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SOUTHWEST NEW MEXICO HYDROGEOLOGY UPDATE

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

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Geologic Mapping & Hazards	Aquifer Mapping (hydrogeology)	Outreach & Education	Energy: oil/gas & geothermal	Laboratories	Mineral & Economic geology	Business and IT support
11	8	9	3	8	2	10

- NM Tech under higher education allocation of state budget
- The state geologic survey (NM Bureau of Geology and Mineral Resources) is an RPSP under NM Tech
- Multiple programs/ divisions of NMBGMR and staff number listed

What is Aquifer Mapping?

Aquifer mapping is a scientific process applying a combination of geologic, geophysical, hydrologic, and chemical field and laboratory analyses to characterize the quantity, quality, and sustainability of groundwater in aquifers.

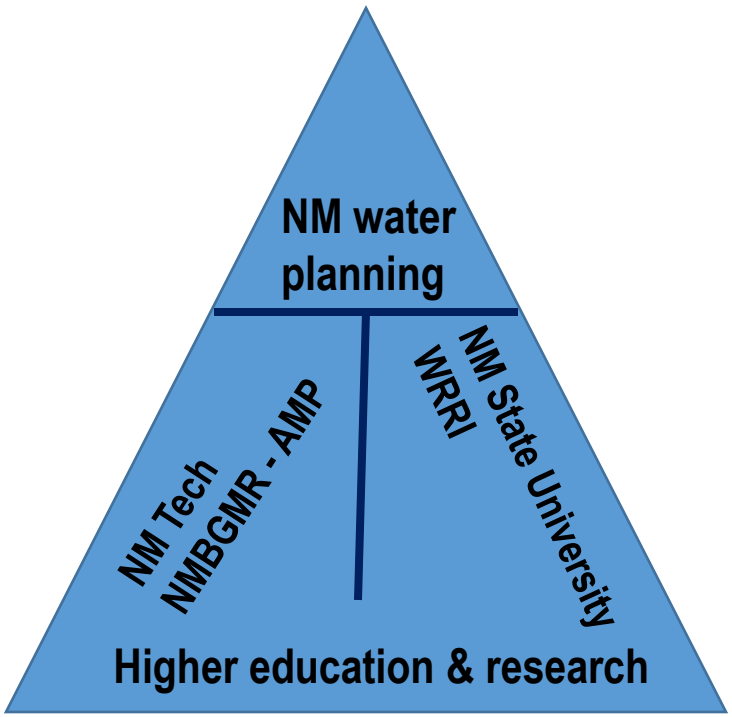
- NON-REGULATORY APPROACH
- IMPARTIAL DATA; UNBIASED INTERPRETATIONS
- RESULTS THAT INFORM DECISION MAKING AND SUPPORTS OTHER FEDERAL, STATE, TRIBAL AND LOCAL AGENCIES/INDIVIDUALS

FUNDING 2017-2018 FY

- HYDROGEOLOGY PORTION OF NMBGMR BUDGET **($280K)**
- LEVERAGED WITH GIFTS AND GRANTS **($480K)**

USED TOWARD BETTER UNDERSTANDING OF OUR WATER RESOURCES

Collaboration and partnership toward our water future



NM WRRI and NMBGMR- Aquifer Mapping

- We work together to address New Mexico's critical water issues, communicating through working groups, collaborative projects, and research teams.
- Findings are distributed through technical and non-technical publications, available on the internet.
- Information is shared at NM WRRI and NMBGMR conferences and meetings.
- We bring together the internationally recognized experts from New Mexico to work on problems together and coordinate, not duplicate efforts.

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AQUIFER MAPPING PROGRAM

NEW MEXICO WATER RESOURCES RESEARCH INSTITUTE

NM STATE UNIVERSITY

Aquifer Mapping Program 2017

Selected current projects

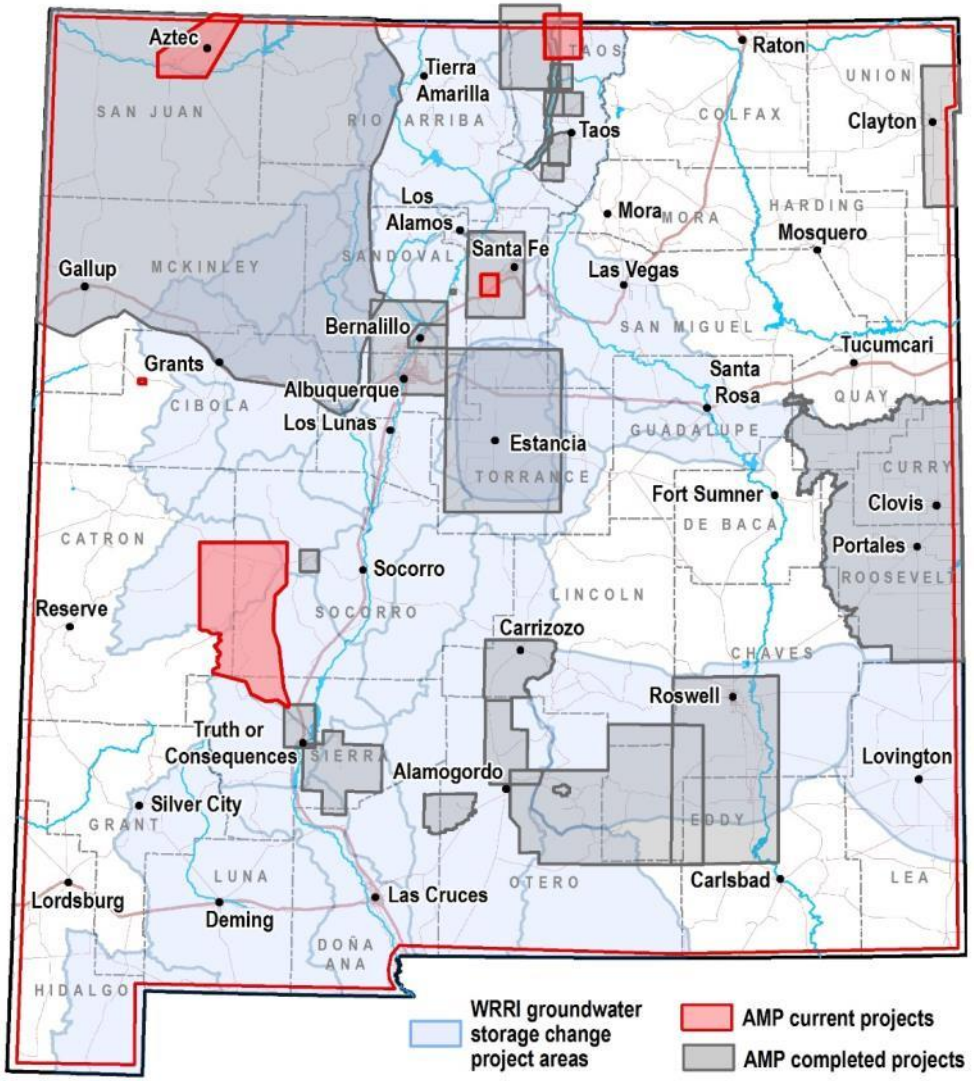
- Animas River aquifer long term monitoring (NMED-EPA funding)
- San Agustin Plains (NMBG)
- Groundwater level monitoring in La Cienega (Las Golondrinas – community)
- Aquifer map 3D visualizations (Healy Foundation)
- Collaborative groundwater level monitoring (Healy Foundation)

Recently completed

- Groundwater level and storage changes[1](WRRI)
- Statewide groundwater recharge model[1] (WRRI)
- Clovis Region Aquifer Lifetime Mapping (Clovis, Curry Cty, ENMWUA)

[1] Project funding ended, not complete

(Primary funding sources in parentheses)



Southwest NM

Presentation resources

- Hydrogeology and groundwater volume estimates from Hawley et al., 2000

https://nmwrri.nmsu.edu/trans-international-boundary-aquifers-in-southwest-new-mexico-2/

- Groundwater storage changes from WRRI SWA
- Recharge to groundwater from WRRI SWA

https://nmwrri.nmsu.edu/category-blocks-swa/#DSWB

SWA = Statewide Water Assessment

Southwest NM

- Major tectonic provinces affect groundwater availability, quality and movement
- Basin and Range – valleys with basin fill sediments make decent aquifers (i.e. Gila Group)
- Mogollon-Datil Volcanic bedrock – fractured volcanic rock may hold water in the open fractures

