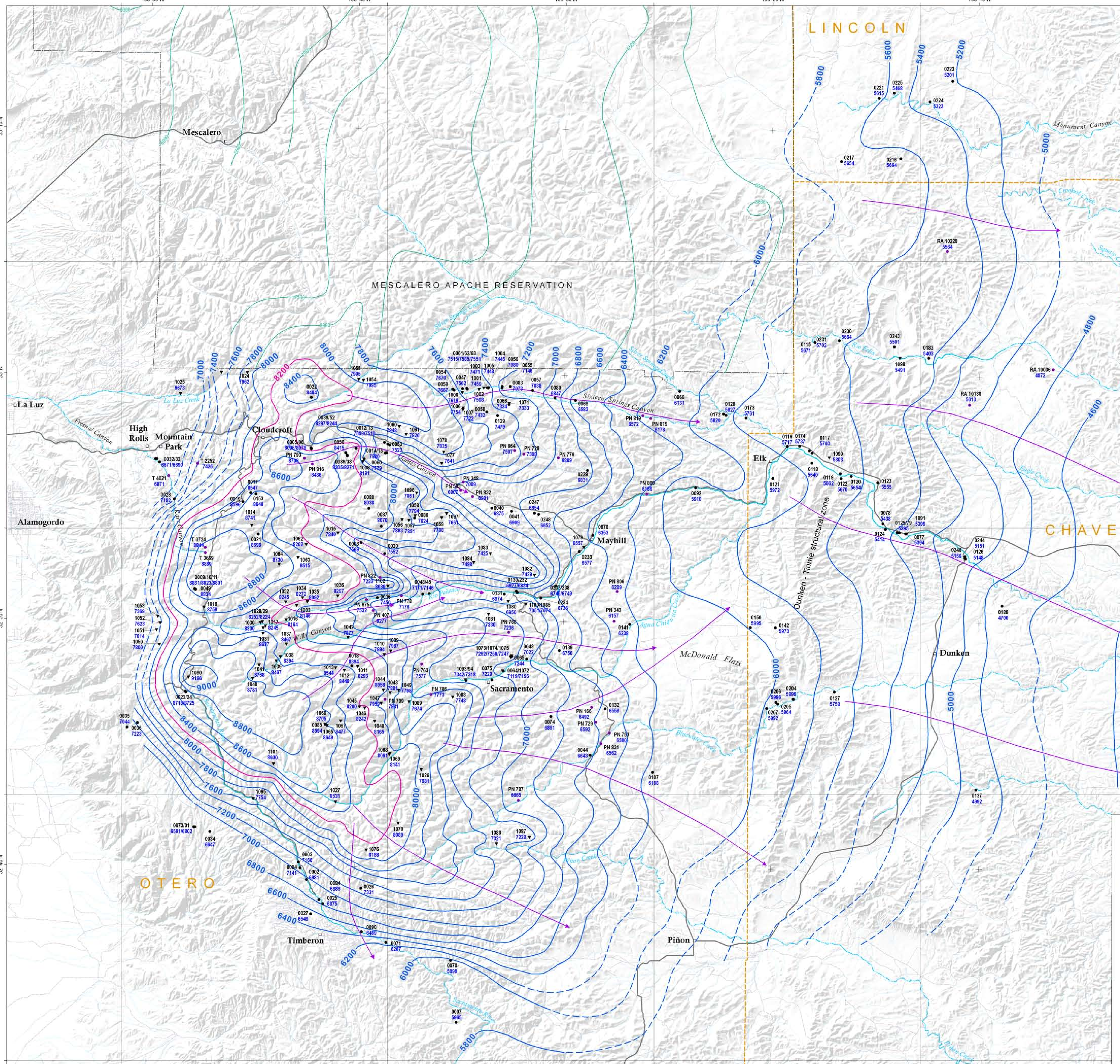


ABSTRACT

We have prepared a map of the regional water table in the southern Sacramento Mountains based primarily on water level measurements made in wells between 2005-2009, and on the elevations of flowing springs and gaining reaches of streams. In locations where these data were not available, static water levels were used from selected, recent (year 1995 or newer) New Mexico Office of the State Engineer's (NMOSE) well records. Green contour lines at 500 foot intervals along the northern margin of the map are taken from Sloan and Garber's (1971) water table map of the Mescalero Apache Reservation.

