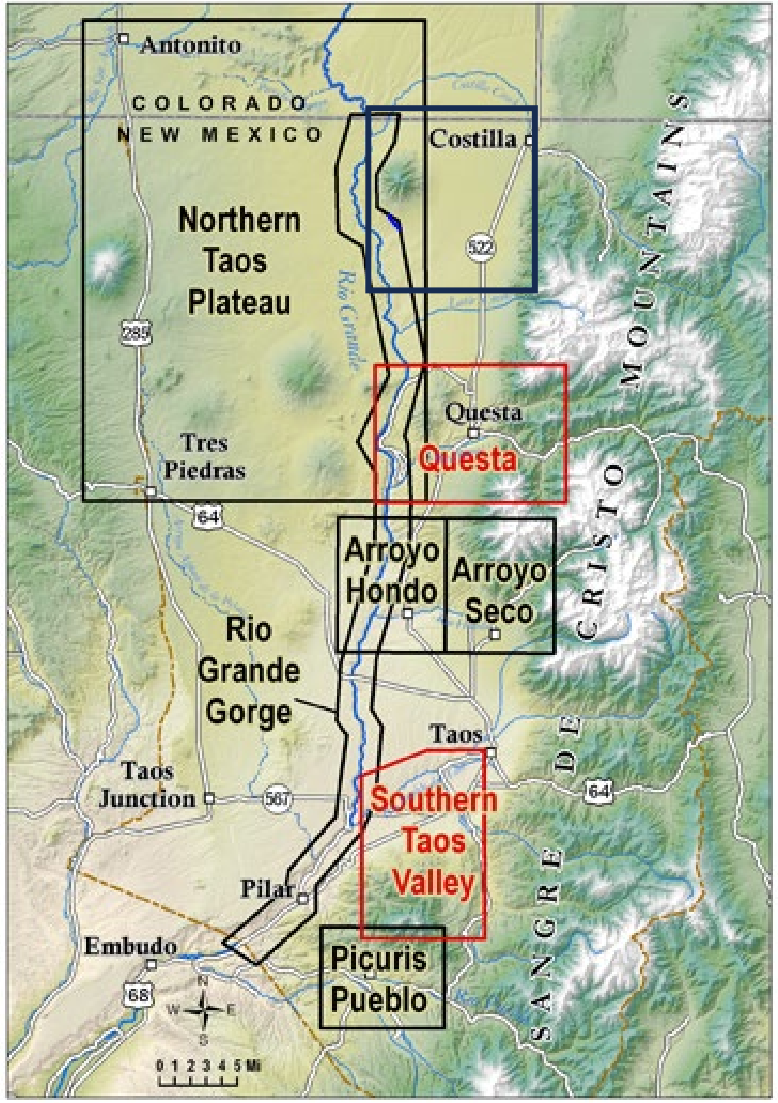

Rio Grande Rift
Tusas Mountains
Cristo Mountains
Sangre de
Taos
Jemez Mtns

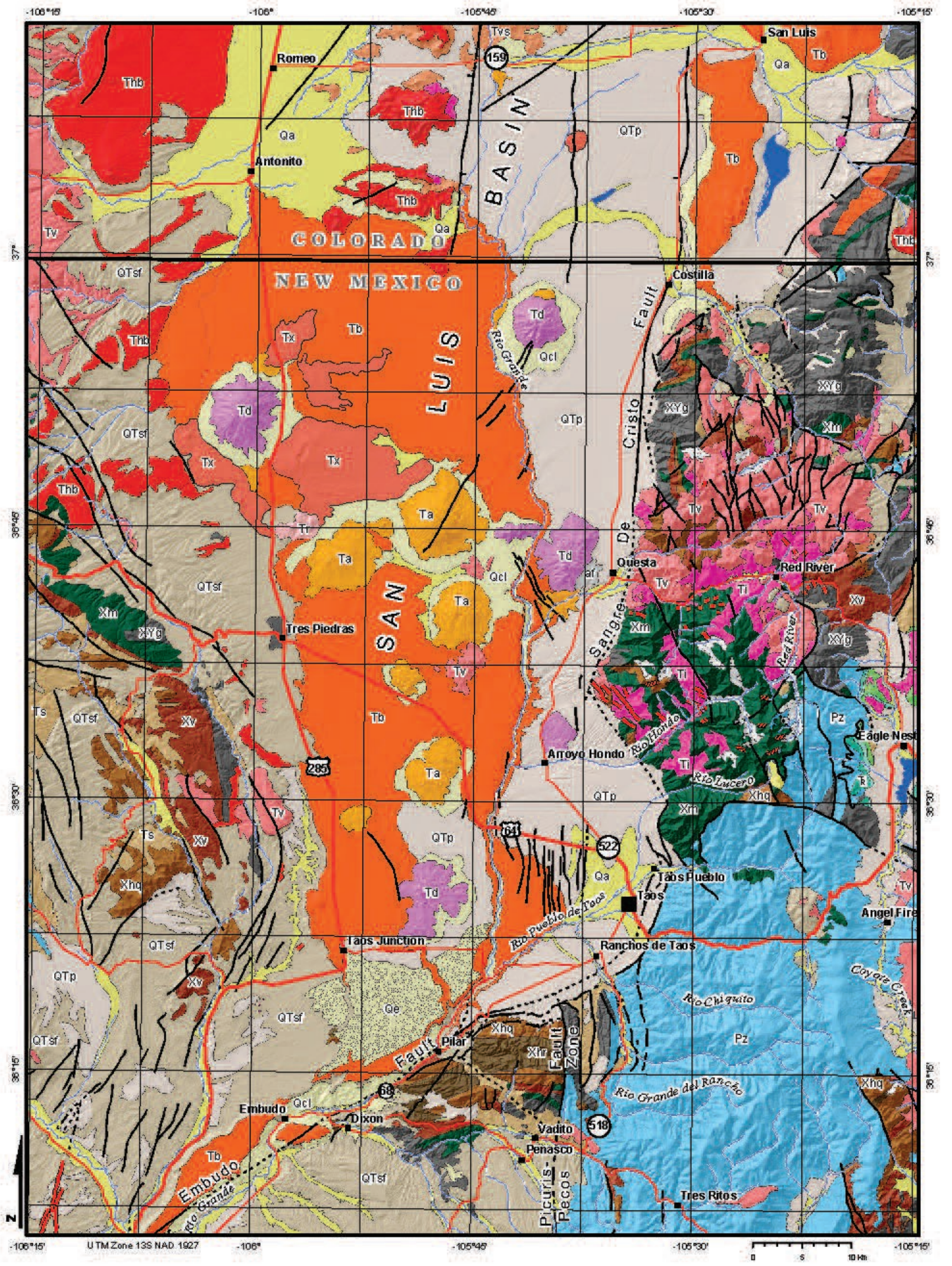

San Luis Basin
Alamosa
COLORADO
NEW MEXICO
Española Basin
Taos
Española
Santa Fe
Santo Domingo Basin
Albuquerque
Albuquerque Basin
Socorro
Rio Grande
Las Cruces
TEXAS
MEXICO
N
0 25 50 Miles

Aquifer Mapping studies in Taos County

- 2005 - Arroyo Seco
- 2007 - Rio Grande Springs
- 2009 - Arroyo Hondo
- 2012 - Northern Taos Plateau
- 2015 - Questa
- 2016 - Southern Taos Valley
- 2020 – Sunshine Valley

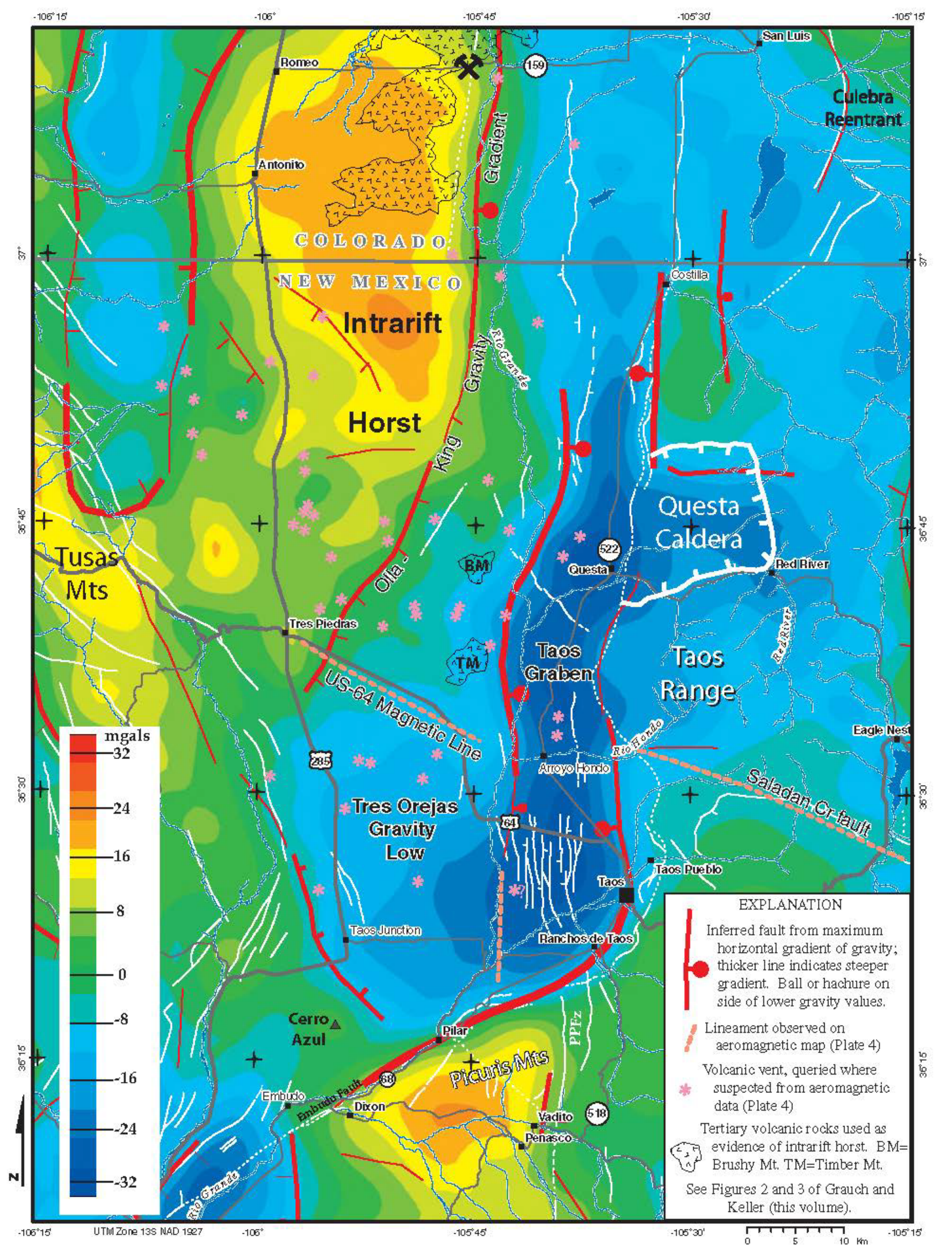
Taos Pueblo - geologic mapping, geophysical studies and characterization of spring water sources in Buffalo Pasture