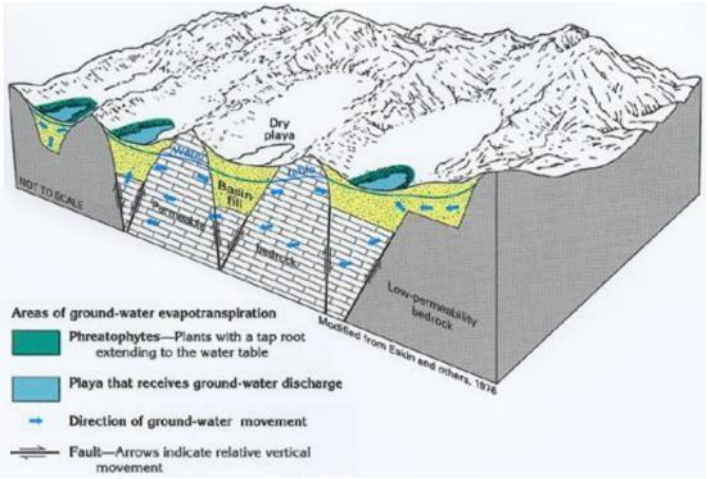
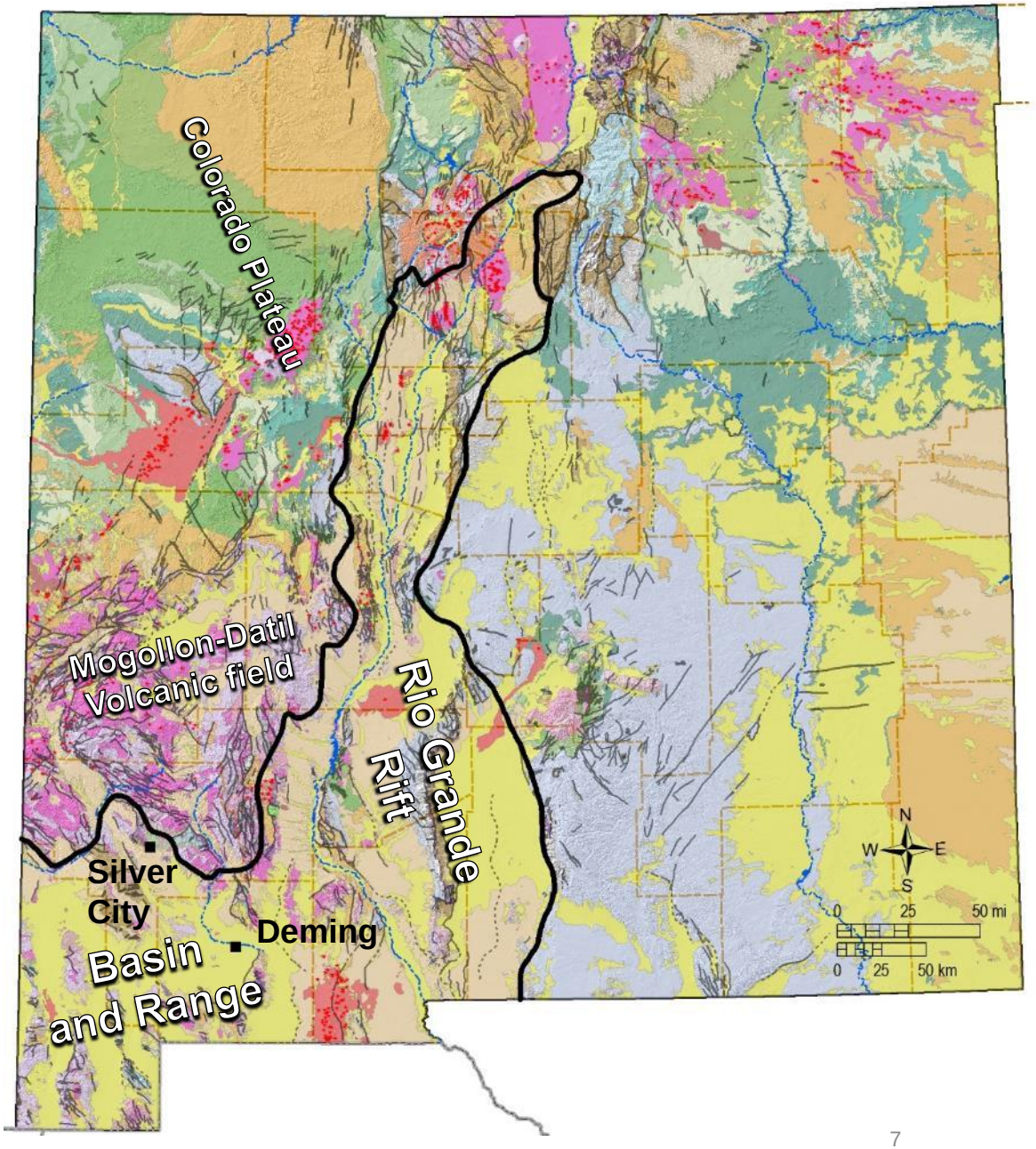
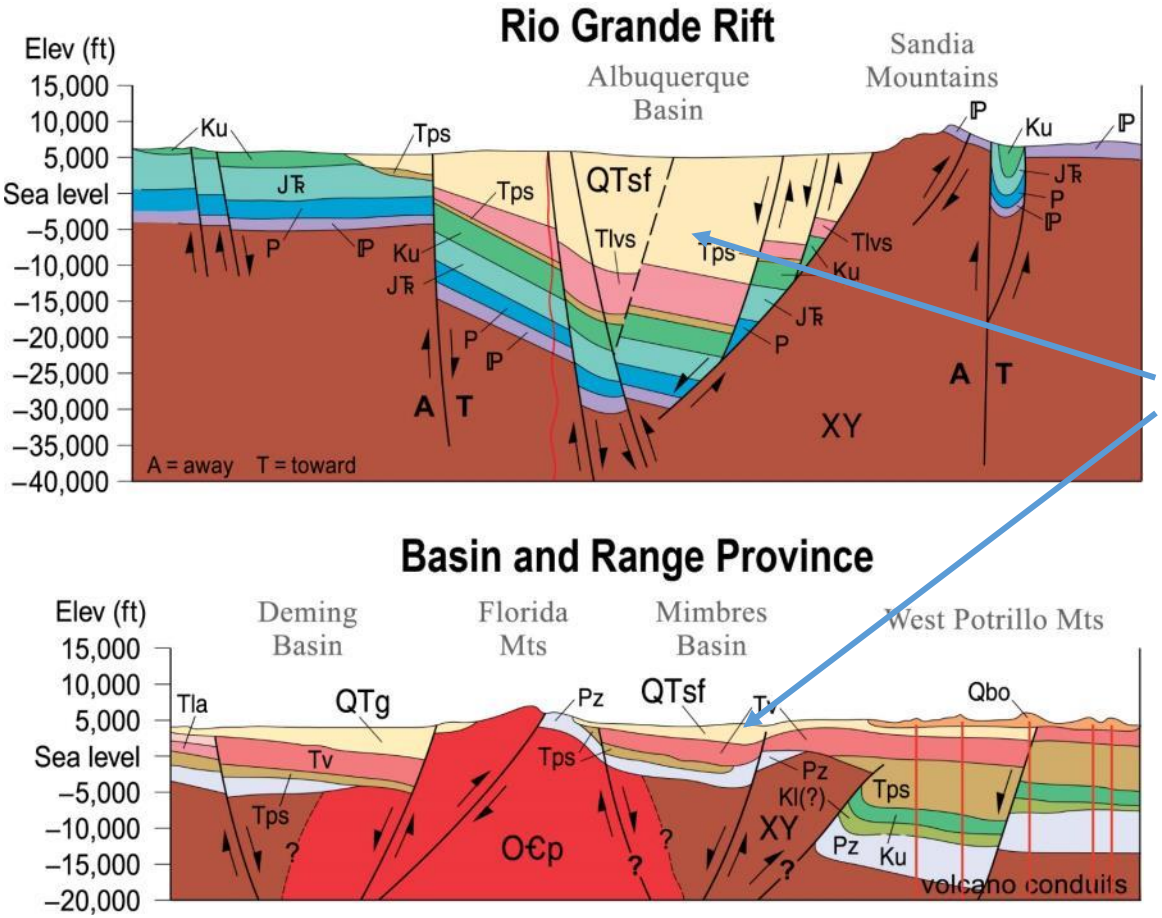