The aquifer system in the southern Sacramento Mountains is developed primarily within the Yeso Formation, a heterogeneous unit composed of limestone, siltstone, mudstone, and gypsum. Most springs discharge from discontinuous, perched aquifers composed of fractured limestone beds that overlie relatively impermeable mudstones. Well and spring data indicate that water-bearing zones are distributed vertically and laterally throughout the section, connected by local and regional fracture systems (Newton et al., 2012). In most cases it is impossible to determine whether a measured water level corresponds to a perched aquifer or is part of the regional piezometric surface, thus any distinction between perched and regional aquifers is ambiguous and very difficult to determine.

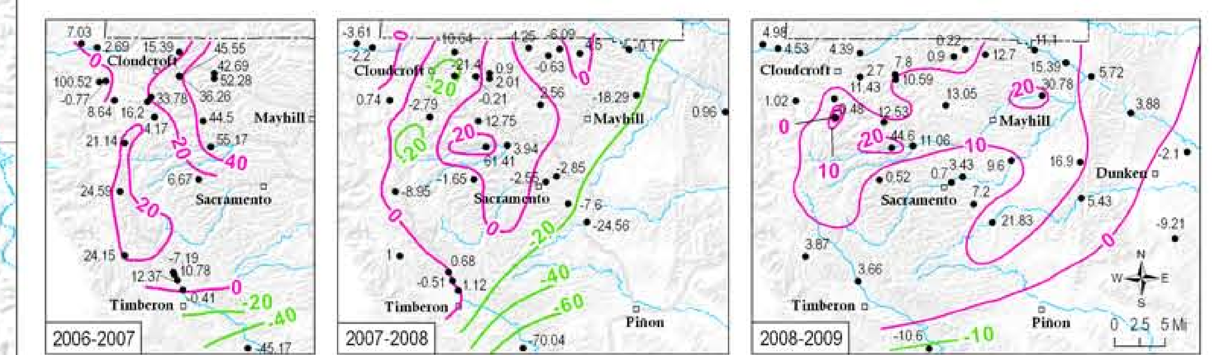
The water table map indicates that most groundwater recharge occurs near the crest of the Sacramentos, above approximately 8200 feet water level elevation, where high mountain springs discharge from small, highly-localized perched aquifers. Streamflow derived from these springs re-enters the groundwater system along losing reaches and may "daylight" multiple times along the flowpath, feeding springs at lower elevations. As one follows the groundwater system downgradient from west to east, the perched aquifers begin to coalesce into a regional flow system that eventually merges with the Yeso-San Andres limestone aquifer in the Roswell Artesian Basin to the east.

Field observations of high-volume spring flow following the 2006 monsoon season, combined with stable isotope measurements, indicate that the Yeso aquifer is a dual porosity system. Long-term storage of groundwater is contained in the rock matrix, while short-term, high-volume flow periodically occurs through fractures and solution-enlarged conduits developed in the Yeso Formation. Fracture and conduit flow may be highly localized, and thus cannot be adequately represented on a large, watershed scale map. The contoured surface thus reflects for the most part groundwater stored in the rock matrix.

Hydraulic gradients are steepest along the western escarpment of the Sacramentos, averaging about 500 feet/mile west of Cloudcroft. On the eastern flank of the mountains, gradients range from ~150 to 220 feet/mile at higher elevations (>7,000 ft). Groundwater flow to the east is sub-parallel to bedding planes and permeable rock layers and is enhanced by fractures. Groundwater divides between sub-regional watersheds are represented on the map by prominent ridges between major drainages such as James Canyon, the Rio Peñasco, and Agua Chiquita Creek.

East of Mayhill there is a pronounced flattening of the hydraulic gradient, which ranges from ~100 feet/mile in the vicinity of Dunken to less than 50 feet/mile west of the village of Hope. Stratigraphic dip in the southern Sacramentos is generally steeper than the hydraulic gradient, and eastward-flattening of the water table indicates areas where water levels rise into higher-transmissivity limestones of the San Andres Formation, which overlies the Yeso. This phenomenon is particularly noticeable across McDonald Flats, where the slope of the water table is less than 48 feet/mile. Flattening of the hydraulic gradient across this area is most likely due to the presence of large fractures and sinkholes developed in the outcropping San Andres Formation, which transmit groundwater easily. Geologic structures such as the Dunken-Tinnie structural zone also influence groundwater flow, causing a local steepening of the hydraulic gradient east of McDonald Flats.