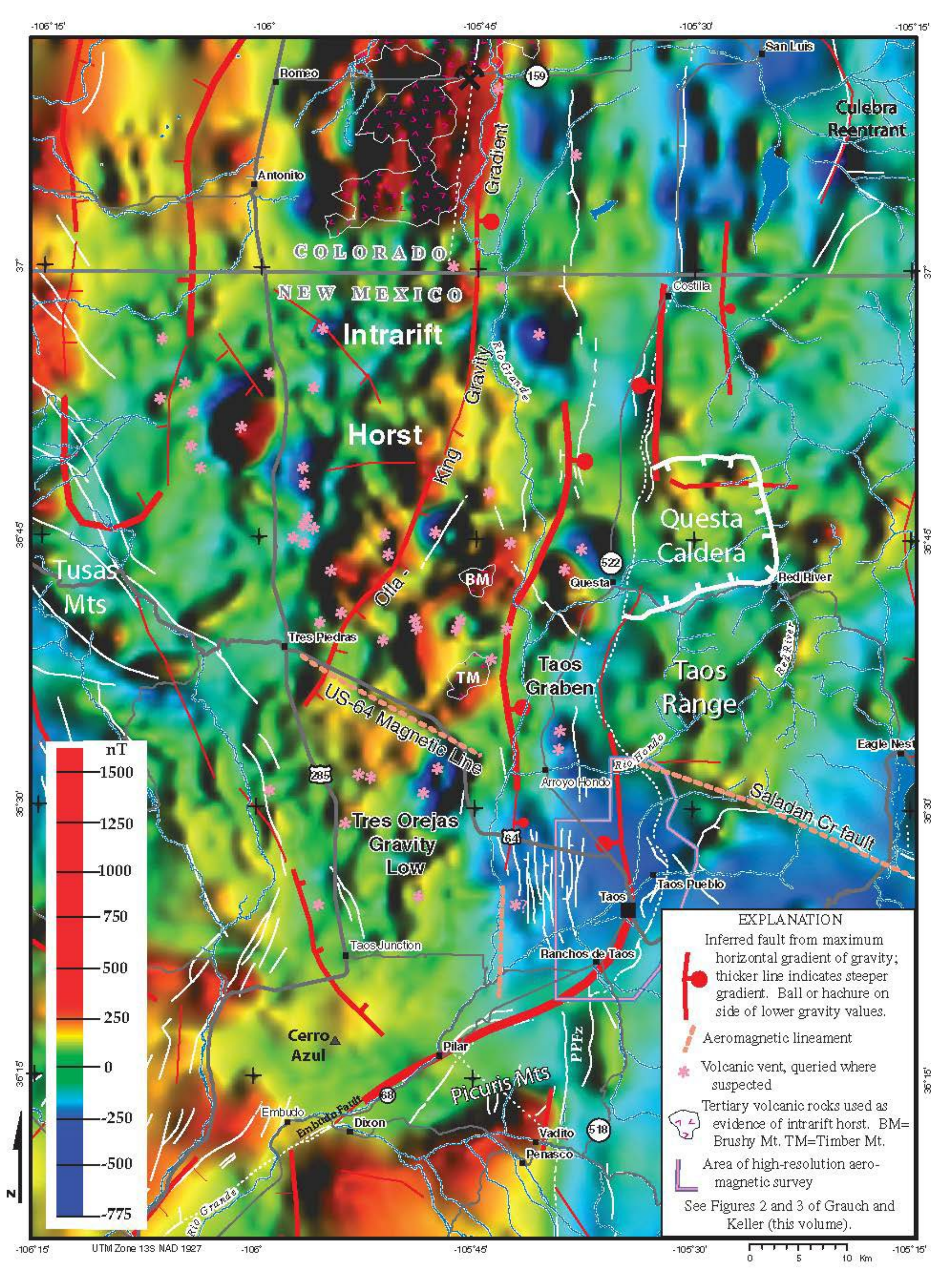
Geology of southern San Luis Basin

- Largest basin of the Rio Grande rift
- Crustal extension from Leadville, CO to Mexico; began here ~ 18 Ma
- East-tilted basin, Sangre de Cristo fault active in the last 30 kyr
- Basin filled with interlayered sediments (Santa Fe group) and basalt lava flows (Servilleta basalt)
- https://nmgs.nmt.edu/publications/guidebooks/55/



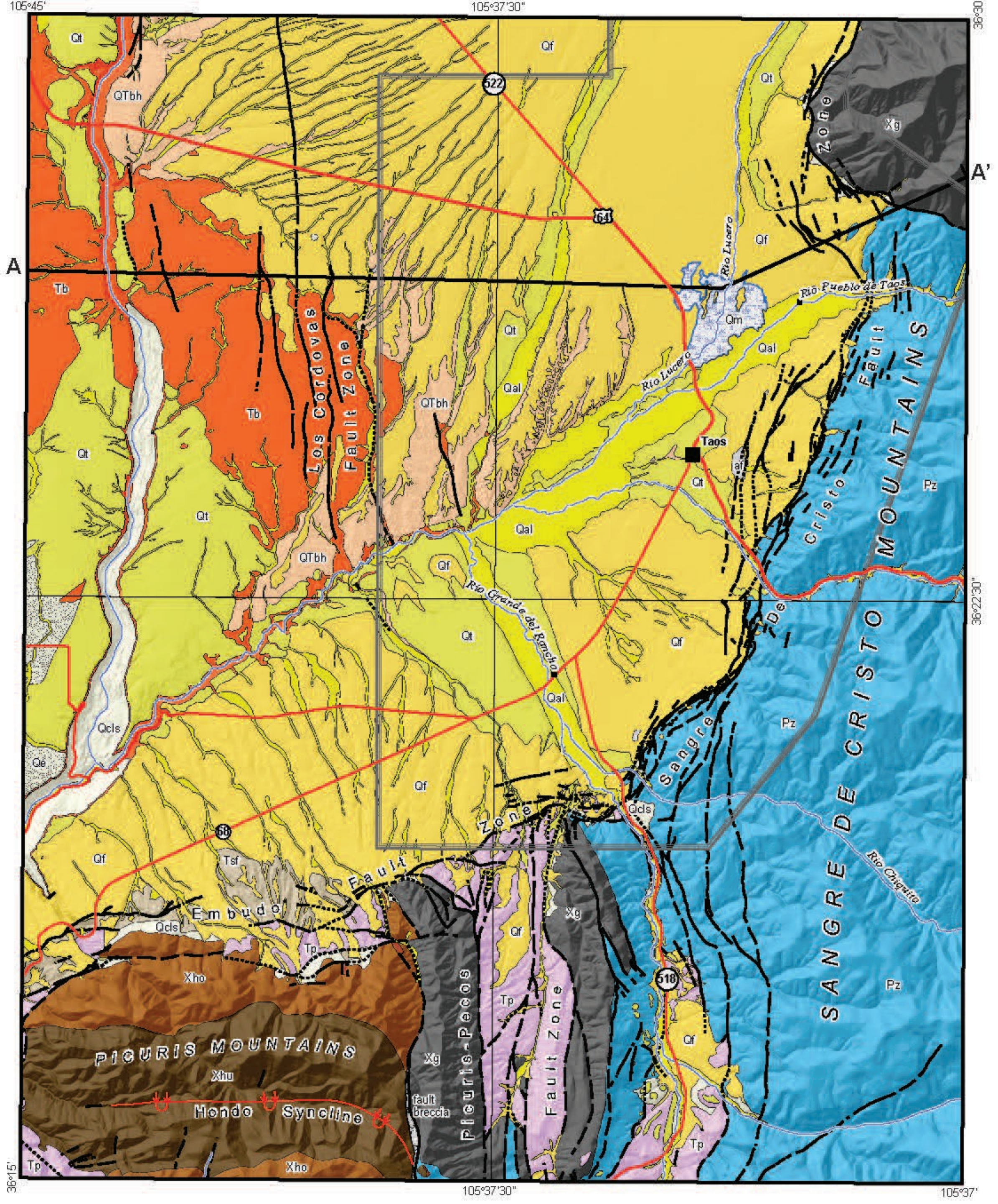
Geophysics - gravity

- Reflects variations in rock density
- Reveals deep geologic structure largely obscured by surface sediment and young basalts
- Deepest part of San Luis basin on east side
- Bedrock of the San Luis Hills horst
- Gradients important = faults = broken rock = much of the course of the Rio Grande
- White lines = faults mapped at surface



Geophysics - magnetics

- Reflects variations in amount of magnetic minerals (e.g. basalts high, sediments low), plus…
- Remnant magnetism (acquired when lavas solidify)
- Also reveals deep geologic structure largely obscured by surface sediment and young basalts
- Gradients important = faults
- Detailed survey around Taos

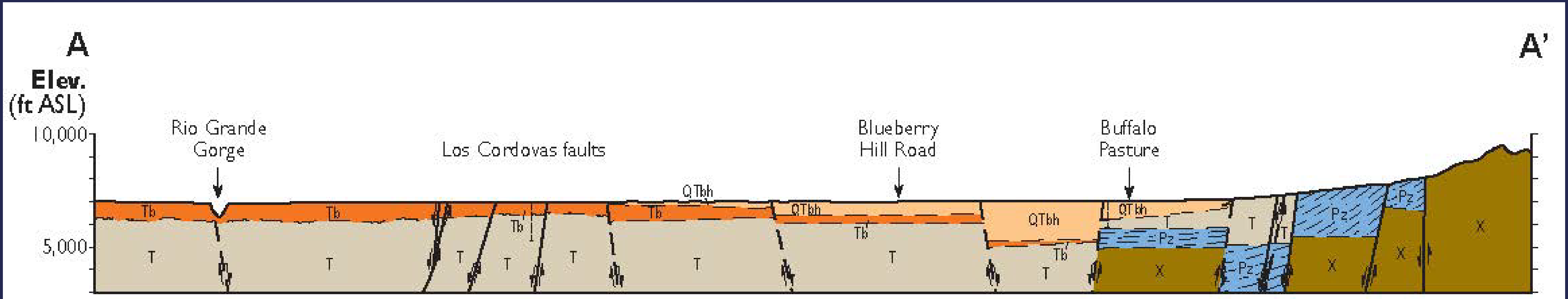


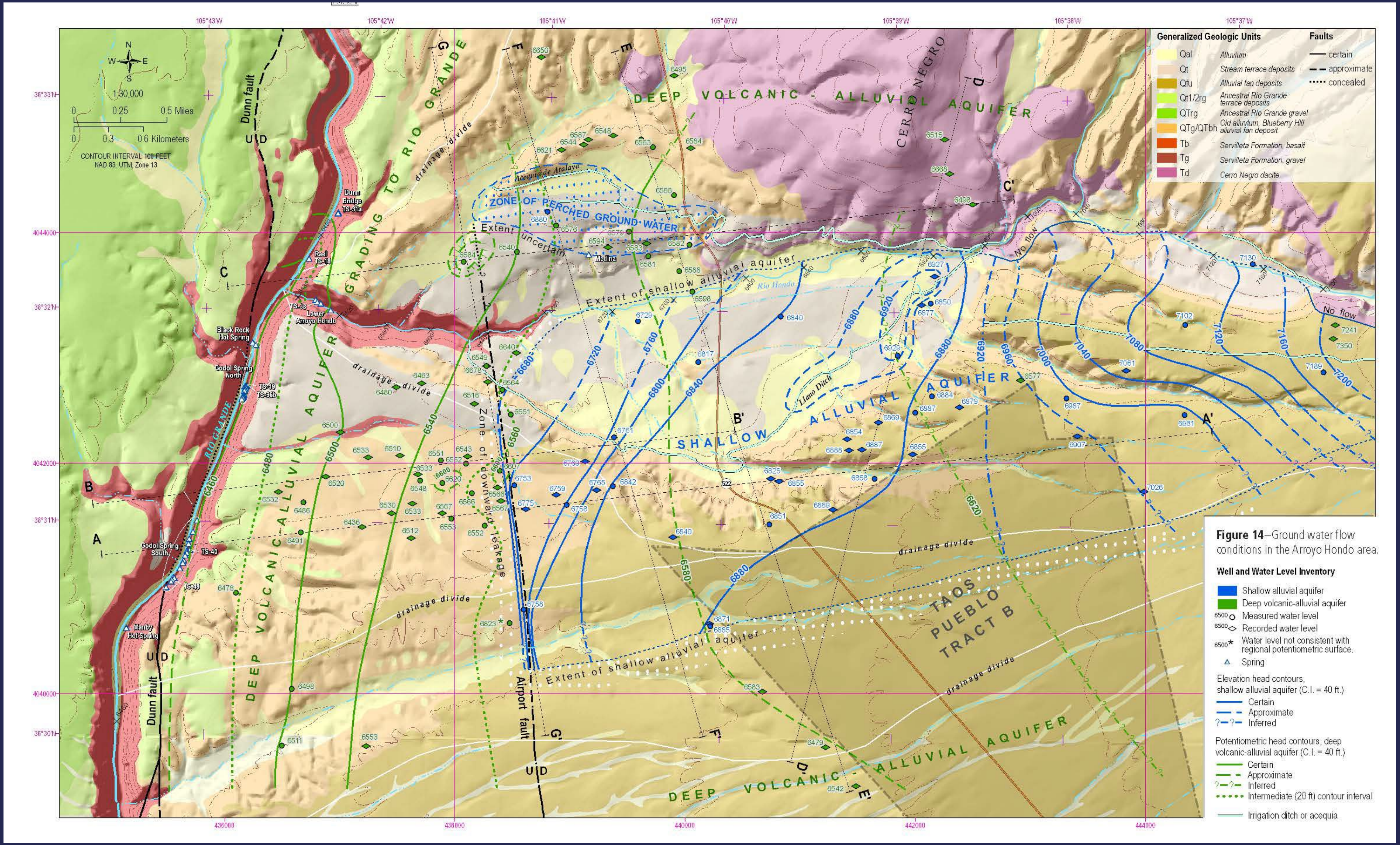
Taos area geology

- Basin filled with sandy and gravelly sediment interlayered with basalt flows
- Youngest sediments (Qt, Qf) thin to west away from mountains
- Proterozoic igneous and metamorphic rocks in Picuris Mts and Pueblo Peak
- Pennsylvanian sandstone, shale, limestone east of town
- Cross section A-A'

