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# WHERE ARE THE BEST AQUIFERS UNDER RIO RANCHO?

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## BACKGROUND

Water for the city of Rio Rancho comes solely from groundwater held in the Santa Fe Group aquifer system, which extends several thousands of feet below the surface. This aquifer is composed primarily of sand that was deposited over several million years as the Albuquerque basin dropped down along several major fault zones. What parts of this critical aquifer are most optimal for storing and transmitting this precious resource, and where are they located in the subsurface?

To answer these questions, the New Mexico Bureau of Geology and Mineral Resources studied permeability-related properties of Rio Rancho's aquifer using both outcrops and well data. Within this aquifer, we mapped the depths and extents of hydrostratigraphic units and evaluated lateral changes in permeability within a given unit.

## MAPPING OUT THE AQUIFER BENEATH RIO RANCHO INTO HYDROSTRATIGRAPHIC UNITS

A hydrostratigraphic unit (HSU) is a three-dimensional zone of an aquifer, here approximating stacked layers in the Rio Rancho area, which exhibit distinctive water-related properties such as permeability or porosity. These differences in hydraulic properties are due to changes in the nature of the sediment in the aquifer. For example, a gravelly-sandy HSU would very likely have higher permeability than a clayey HSU.

Within the Santa Fe Group aquifer, the Upper, Middle, and Lower Rio Rancho HSUs and the Zia HSU were mapped and listed from shallowest to deepest. These HSUs can be recognized in various datasets using the proportion of sand to clay sediment, the thickness of sand bodies, and the connectedness of sand bodies. The extents and depths of these four HSUs are illustrated in Figure 1 and are available as raster files and in PDF map format at https://bit.ly/RioRanchoAquifers.