Figure from GROUND WATER ATLAS of the UNITED STATES: Arizona, Colorado, New Mexico, Utah: USGS HA 730-C



Cross section of geology

Basins in southwest NM are similar to Rio Grande Rift near Albuquerque, but much shallower basins (and smaller aquifers)



Albuquerque Basin:

Greater than 15,000 ft thick in some parts

Beige units = most productive aquifers

Mimbres Basin:

Less than 5,000 ft thick

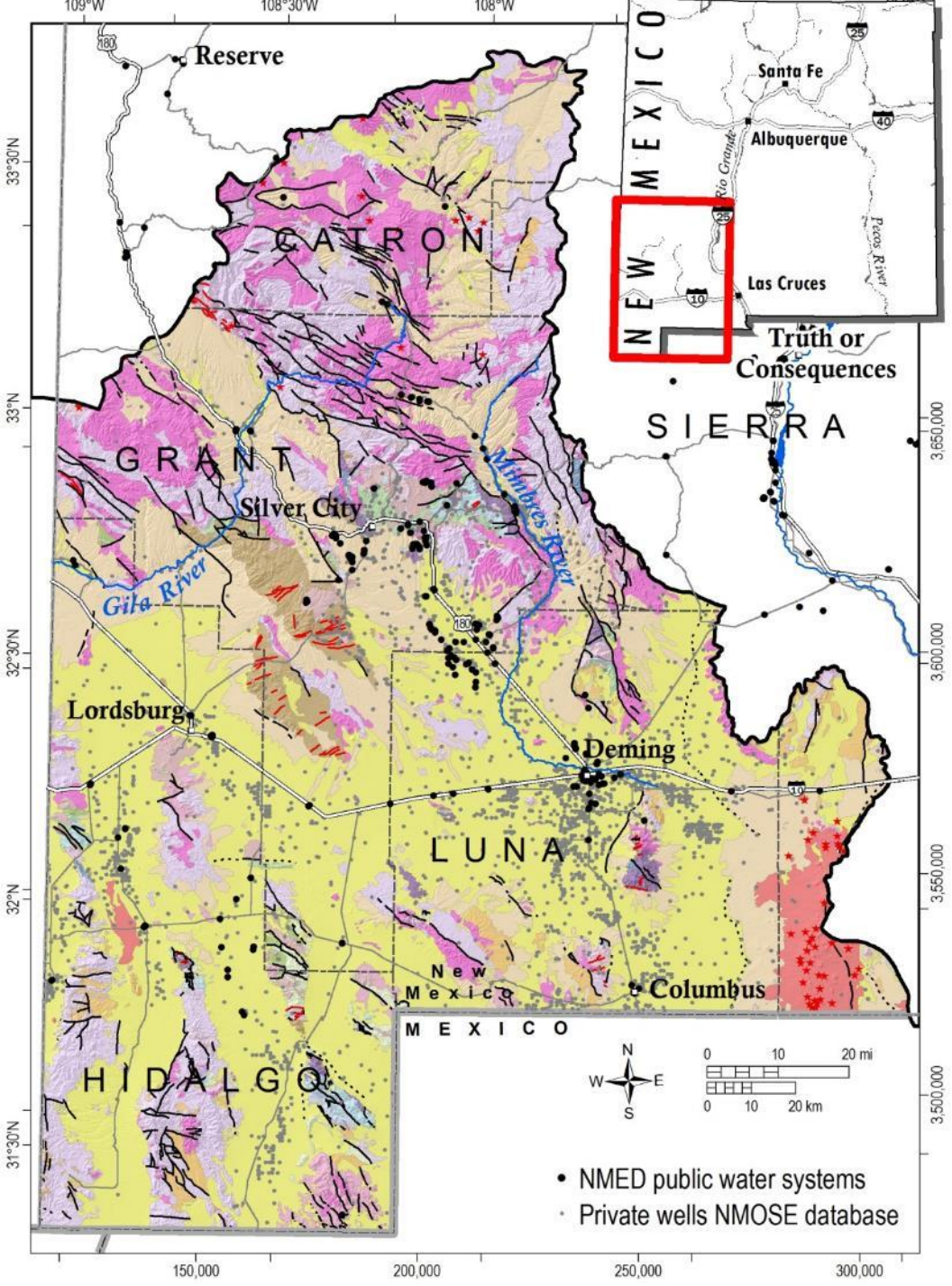
Primary aquifer systems

1) Primary aquifer systems in basin fill sediments of the **Gila Group** (yellow and beige map units)

- Variable thickness, several sub-basins, better aquifers in upper 300 ft where it is coarser
- Most productive wells completed in Gila Group – basin fill sediments

2) Groundwater also found in fractured bedrock and volcanic material of **Mogollon-Datil volcanics** (Pinks on map)

- Less storage, groundwater exists in fractures, serves as recharge zone



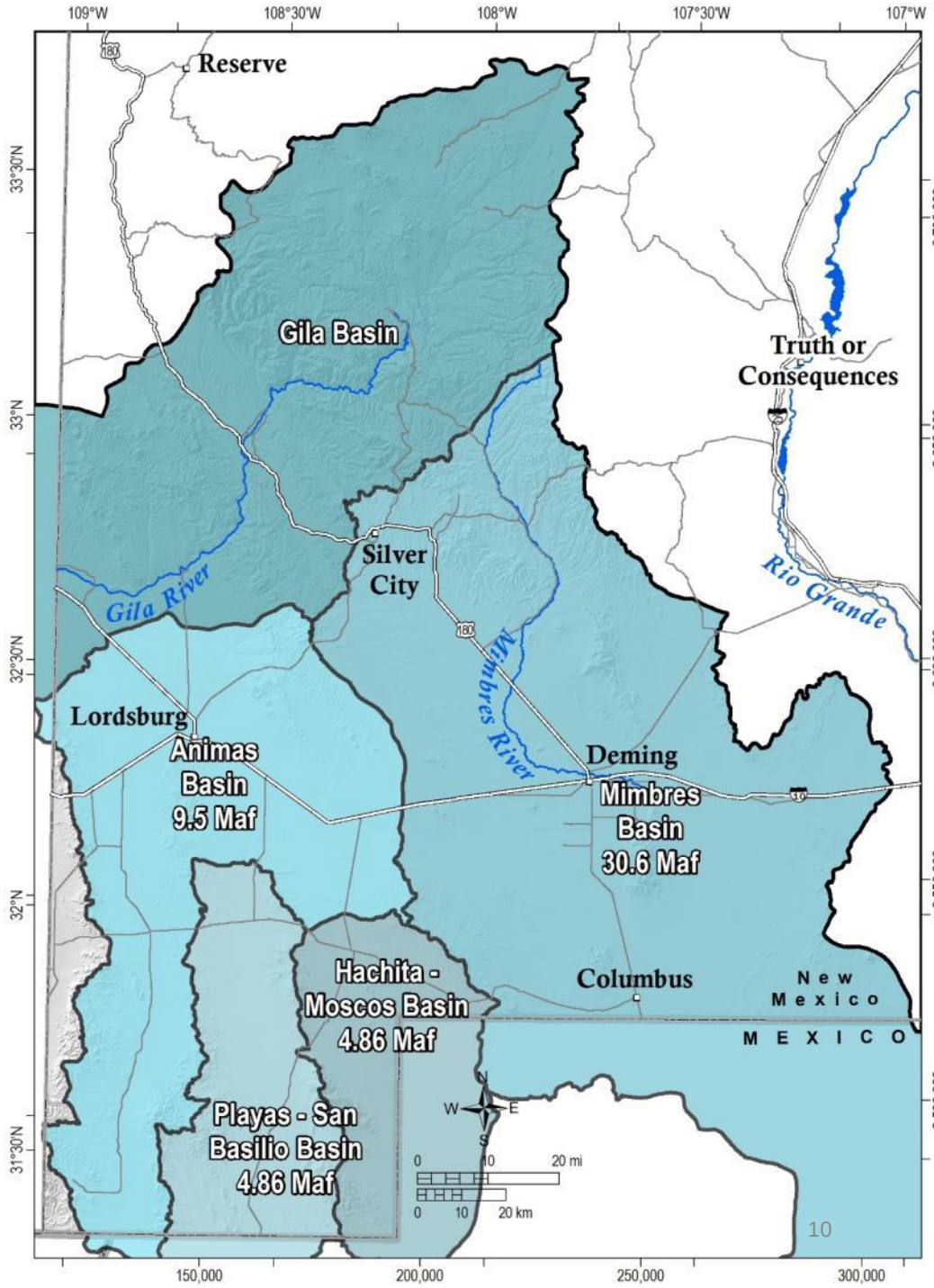
AQUIFER MAPPING PROGRAM

Results from Hawley, et al. (2000)