TEMPORAL WATER LEVEL CHANGES



With every other month repeated water level measurements in the southern Sacramento Mountain study area, we are able to compare water levels from one year to the next. Pink lines on the images left indicate feet of water level increase or stability between the year ranges indicated on image. Green lines indicate approximate regions of water level decline. Points are well sites, with individual well water level change (in feet) over the year range for each figure. In the period from 2006 to 2007, water levels in the high Sacramentos began rising in response to unusually intense monsoonal rains in fall, 2006. Water levels continued to rise in the subsequent two years, but the center of greatest increase migrated progressively farther to the east, suggesting that the 2006 monsoon event was continuing to be felt as an eastward diffusion of pressure head through the aquifer system.

Comments to Map Users

The purpose of this map is to illustrate important aspects of regional groundwater flow. Groundwater elevation data depicted herein were calculated primarily from depth-to-water measurements taken between 2005 and 2009 by the New Mexico Bureau of Geology and Mineral Resources (NMBGMR) at New Mexico Tech and from the elevations of springs and the gaining reaches of streams. In locations where these data were not available, static water levels were used from selected, recent (year 1995 or newer) New Mexico Office of the State Engineer's (NMOSE) well records. Water table contours from Sloan and Garber's (1971) water table map of the Mescalero Apache Reservation are shown along the northern margin of this map. Land surface elevations used to calculate groundwater elevation values originated from the 10-m digital elevation model (DEM). Groundwater levels in the vicinity of pumping wells are erratic and fluctuate significantly over time and natural variations also occur. The user should be aware that conditions change and information contained on this map may not reflect actual or current conditions. Site- and time-specific conditions should be verified by the user. All additional information contained on this map, other than groundwater elevation data, are interpretations of the author. The groundwater elevation contours were drawn by hand based on the author's interpretation of water level data. The groundwater elevation contours were used to further interpret or generate groundwater flow direction and the boundaries of groundwater flow units.

References

- B. Talon Newton, Geoffrey C. Rawling, Stacy Timmons, Lewis Land, Peggy S. Johnson, Trevor J. Kludt, Mike Timmons, and Brigitte Felix, 2012, *Sacramento Mountains Hydrogeology Study*: New Mexico Bureau of Geology & Mineral Resources Open-File Report 543
- Sloan, C. E. and Garber, M. S., 1971, *Ground-water hydrology of the Mescalero Apache indian reservation, south-central New Mexico*: U.S. Geological Survey, Hydrologic Investigations Atlas HA-349, 1:125,000.

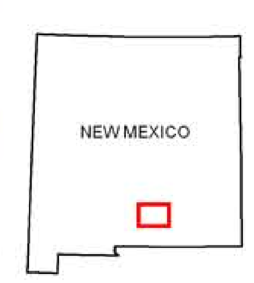
Map Symbols

- 1049 Site Number
- 7798 Water level elevation
- Spring
- Well
- OSE well
- Approximate groundwater elevation in regional aquifer, contour interval 200 ft (ft asl)
- Elevation of recharge
- Horizontal groundwater flow direction
- Water table contour (Sloan and Garber, 1971)
- Ephemeral stream
- Perennial stream reaches as of April 2008

New Mexico Bureau of Geology and Mineral Resources
Open-file Report 542

Water Table Map of the southern Sacramento Mountains, New Mexico

February, 2012
by
Lewis Land, Stacy Timmons, Geoff Rawling, Brigitte Felix



Magnetic Declination
June 2009
8° 46' East changing by 0° 6' W/year
At Map Center

1:150,000

5 2.5 0 5 MILE
20,000 10,000 0 20,000 FEET
5 2.5 0 5 KILOMETERS

CONTOUR INTERVAL 500 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1983

The Otero Soil & Water Conservation District and the New Mexico Department of Agriculture provided funding for the compilation effort as well as the ongoing hydrogeologic investigation. This project would not be possible without the kind cooperation of the many residents of the Sacramento Mountains who have granted access to their property and wells.

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