Taos area geology cross section

- Taos graben in eastern half
- Youngest sediments (Qtbh) thin to west away from mountains
- Basalts thin to east towards mtns (sources were to the west)
- Older Tertiary sediments of Santa Fe group beneath the basalt flows



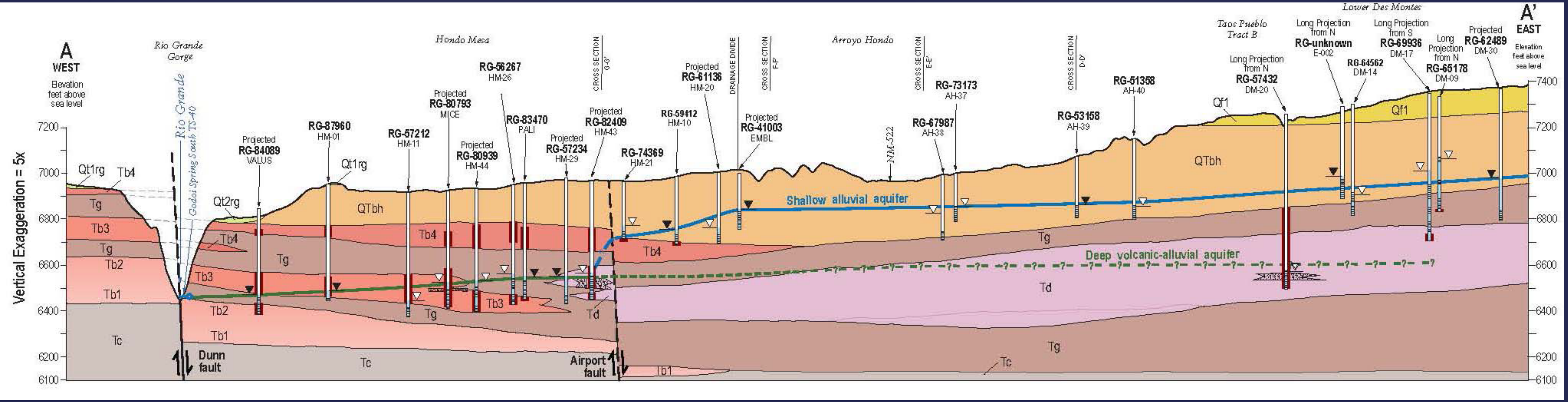


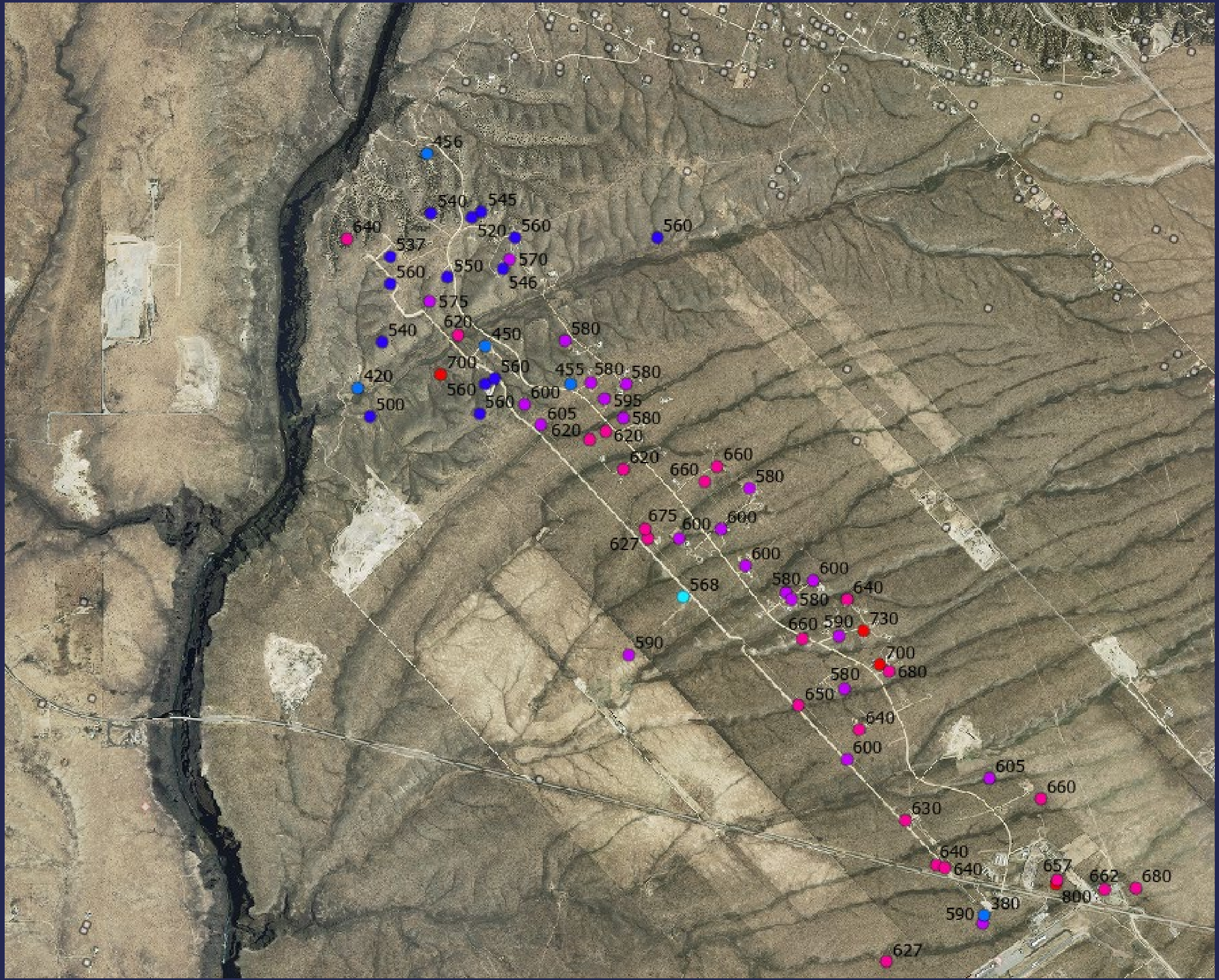
Arroyo Hondo hydrogeology

- Points = wl meas.
- Blue = shallow aquifer water level
- Green = deep aquifer water level
- Aquifers merge at fault
- Flow is E to W
- https://geoinfo.nmt.edu/publications/openfile/details.cfml?Volume=505

Arroyo Hondo hydrogeology

- Wells with screen interval and water level (triangle)
- Blue = shallow aquifer water level
- Green = deep aquifer water level
- Aquifers merge at fault, steep transition in water level