LIBERAL estimate of groundwater in storage from 4 of these regions (excluding Gila Basin)

- Groundwater storage of **NO MORE THAN 49.8 Million Acre Feet** (Maf)
- Assumes fairly uniform thicknesses and hydrologic properties
- Largest estimate of 30.6 Maf in Mimbres Basin

Limited information on aquifer systems at depth – unknown water quality



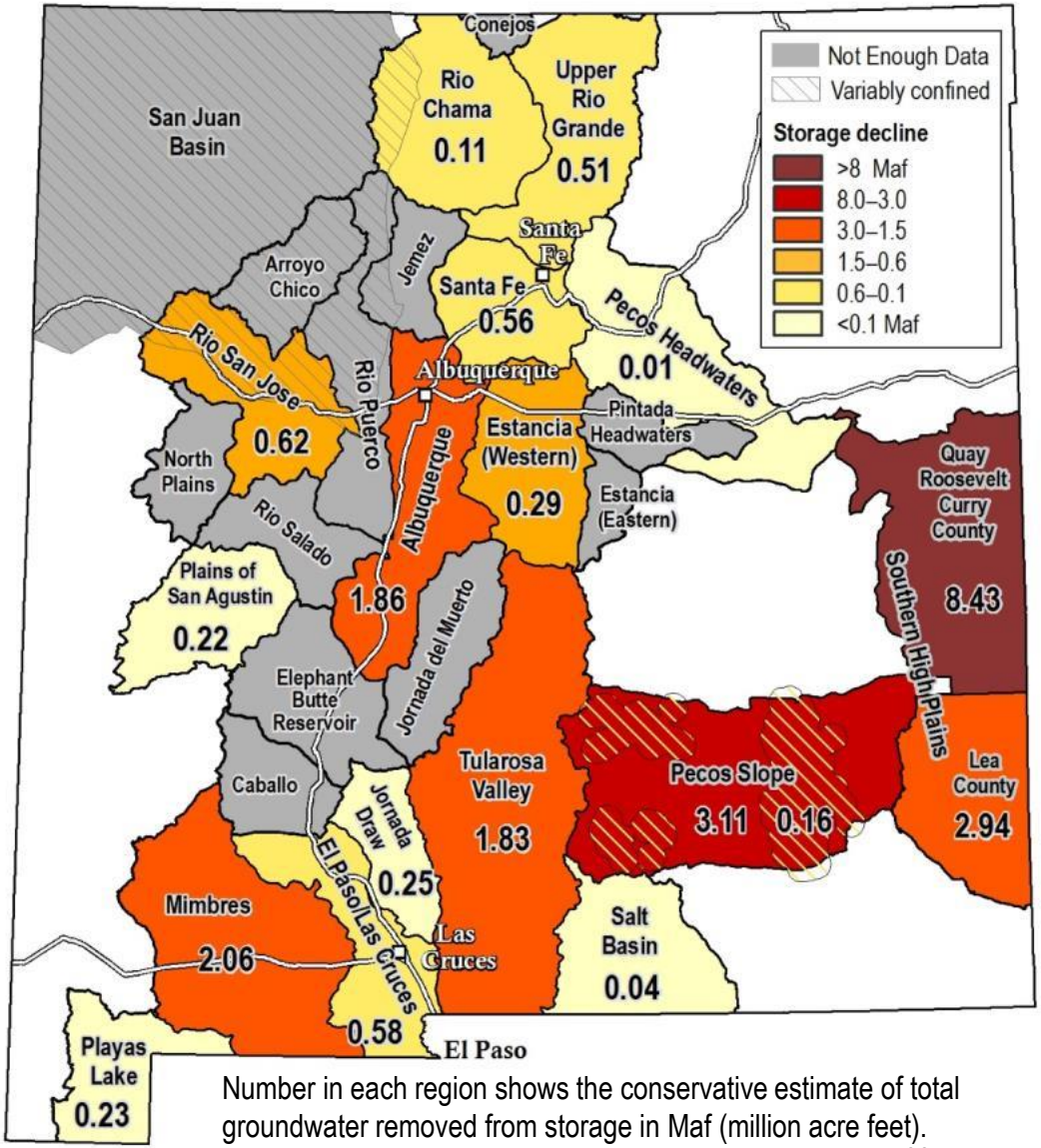
Groundwater Level and Storage Changes

Funding from WRRI Statewide Water Assessment 2014-2017

Project lead: Dr. Alex Rinehart
NMBGMR – AMP

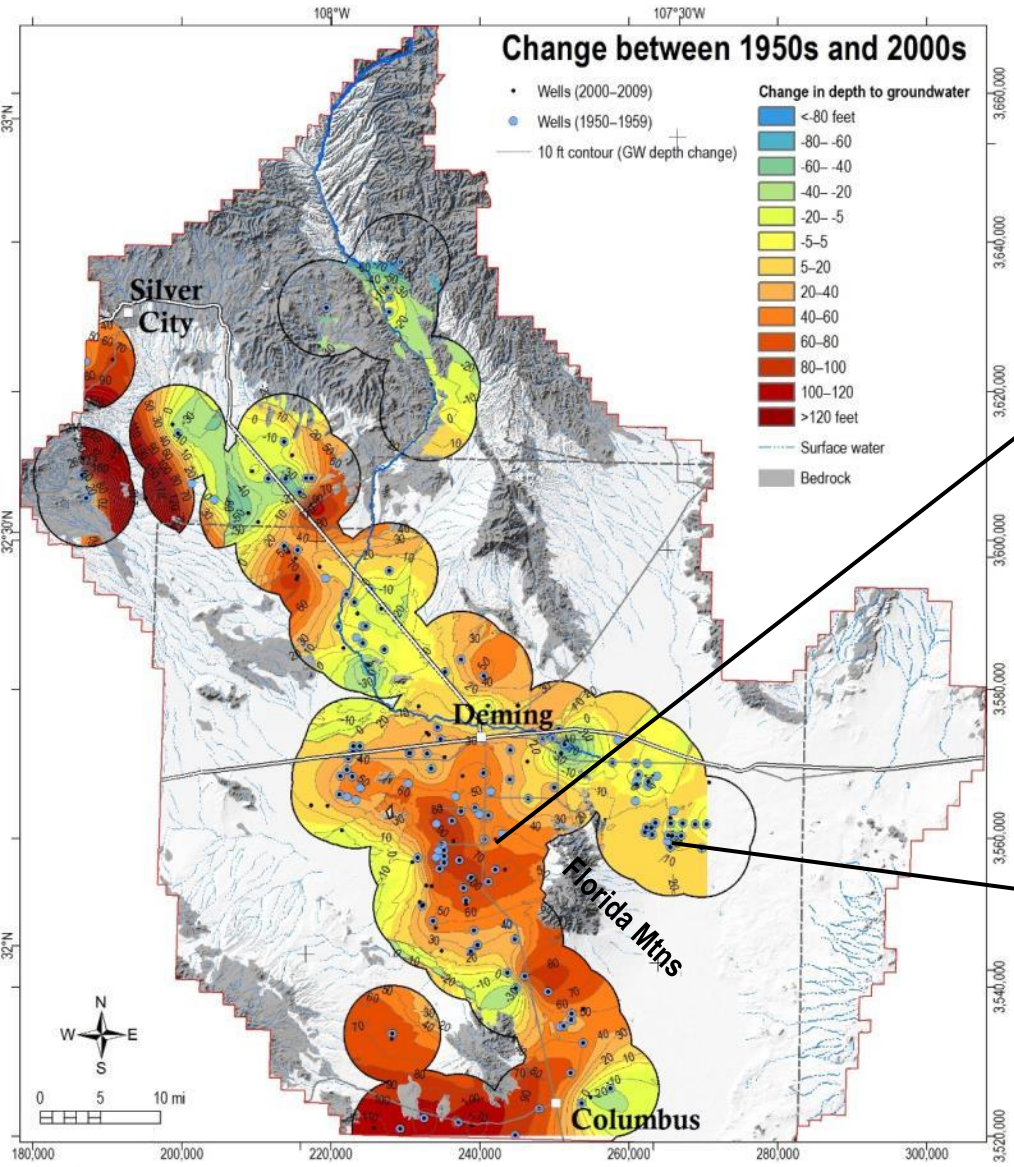
Results

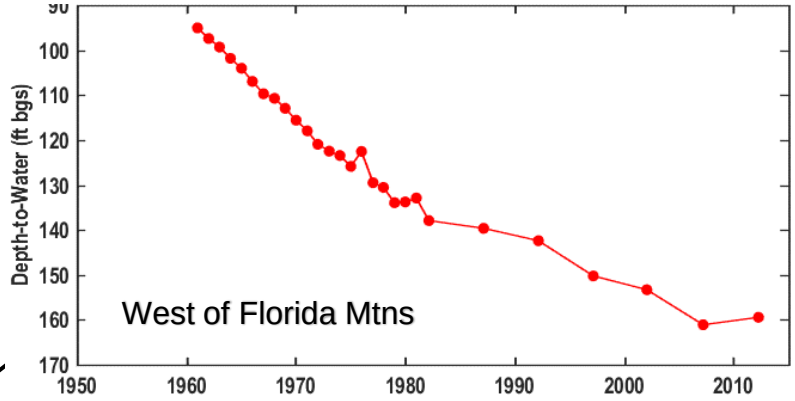
- A geostatistical analysis entirely based upon ***groundwater level monitoring network*** from USGS/OSE/NMBG since 1900s
- Larger groundwater storage declines in Eastern NM, Pecos Slope, **Mimbres**, Tularosa, Albuquerque, and Mesilla Basins.
- Results are ***likely low estimates*** due to well network and sparse data coverage



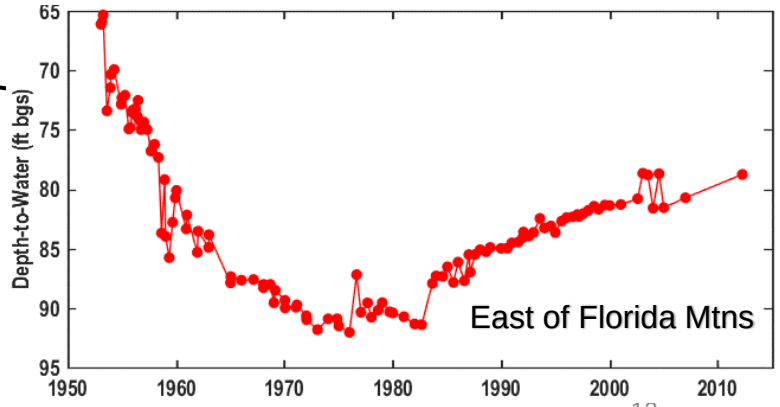
Number in each region shows the conservative estimate of total groundwater removed from storage in Maf (million acre feet).
Grey = lack sufficient data

Groundwater Level Changes: Mimbres





- Declining groundwater levels indicates more is being removed than is being added to aquifer
- Declines in groundwater levels are variable in Mimbres Basin - Differences on east and west side of Florida Mountains, possibly due to changes in land use



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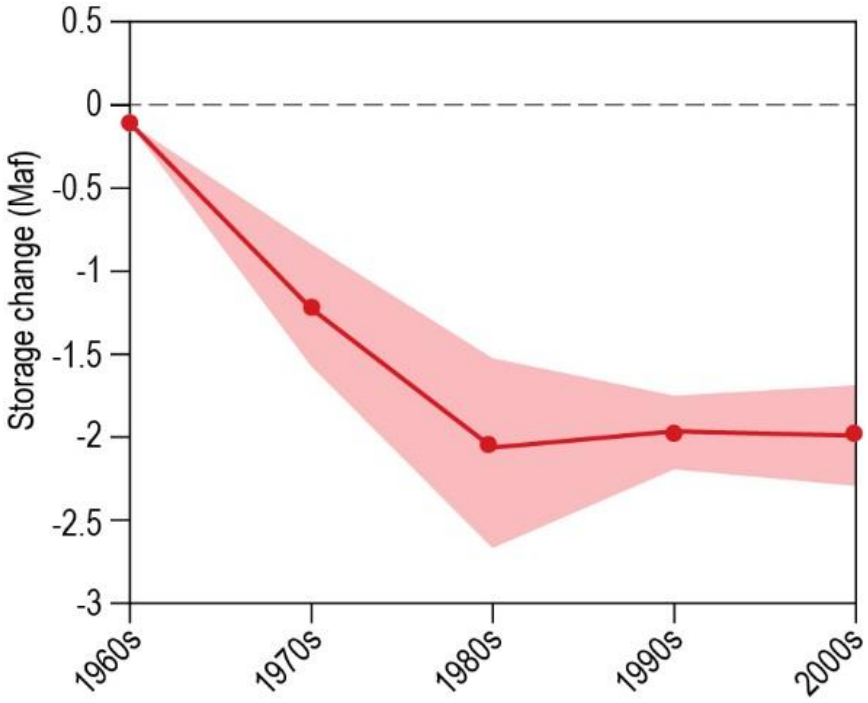
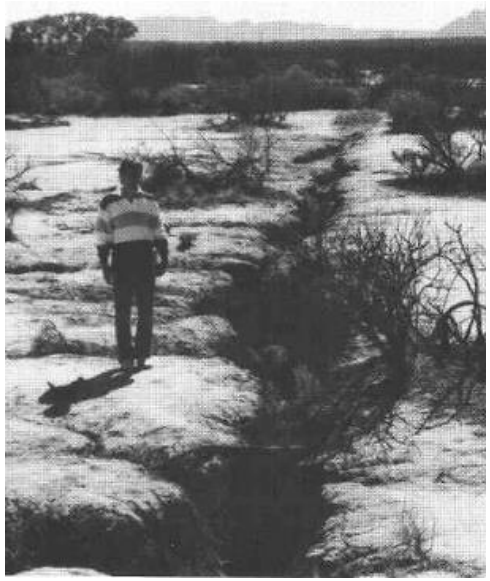
Groundwater Storage Changes: Mimbres

- **Basin-wide total storage loss of *at least* 2 Maf since 1950s** (a conservative estimate)
- Reduced decline of changes observed since 1990s – showing that changes in use of groundwater can improve sustainability
- USGS National report estimates at least 3.4 Maf loss [from Konikow, L.F., 2013, Groundwater depletion in the United States (1900–2008): U.S. Geological Survey Scientific Investigations Report 2013–5079]



Graph - Red points are average estimated cumulative storage change for each decade. (Pink is max and min ranges)

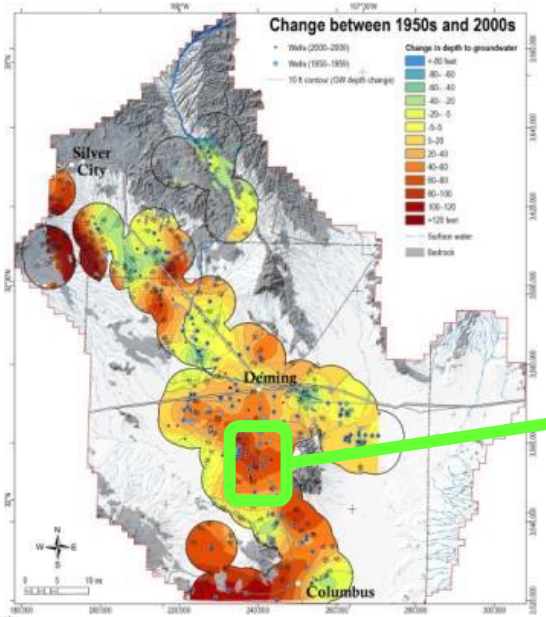


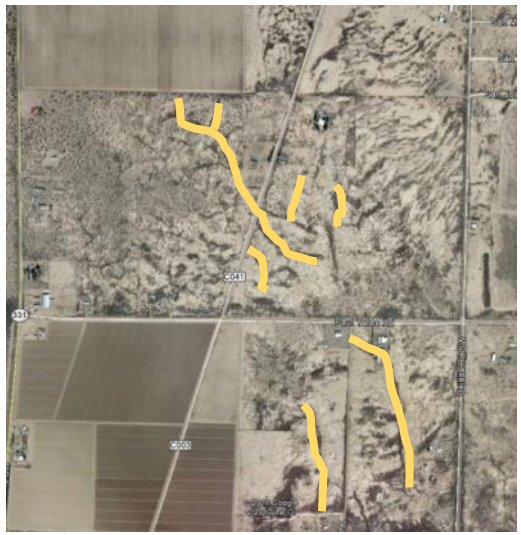
Surface fissure 1988

Images from Contaldo, G., and Mueller, (1991) New Mexico Geology, Volume 13, No. 4