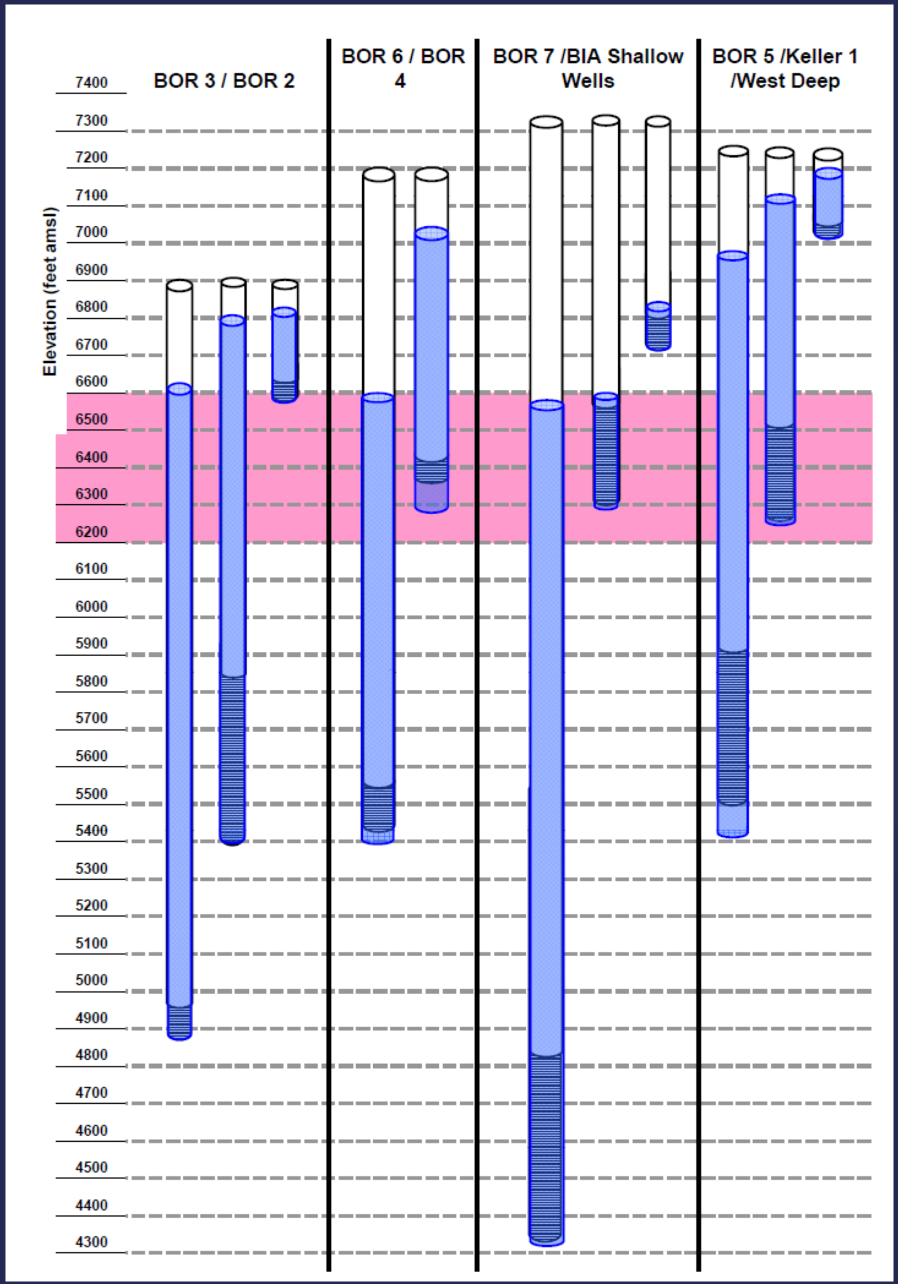




Stagecoach area wells

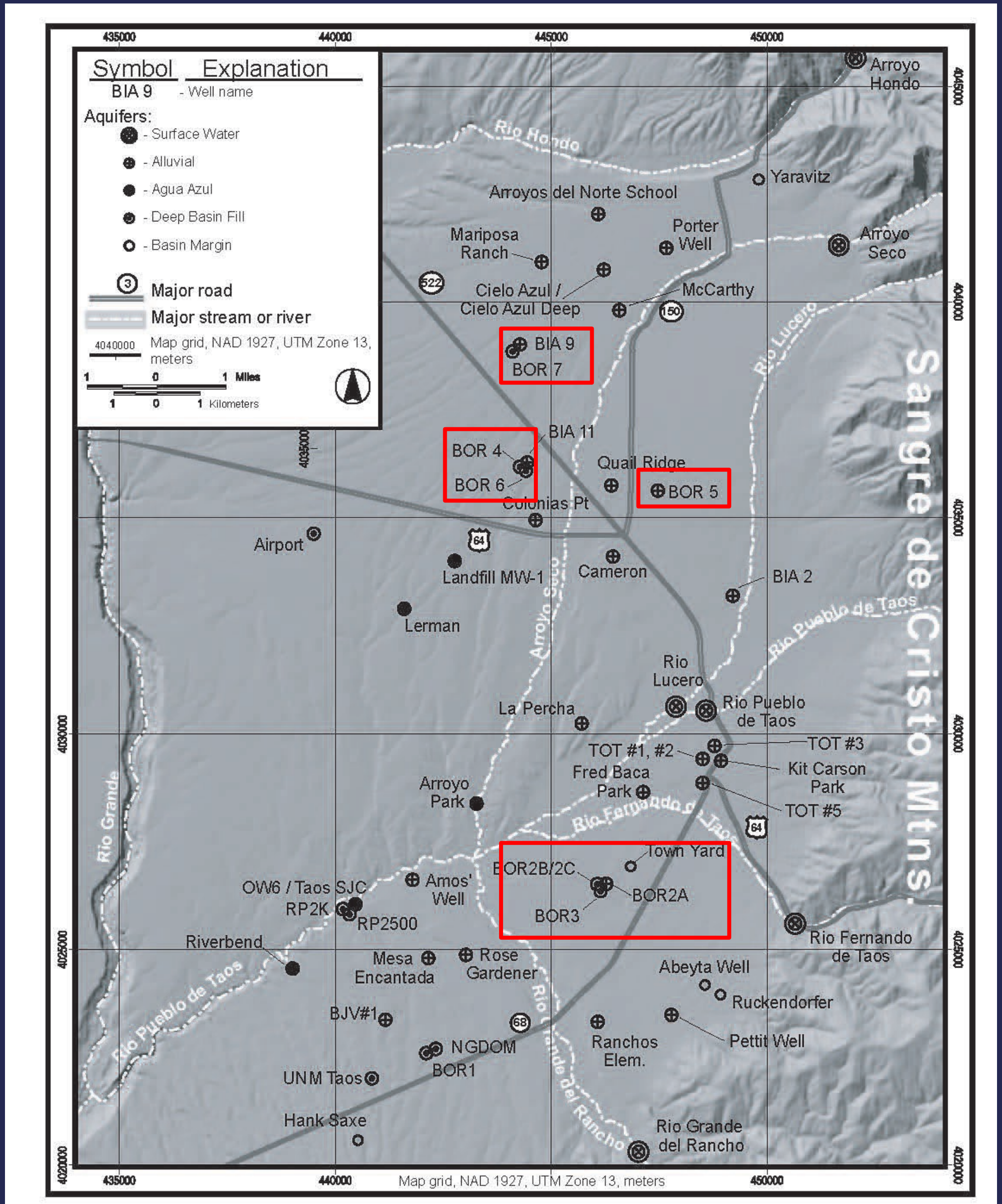
Highlighted well

- Elevation 7009 ft, TD 568 ft, TD elv. 6441 ft
- Wbz 480 – 500, 545 – 568 ft depth
- Wbz interval elv. 6529 – 6441 ft
- Static water level 471 ft depth, 6538 ft elv.
- Rio Grande to the west ~ 6416 ft elv.
- Gradient of 0.01 or ~ 58 ft/mile
- 0.012 to north, Rio Hondo section A-A'



Shallow vs. deep aquifer

- Pink = basalts
- Deep wells, deep water
- Shallow wells, shallow water
- Implies little connection between shallow and deep aquifer



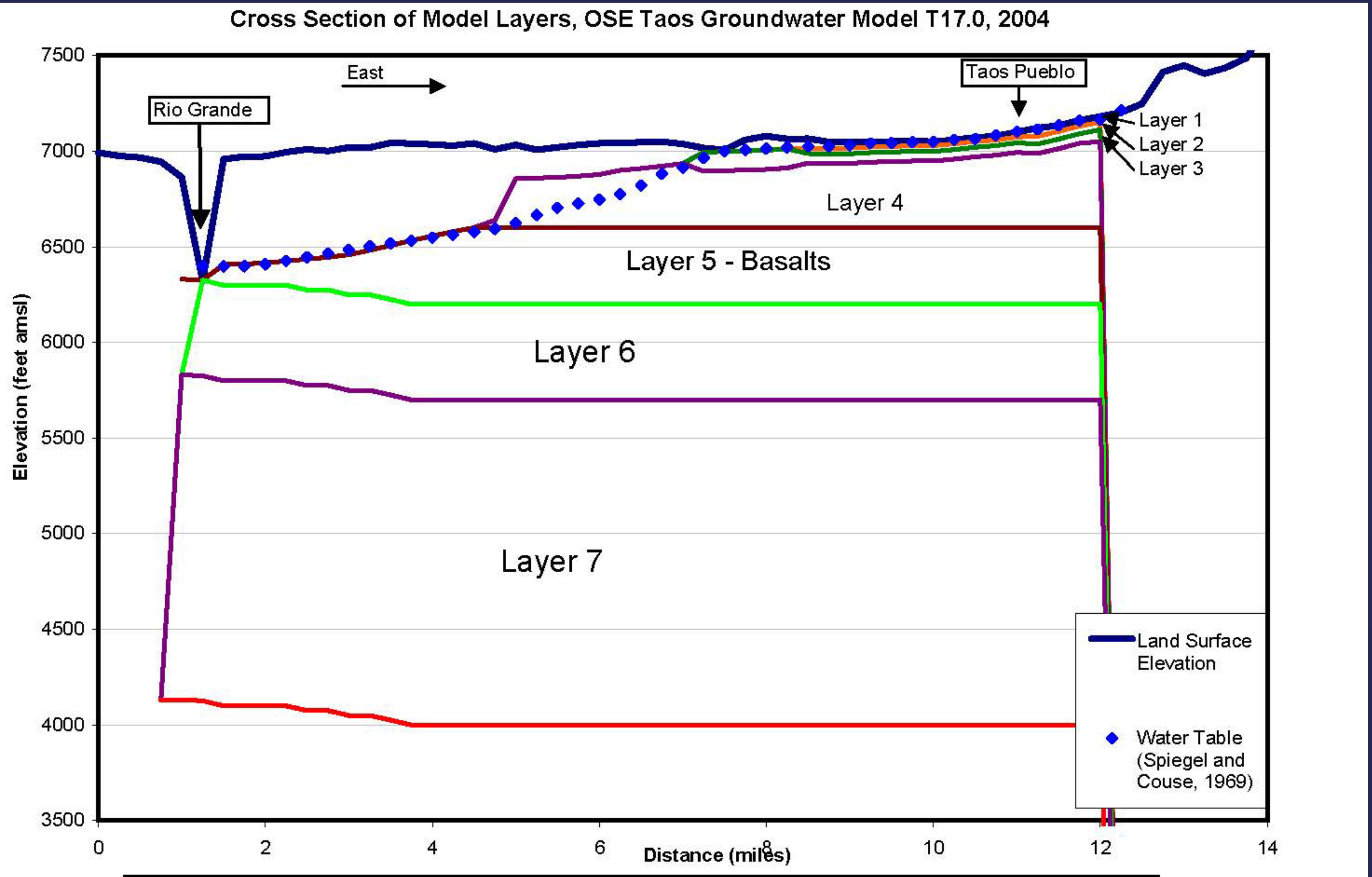
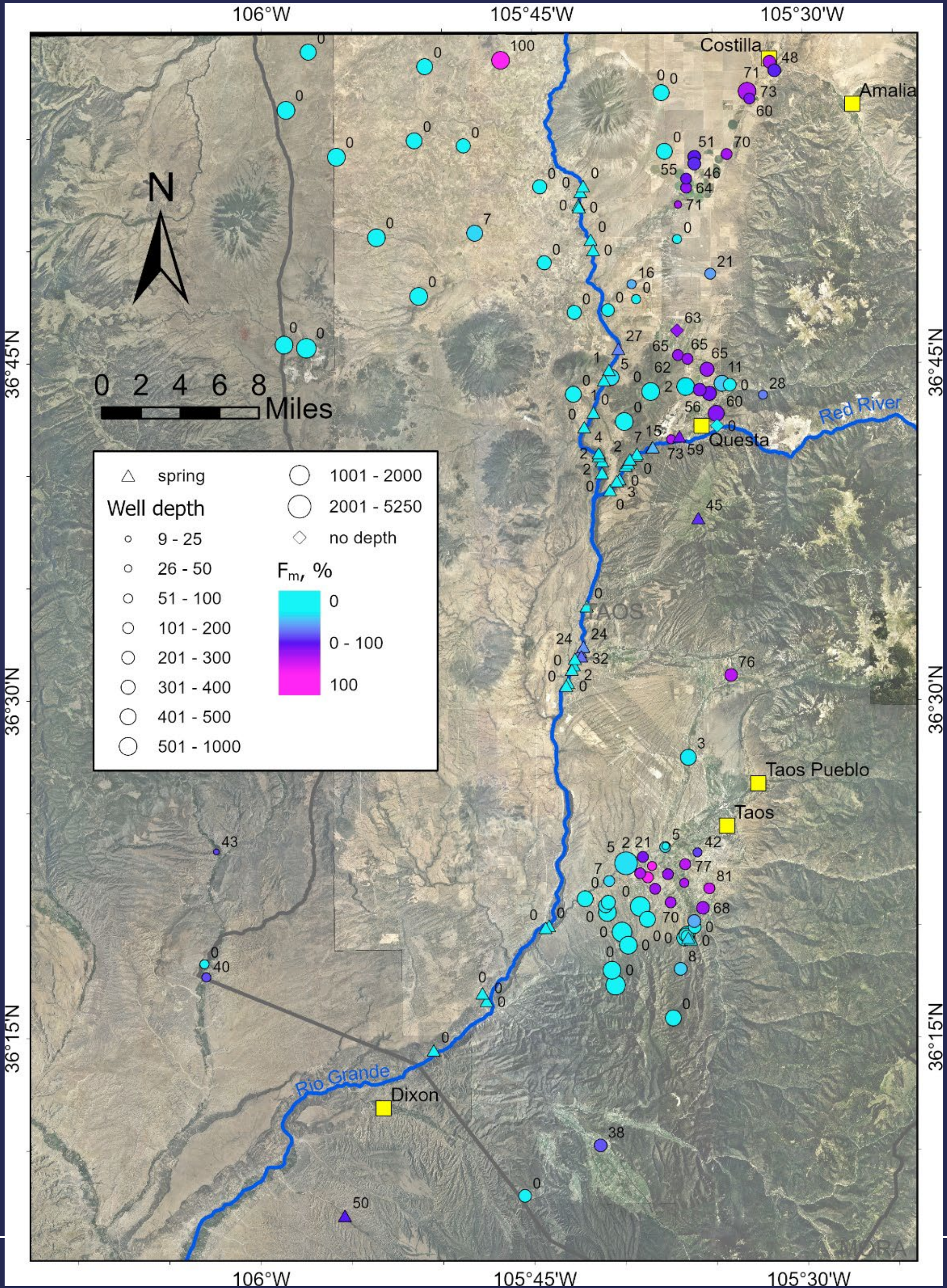


Figure 6: East-west cross section of Model Layers with Approximate Water Table Superimposed.