Land subsidence of over 1 ft (1988)

More than 100 ft groundwater level declines from 1910 to 1990 in some wells





South of Deming - several fissures from Google Earth imagery (same image, fissures drawn in on right)

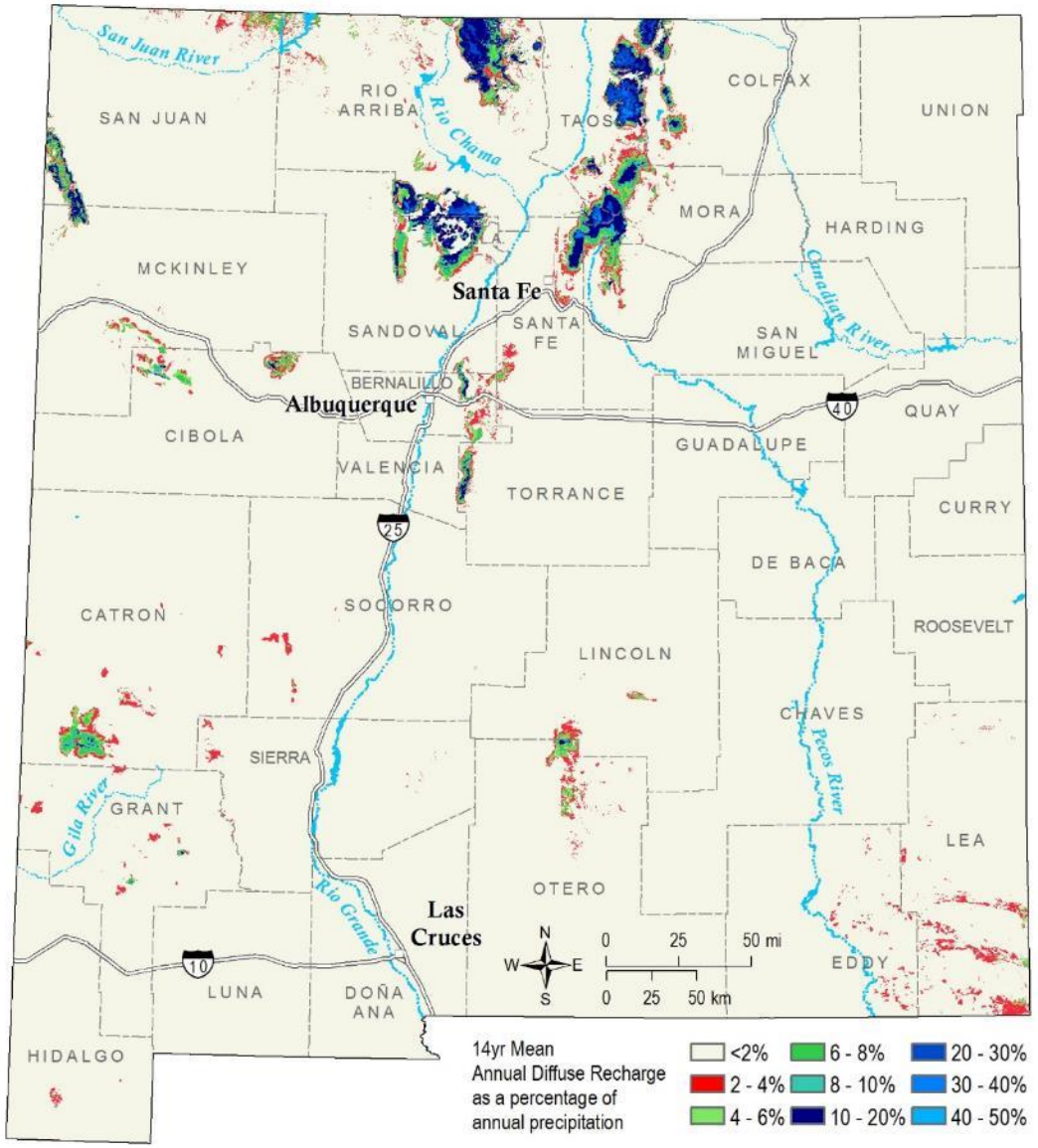
Groundwater Recharge Model

Project lead: **Dr. Talon Newton**
NMBGMR – AMP

Funded by NM WRRI – Statewide Water Assessment

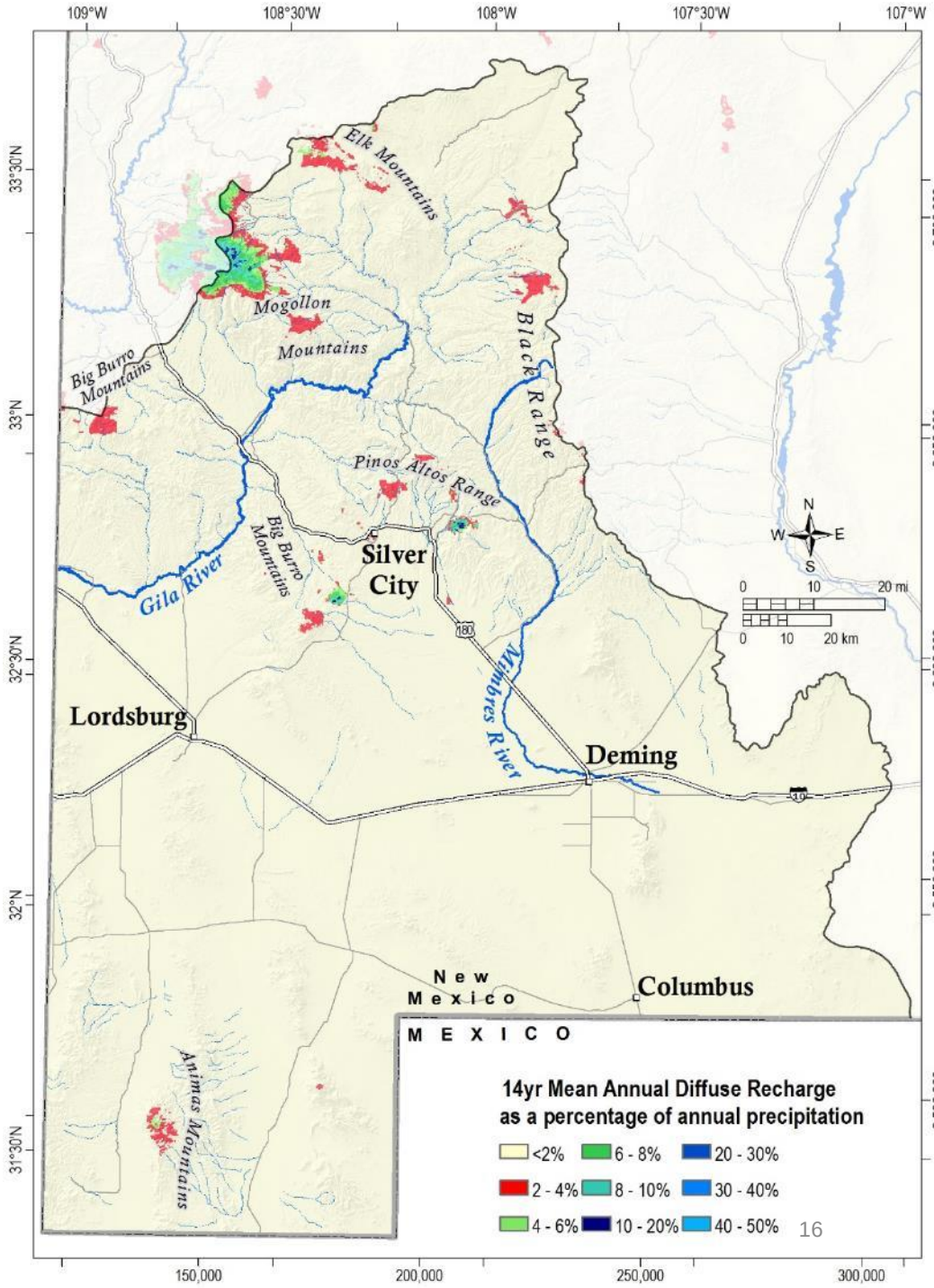
Results

- This model shows “diffuse” recharge - where the water balance calculations estimate some water will percolate into aquifer
- There is very little to no “diffuse” recharge over most of NM
- Model results here do not account for focused recharge through streams/rivers