NMOSE Taos area GW model

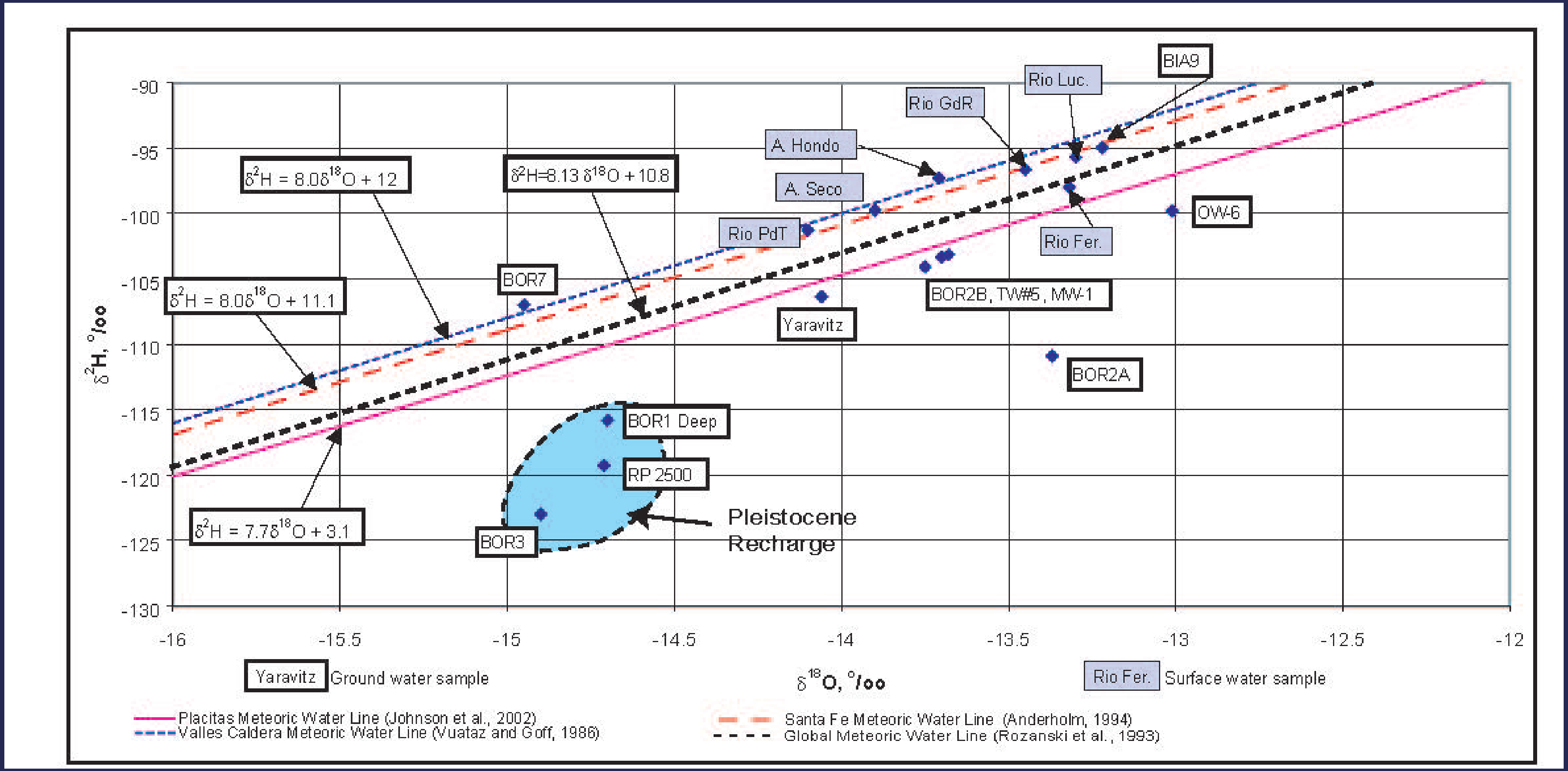
- Layer 5 = basalts
- Layers 6 and 7, deep aquifer beneath basalts
- Blue = combined water table
- https://www.ose.nm.gov/Hydrology/reports.php

Groundwater age from tritium



- Naturally occurring radioactive isotope of H
- Half-life of 12.32 years
- "Bomb pulse" during era of aboveground nuclear weapons tests
- F_m = "Fraction modern" = fraction of water sample recharged post-1953
- Deep wells and gorge springs have little or no modern water = no recharge
- Shallow wells near mountain front have abundant modern water = active recharge

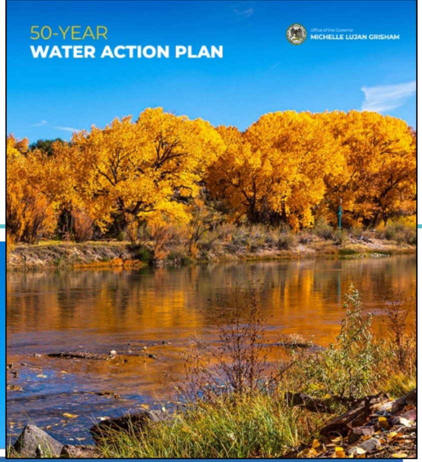
Stable isotopes of H and O

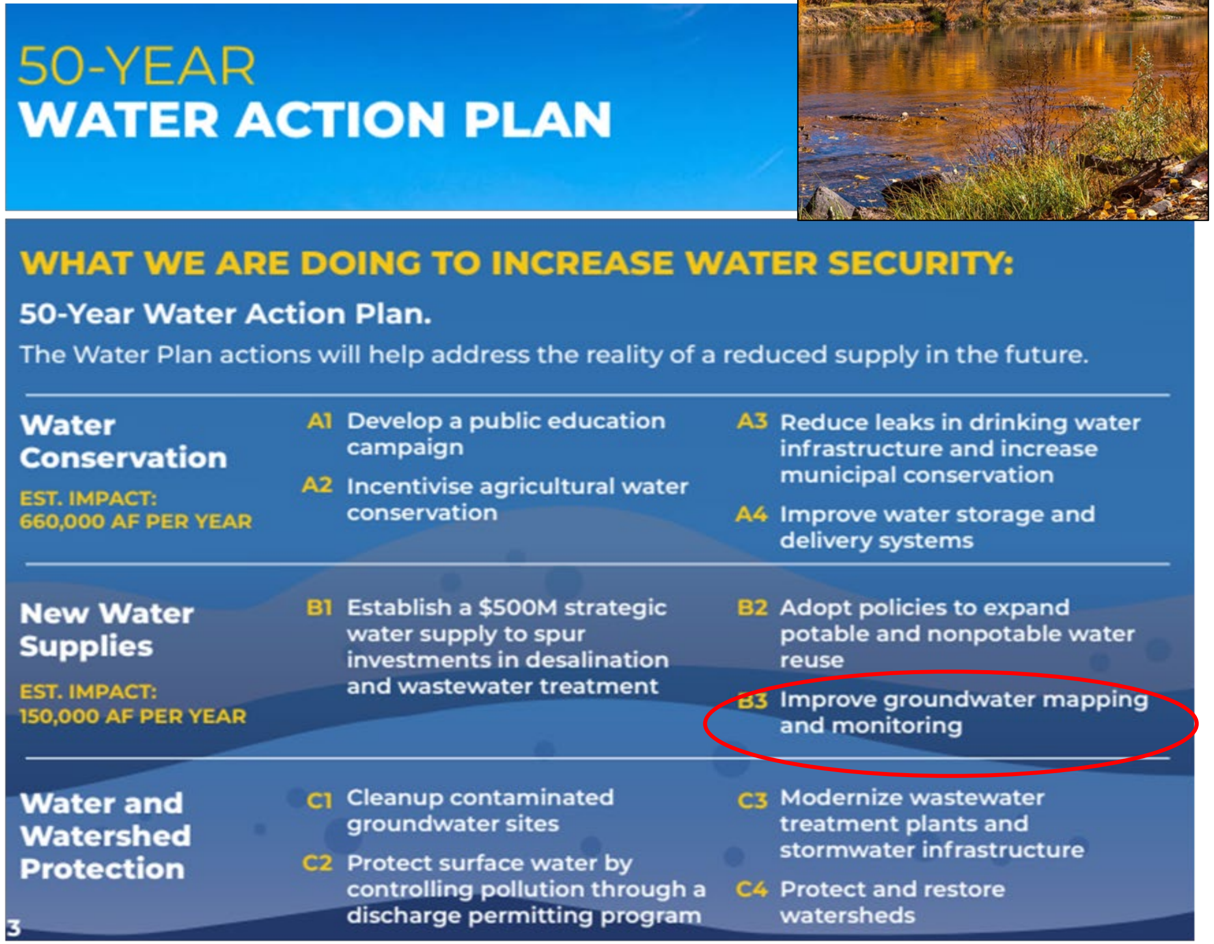


- Isotopic composition is affected strongly by temperature and elevation
- Groundwater plotting off lines is affected by evaporation or colder climate
- Deep wells > 1500 ft show fossil water

NM Bureau of Geology in the 50-Year Water Action Plan

1. **Identify and characterize major and minor aquifers within the state, including fresh and brackish sources by 2032**
   - Develop comprehensive subsurface datasets and model layers to support groundwater management and planning efforts
   - Produce accurate estimates of aquifer boundaries, water quality, and production potential for fresh and brackish aquifers
   - Create online visual tools to provide accessible aquifer visualizations
2. **Establish a statewide groundwater-monitoring network with100 dedicated wells by 2037**
   - Regional and statewide dashboards to effectively monitor groundwater levels





50-YEAR
WATER ACTION PLAN

WHAT WE ARE DOING TO INCREASE WATER SECURITY:

50-Year Water Action Plan.

The Water Plan actions will help address the reality of a reduced supply in the future.

Water Conservation EST. IMPACT: 660,000 AF PER YEAR	A1 Develop a public education campaign; A2 Incentivise agricultural water conservation	A3 Reduce leaks in drinking water infrastructure and increase municipal conservation; A4 Improve water storage and delivery systems
New Water Supplies EST. IMPACT: 150,000 AF PER YEAR	B1 Establish a $500M strategic water supply to spur investments in desalination and wastewater treatment	B2 Adopt policies to expand potable and nonpotable water reuse; B3 Improve groundwater mapping and monitoring
Water and Watershed Protection	C1 Cleanup contaminated groundwater sites; C2 Protect surface water by controlling pollution through a discharge permitting program	C3 Modernize wastewater treatment plants and stormwater infrastructure; C4 Protect and restore watersheds

3

https://www.nm.gov/wp-content/uploads/2024/01/New-Mexico-50-Year-WaterAction-Plan.pdf

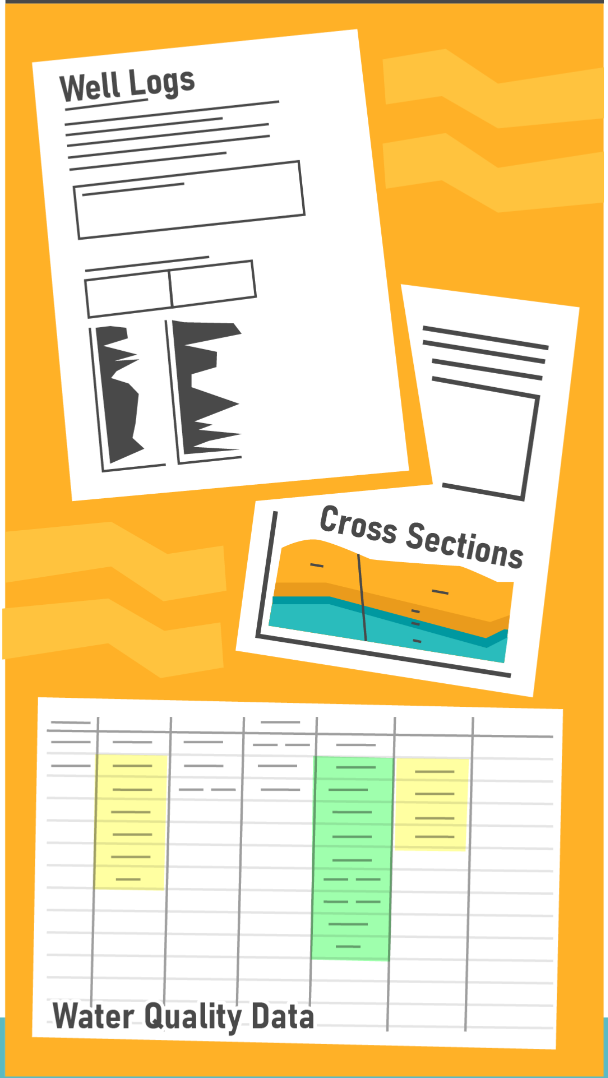
NEW MEXICO AQUIFER MAPPING & MONITORING

New Mexico Bureau of Geology and Mineral Resources
New Mexico Tech
Earth Science for the 21st Century

Step 1

Collect Existing Data

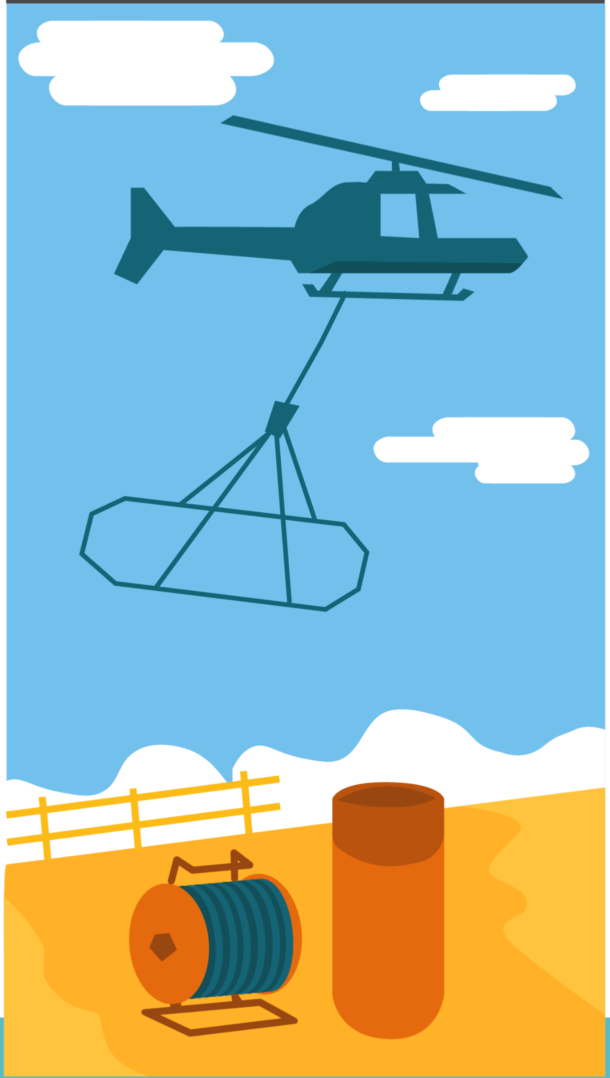
Collection of surveys, well logs, cross sections, water quality data, and models



Step 2

Collect New Data

Conducting AEM surveys, drilling wells, groundwater level measurements



Step 3

Build New Aquifer Maps!

Building new models with new and old data, short reports, data services

NEW MEXICO TECH
SCIENCE • ENGINEERING • RESEARCH UNIVERSITY

Geophysics for groundwater resources: Airborne Electromagnetic Surveys (AEM)

AEM surveys help to identify fresh & brackish groundwater

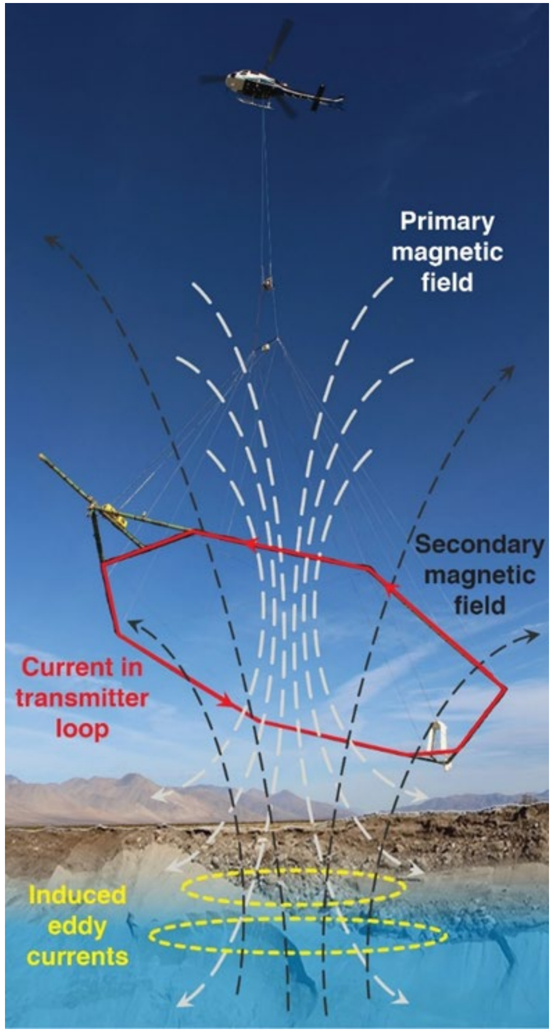
- Facilitate mapping of aquifers & locate sites for new monitoring wells
- Enable coverage of extensive areas without disturbing the ground
- Depth of investigation: ~1500 ft (*depending on equipment & local conditions*)

Ongoing evaluation of technologies tailored for New Mexico basins

- <u>This year:</u> assess tools, teams, and optimize survey coverage

Typical Configuration
- 66-ft diameter hoop
- Suspended 100 ft above ground
- Speeds of 50-60 MPH
- Winds <15 MPH

SkyTEM in flight



AEM Survey Schematic (from CA DWR)

New Data Collection: FY2026

A. **Lower Rio Grande Basins (Intera/GIP)**
   - Fall 2025
   - Total Line Length: ~2500 miles

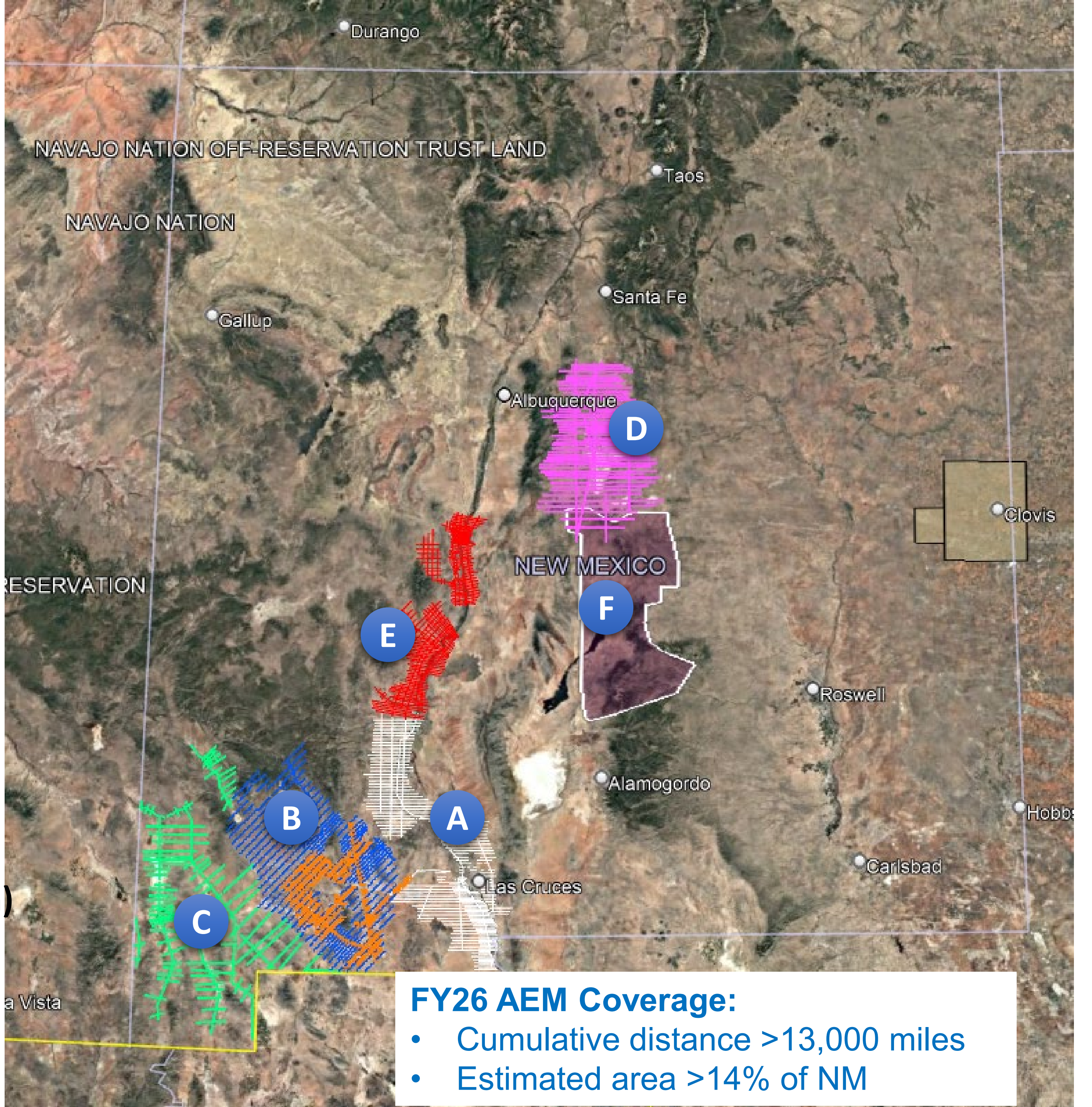
B. **Mimbres Basin (WSP/AGF)**
   - Fall 2025
   - Total Line Length: ~2000 miles

C. **Gila–Animas Valley Region (DBSA/Geotech)**
   - Fall 2025
   - Total Line Length: ~1250 miles

D. **Estancia Basin (DBSA/Geotech)**
   - Winter 2026
   - Area: ~2350 sq. miles
   - Total Line Length: ~1700 miles

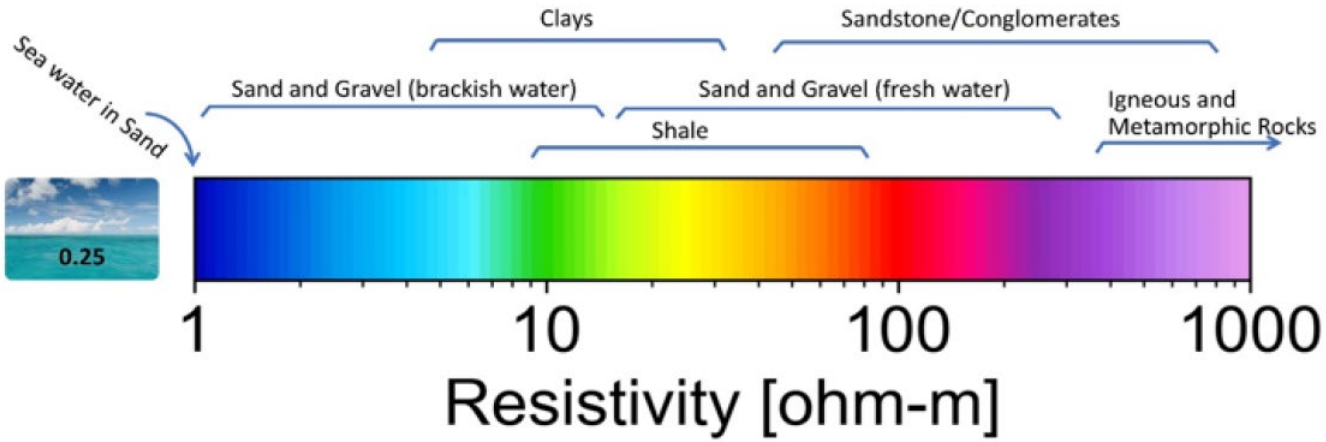
E. **Middle Rio Grande Basins (SSPA/Ramboll)**
   - Winter 2026
   - Total Line Length: ~2000 miles