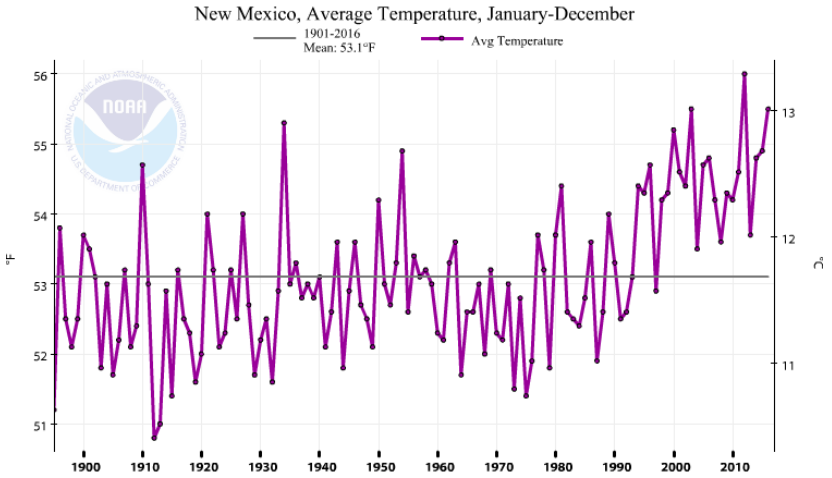


Recharge to Aquifers

- Recharge to groundwater occurs mostly in mountains with higher precipitation and cooler temps
- Over most of region, about **1-2% of annual precipitation provides recharge to aquifers**
  - Mimbres may get recharge of up to ~63,000 ac ft per year (Hawley et al., 2000)
- Map results shown here do not account for focused recharge, such as streams/rivers
  - Perennial streams help recharge aquifers
  - Intermittent mountain streams, arroyos, springs and seeps provide some recharge



Climate change and impact to recharge to local aquifers



- Dr. David Guztler (UNM faculty) study funded by ISC indicated **5-10% reduction of upper Gila River runoff**, due to less snowmelt and climate change
- Other rivers in region would likely see similar impacts
- Likely reduction to recharge into many groundwater aquifers

Future expectations

- *Warmer temperatures*
- *Increasing aridity*
- *Decrease in surface water availability*
- *Increase demand on groundwater*

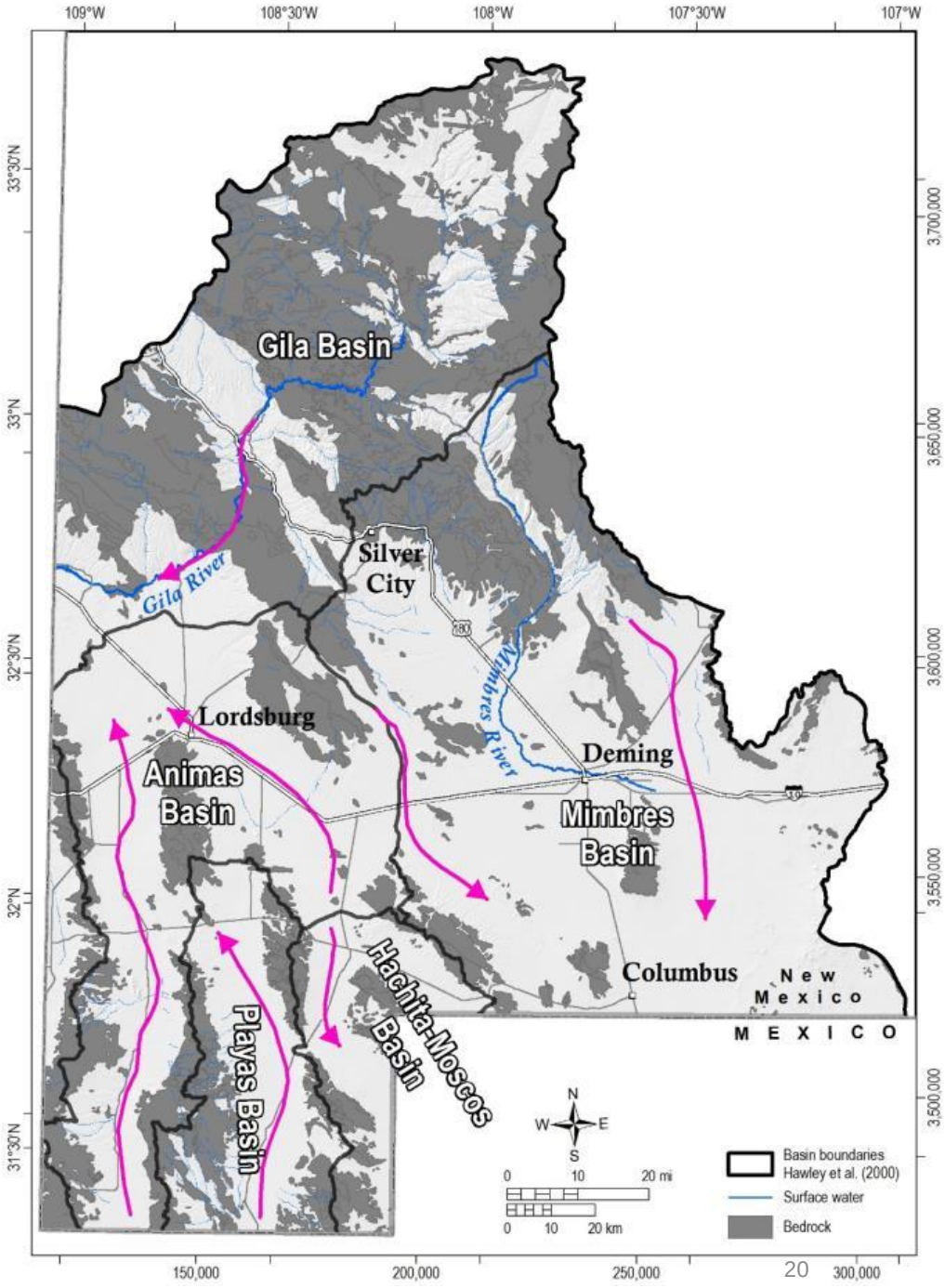
Summary points

1. Reconnaissance level hydrogeology has been done for much of the region
   - Previous studies were based on limited wells/ depths
   - Little is known about local aquifer systems at depth, especially water quality
2. Declines in groundwater levels are variable in Mimbres Basin, and the regional water levels indicate a overall loss of groundwater in storage of at least 2 Maf; this stabilized in late 1990s.
3. Recharge to region is limited, and likely to decrease in future years with surface water flow changes.
4. To improve understanding of the groundwater resources, building off of previous work:
   - Improve basin characterization by applying new techniques
   - Maintain or grow groundwater monitoring network (important data!)
   - Evaluate water quality with depth
   - Refine estimates of good quality groundwater in storage
5. WRRI Statewide Water Assessment can provide many useful tools and datasets for many regions of NM, including southwest.

EXTRA MATERIAL

Mimbres: Groundwater flow direction

- Groundwater flow direction here roughly mimics the slope and gradient of the surface
- *Approximate* flow direction in pink lines
- Based numerous well locations and groundwater level measurements, connected to form groundwater contours (not shown) from Hawley et al. (2000)