F. **Northern Tularosa Basin – Ruidoso Slope (Geotech)**
   - Spring 2026 (underway NOW)
   - Length: ~1200 miles

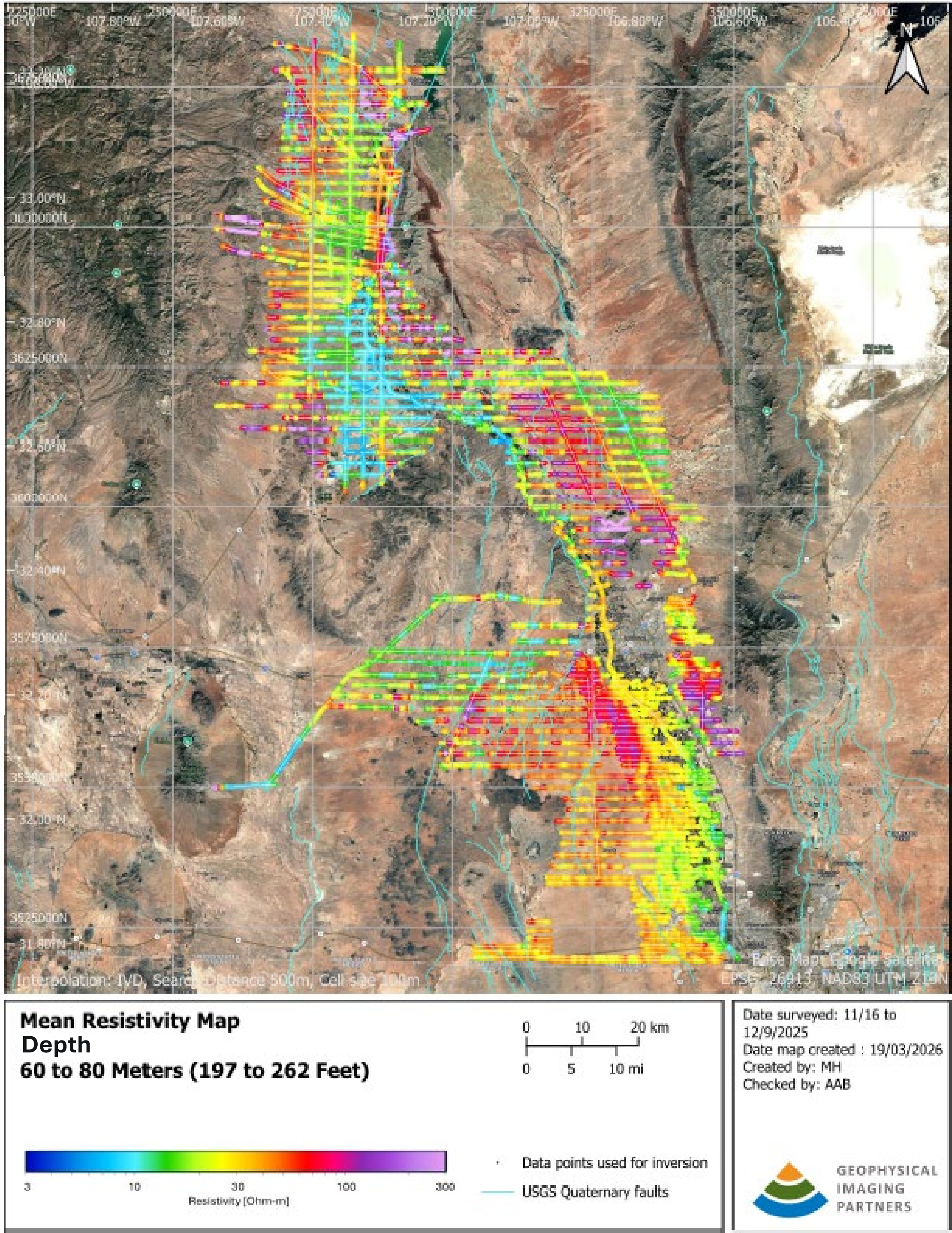


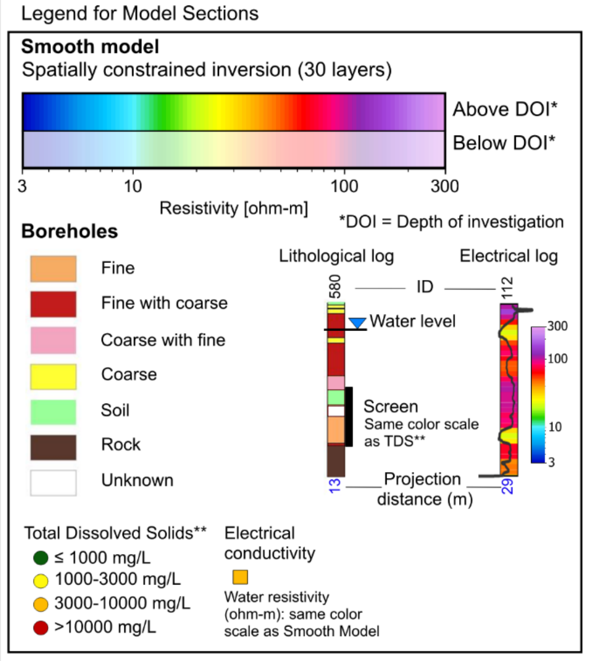
FY26 AEM Coverage:
- Cumulative distance >13,000 miles
- Estimated area >14% of NM

Mean Resistivity Map

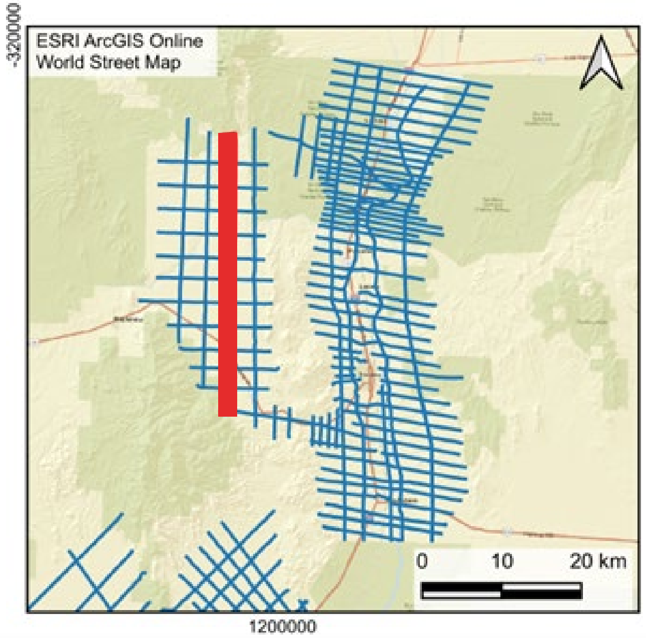


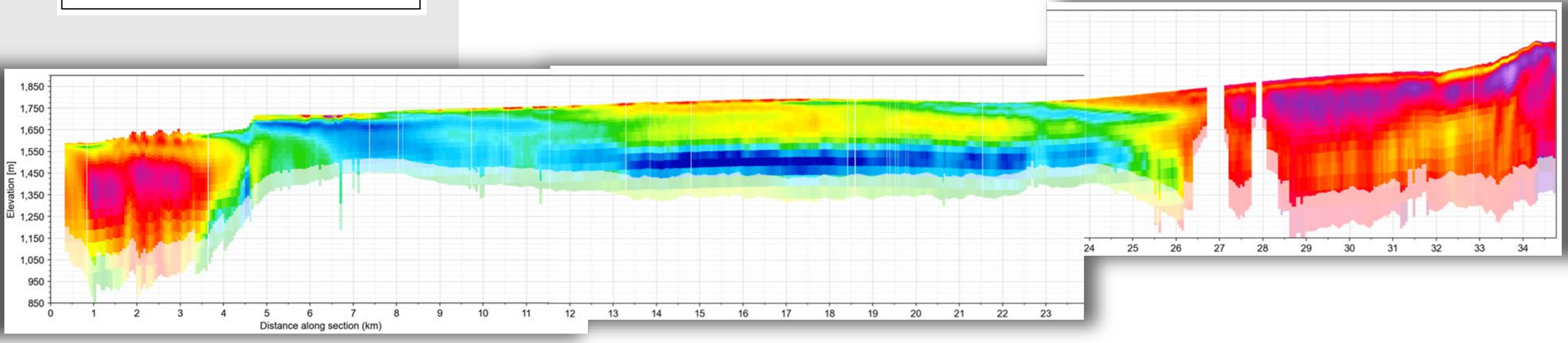
- Distinct regional variances in resistivity values across the survey area





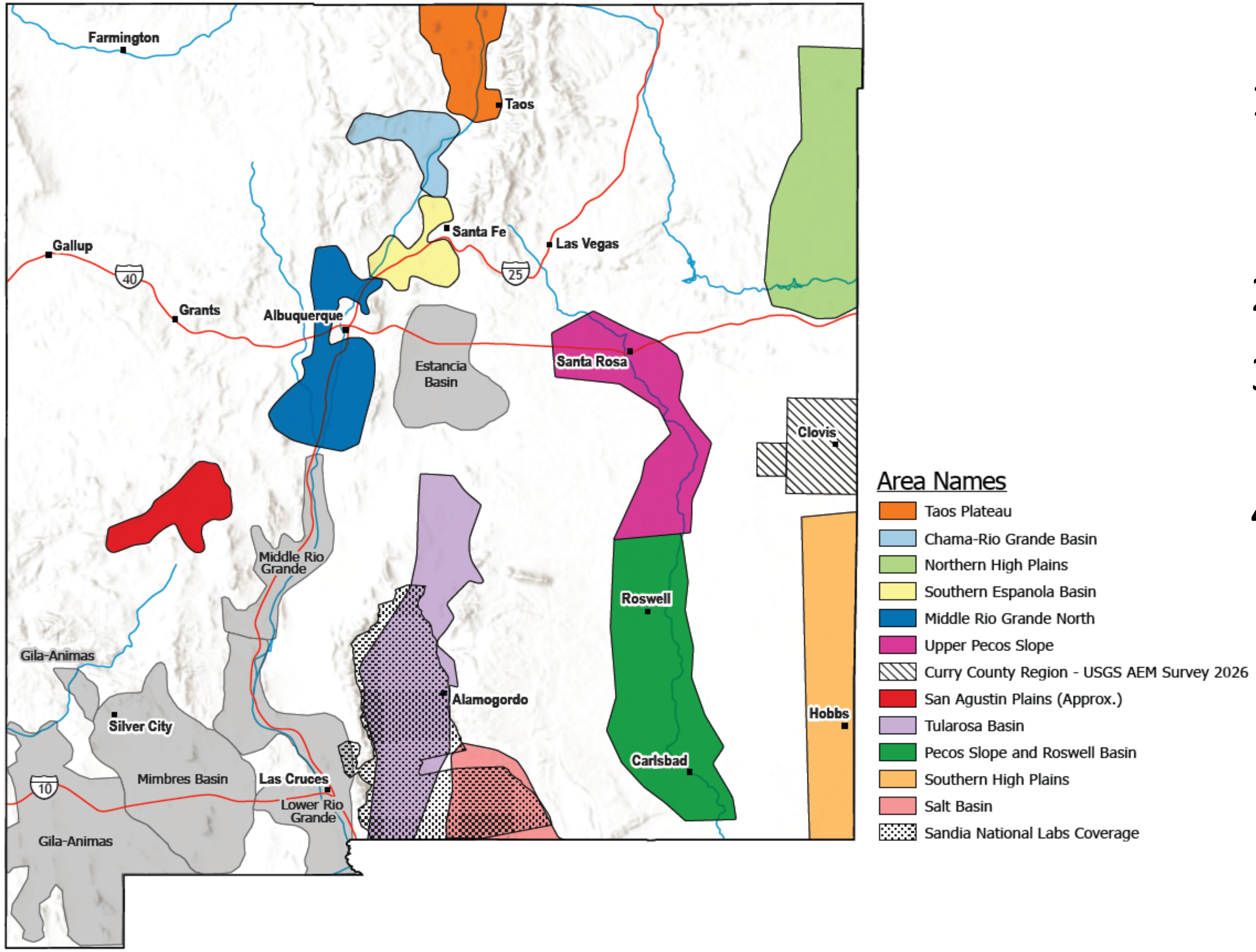
DRAFT Results
Resistivity Inversions
La Jencia Basin





Σ²Π

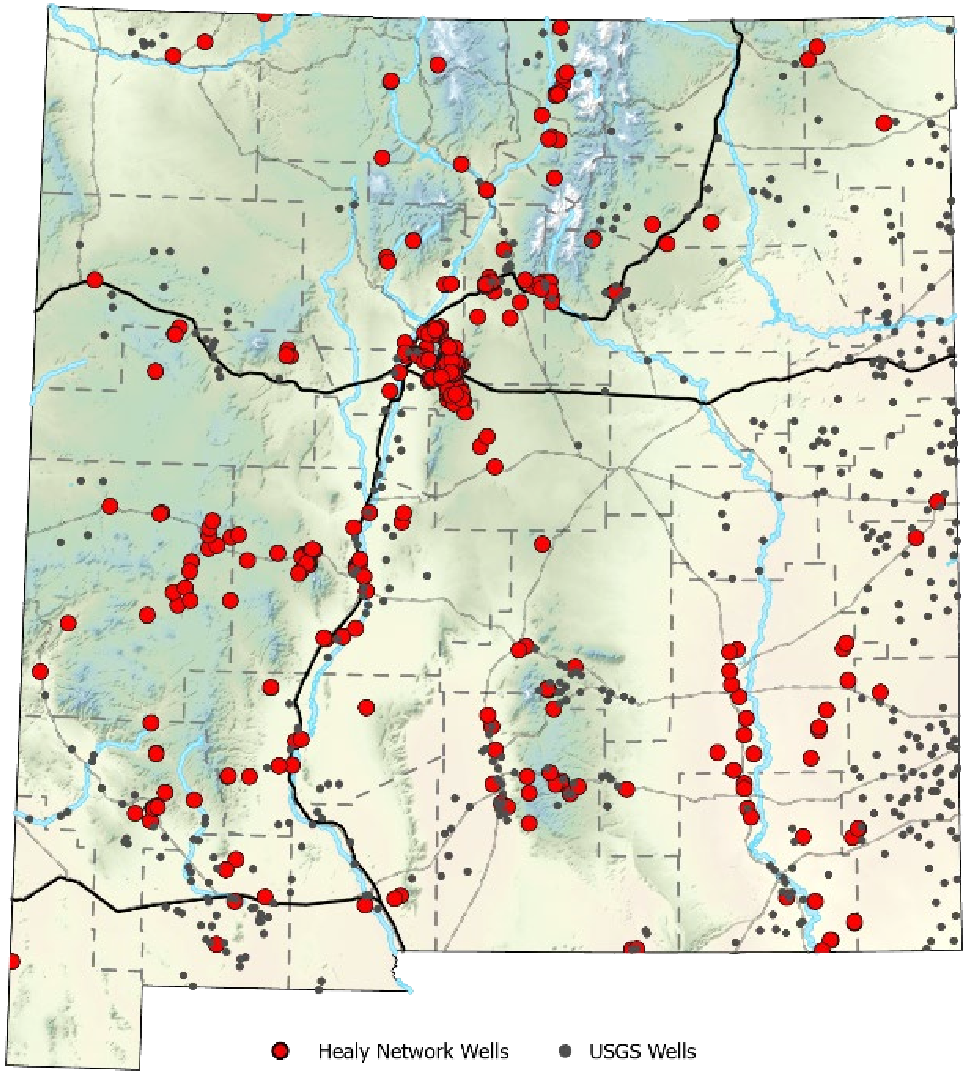
A multi-year project: Looking ahead to next year



1. Continue building conceptual hydrogeologic models with consulting teams
2. Developing data sharing platforms
3. Determining locations for exploration well drilling
4. Additional data collection in new regions!

NEW MEXICO AQUIFER MAPPING & MONITORING

With geologically complex state facing climate impacts, we need even more water data!

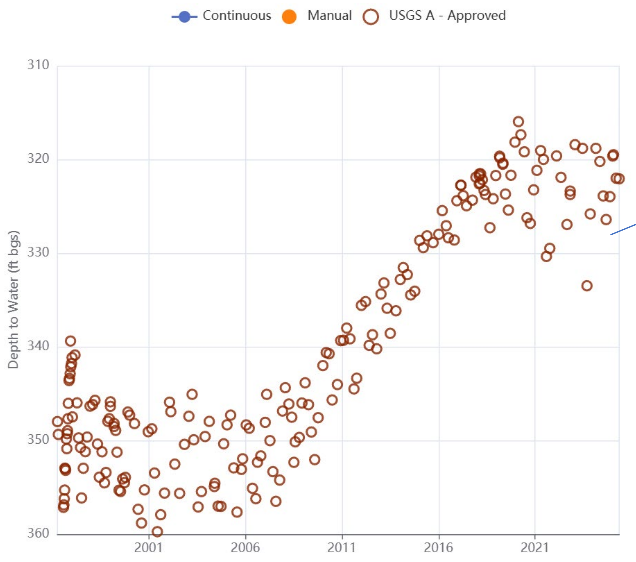


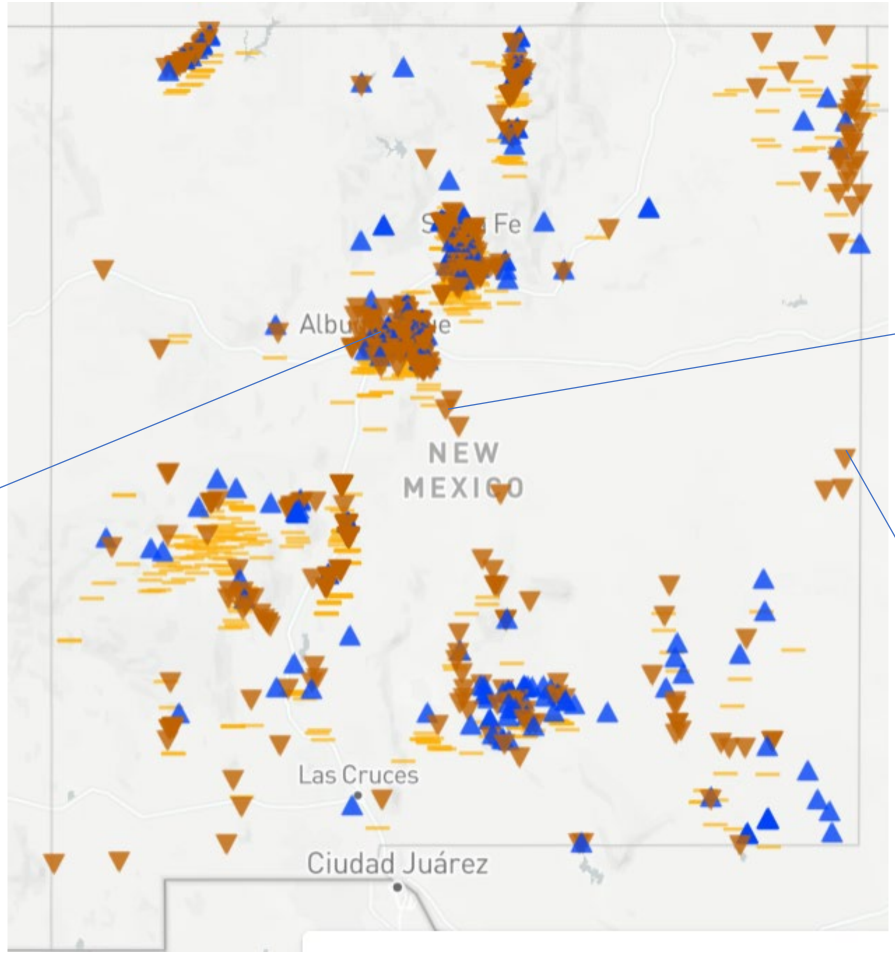
- NMBGMR maintains a network of about 250 wells (funded by Healy Foundation) that **is free to well owners**
- USGS has a cooperative agreement with NMOSE to measure about 600 wells annually
- Significant spatial gaps across the state
- Many sites are not measured frequently enough
- Most sites are “reused” wells – not drilled with monitoring purpose

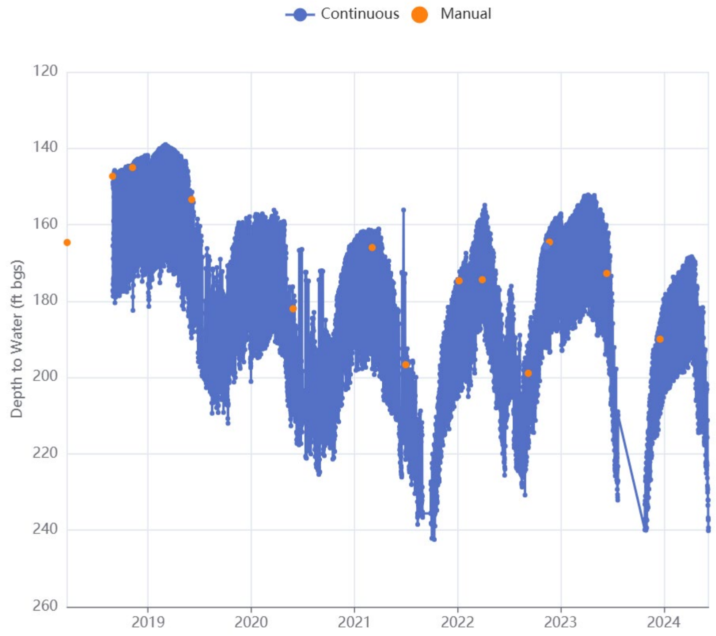
NEW MEXICO AQUIFER MAPPING & MONITORING

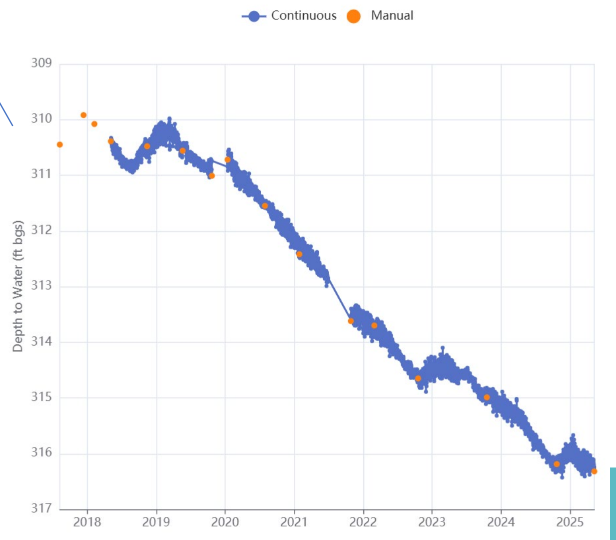
Tracking groundwater level changes in New Mexico

New Mexico Bureau of Geology and Mineral Resources
New Mexico Tech
Earth Science for the 21st Century









https://weaver.newmexicowaterdata.org/

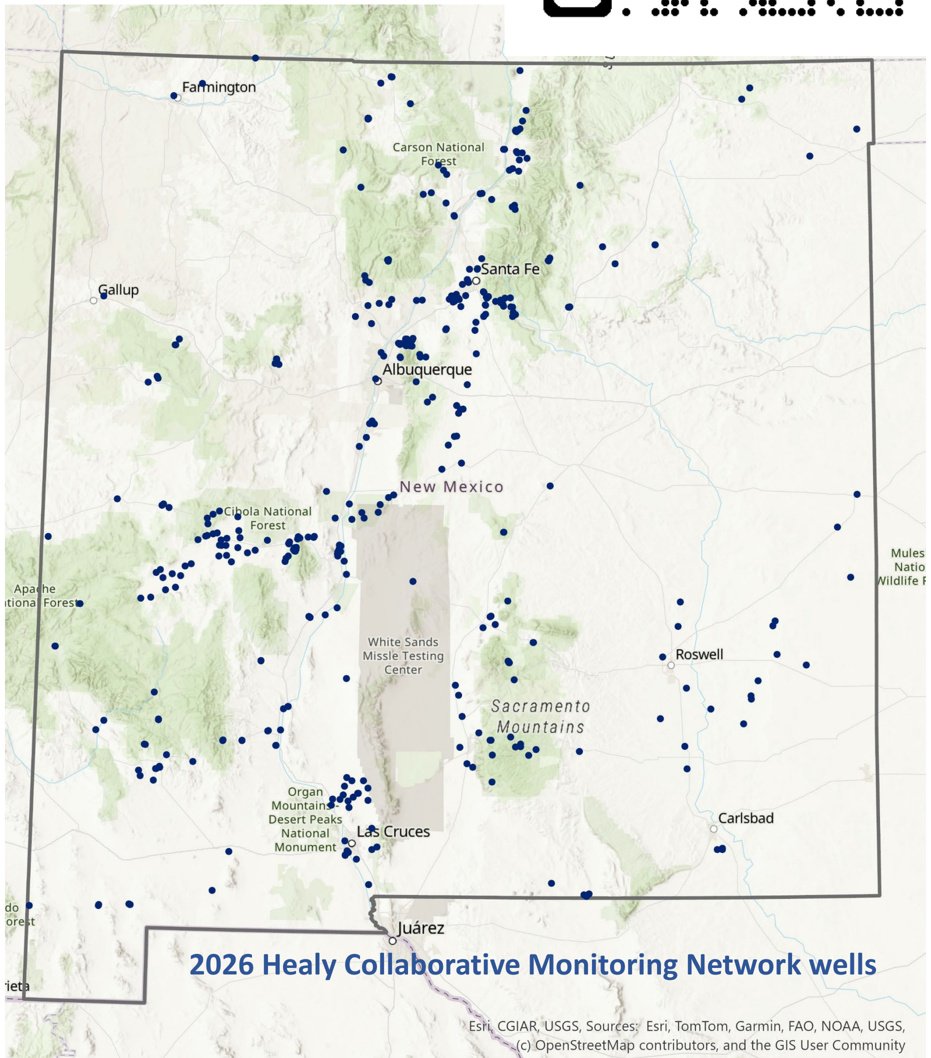
NEW MEXICO
WATER DATA

NEW MEXICO TECH
SCIENCE • ENGINEERING • RESEARCH UNIVERSITY

Healy Collaborative Groundwater Monitoring Network

- Created in 2016, the Healy Collaborative Monitoring Network provides support to install groundwater monitoring devices or manually measure groundwater levels in wells.
- Funded by the Healy Foundation
- Free for well owners
- NMBGMR currently visits about 330+ wells annually
    - We rely solely on well owner cooperation, no wells are currently owned by the NMBGMR
    - Manual measurements wells and some also equipped with pressure transducers or acoustic loggers

Email us! **nmbg-waterlevels@nmt.edu**



Thank You

Stacy Timmons: stacy.timmons@nmt.edu

Geoff Rawling: Geoffrey.Rawling@nmt.edu