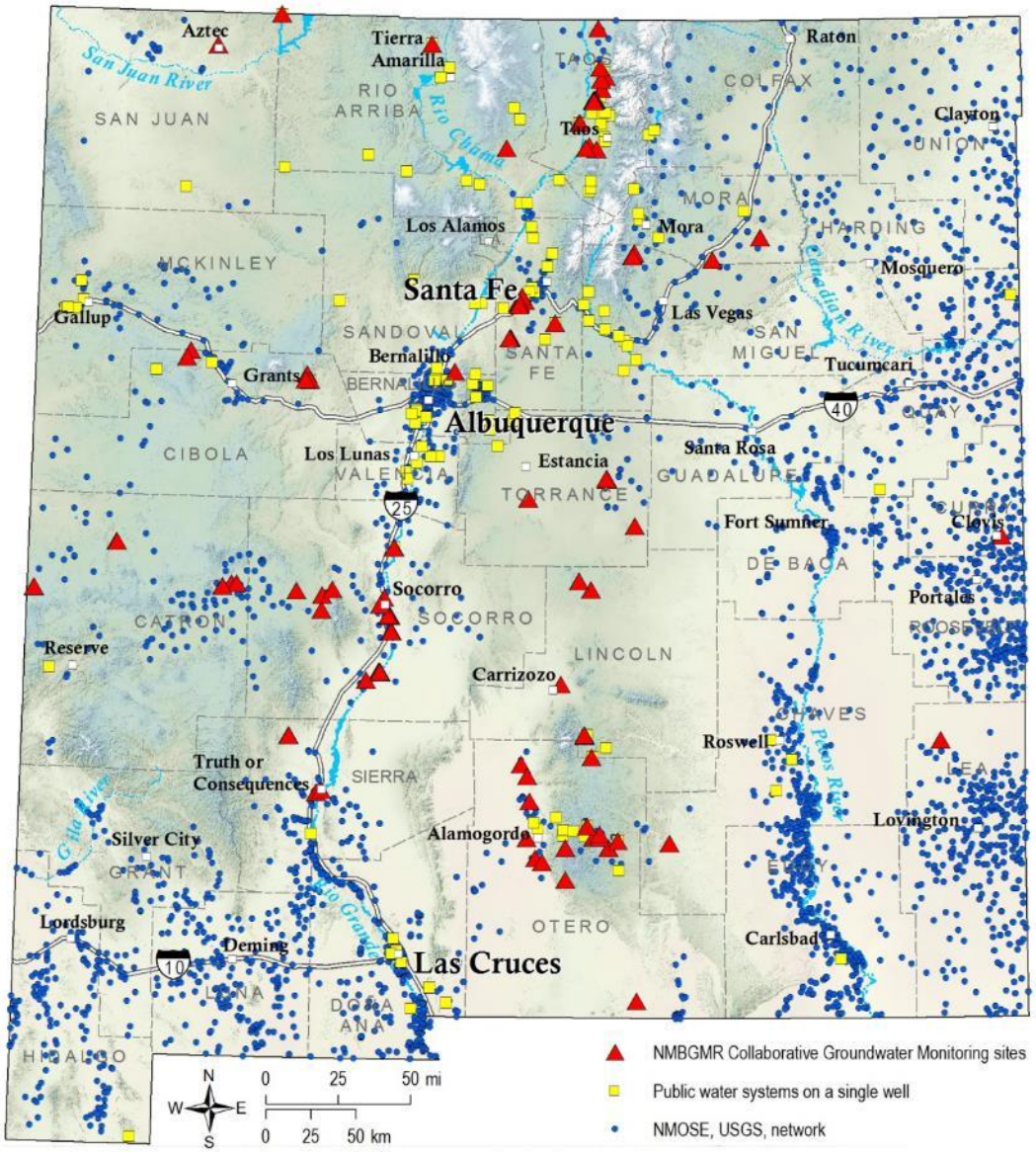


Collaborative Groundwater Monitoring Network

- Filling in data gaps in state monitoring network, where possible, with continuous monitoring
- Reaching out to rural communities, particularly those on a single well (yellow points on map)
- Red points are our monitoring network (continuous, and manual measurements)
- Blue points are part of the once per year or per 5 year monitoring network currently operated by OSE/USGS

Cooperating with NM Rural Water Association, NMED, OSE, and USGS

Current funding from Healy Foundation

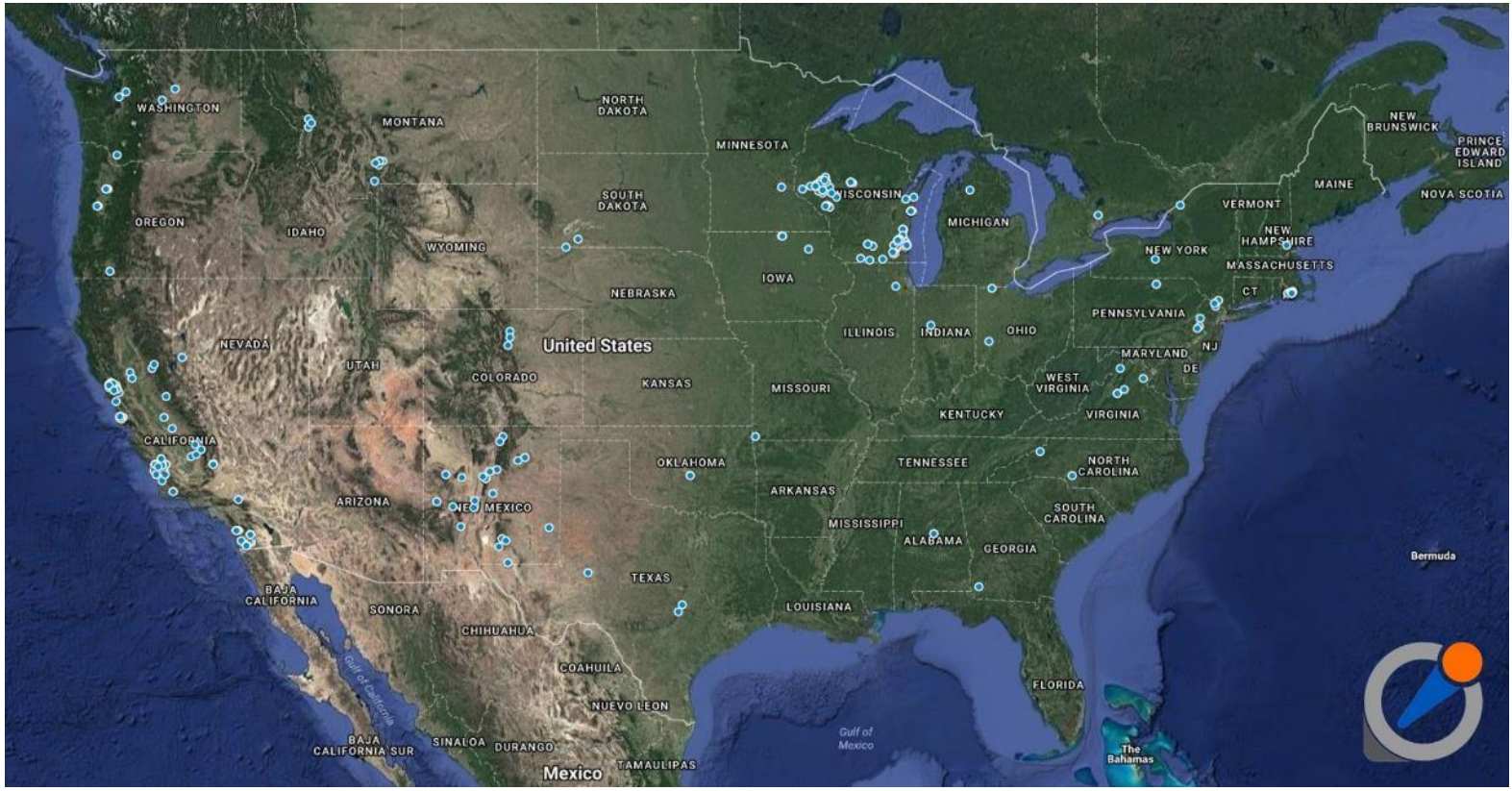


Collaborative Groundwater Monitoring Network: Using new technology

- Using new acoustic technology, we're building a broad network of continuous water monitoring
- Coverage in New Mexico is better than most states!
- Several of these are REAL-TIME daily readings

NM region funded by Healy Foundation

New acoustic groundwater monitoring devices, providing real time data (WellIntel)



Geothermal potential in southwest NM

The Play Fairway project: Hydrogeologic Windows (completed in 2016)

Funding: DOE to LANL, Ohio State University, NMBGMR, NMT, Southern Methodist University, and consulting firm Witcher and Associates.

Goal: Analyze available geologic, geochemical, and geophysical data within a new conceptual framework to increase the prospects of successfully locating new geothermal systems in southwestern New Mexico.

Result: We identified 8 high-potential areas using a framework developed in this project. (see map)

Future work*:* The region is nationally recognized as a leader in the economic development of large-scale, direct-use greenhouses and aquaculture.

Further development of this resource will require using low-cost techniques, such as reconnaissance geologic mapping, thermal measurements, and water sampling, in the vicinity of the targeted areas in order to fill some significant data gaps. After further refinement of targets, subsurface geology and hydrogeologic conditions in the most prospective areas could be better resolved using several geophysical techniques.