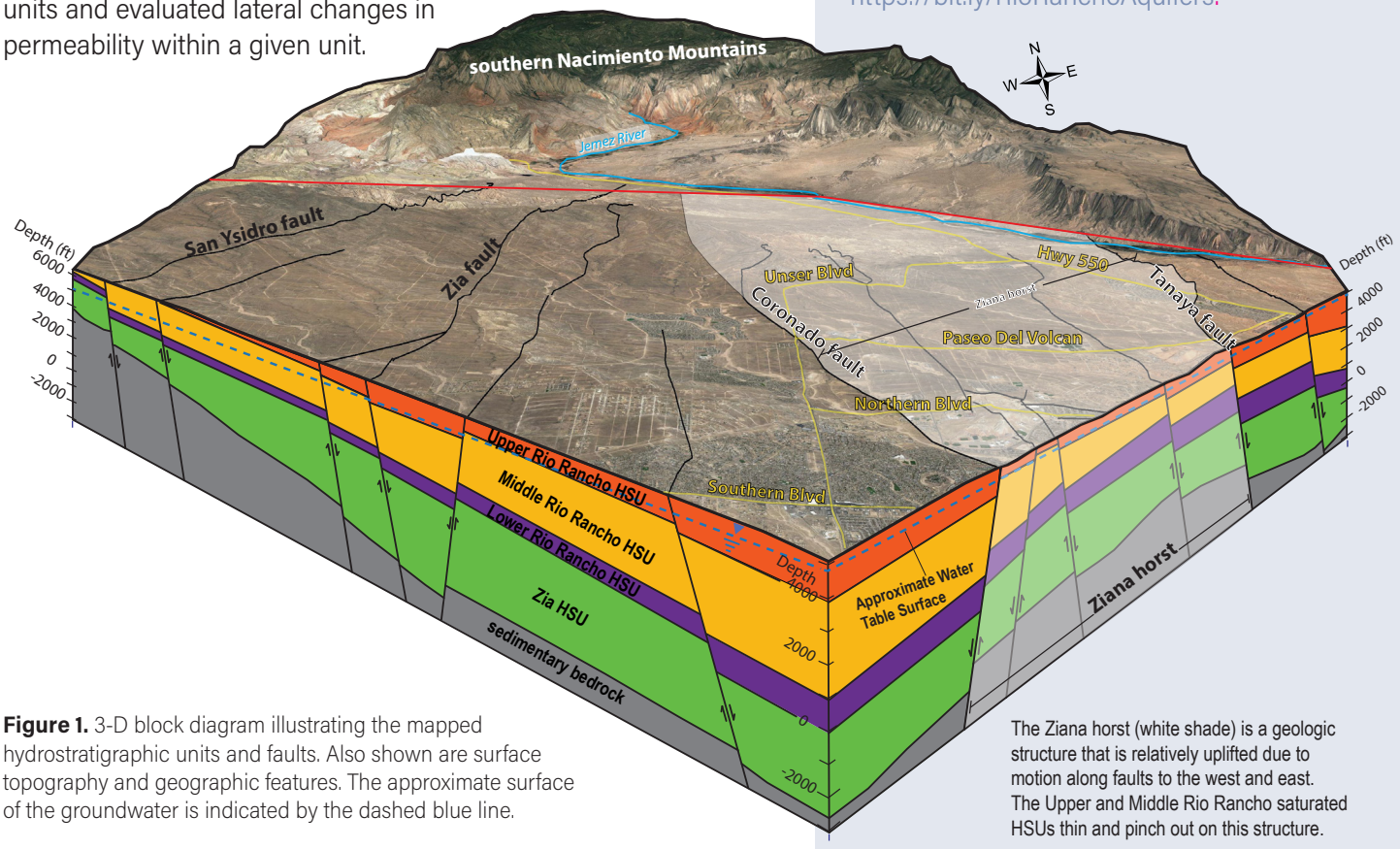


**Figure 1.** 3-D block diagram illustrating the mapped hydrostratigraphic units and faults. Also shown are surface topography and geographic features. The approximate surface of the groundwater is indicated by the dashed blue line.

The Ziana horst (white shade) is a geologic structure that is relatively uplifted due to motion along faults to the west and east. The Upper and Middle Rio Rancho saturated HSUs thin and pinch out on this structure.

## PERMEABILITY DIFFERENCES BETWEEN HSUS

The permeability of an aquifer or HSU describes how easily water moves through the rock material. One way to assess permeability uses hydraulic conductivity values, which are estimated with pumping tests of wells. Figure 2 shows these values for the three shallower HSUs (no hydraulic conductivity data is available for the Zia unit). The Upper Rio Rancho HSU has a notably higher range of hydraulic conductivity values (mostly 6–18 ft/day) than the Middle Rio Rancho HSU (mostly 2–5 ft/day). Only one data point is available for the Lower Rio Rancho aquifer, but it had a value of 21 ft/day. Thus, the Upper and possibly the Lower Rio Rancho HSUs appear to have higher permeabilities. This is consistent with other permeability proxies we analyzed, such as sand body thickness and proportion of sand, clayey sand, and clay for each HSU.

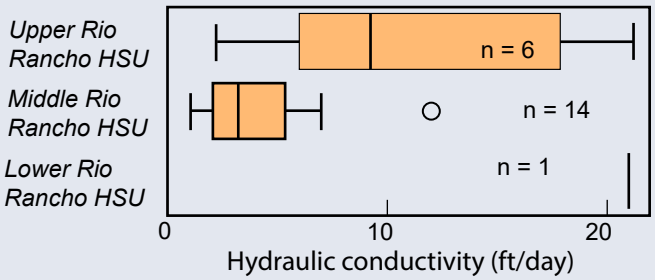


**Figure 2.** In this box-and-whisker plot, hydraulic conductivity data were compiled from 21 pumping tests, which were separated according to hydrostratigraphic units within the aquifer. The shaded boxes represent values between the 25th and 75th percentile of the data. The vertical line within a box is the median value, and the whiskers on either side are the minimum and maximum of the data. The circle denotes a data outlier. "n" is the number of measurements. The further to the right the boxes and vertical lines lie, the higher the hydraulic conductivity (and permeability) of a given HSU.

## LATERAL DIFFERENCES IN PERMEABILITY

By plotting the values of permeability proxies on a map, one can evaluate whether there are lateral changes within an aquifer. In Figure 3, hydraulic conductivity is plotted for the Middle and Upper Rio Rancho HSUs. The size of the circles (blue for Middle Rio Rancho HSU, red for Upper Rio Rancho HSU) is scaled to the hydraulic conductivity value calculated for the aquifer from a well pumping test. The Upper Rio Rancho HSU generally exhibits higher hydraulic conductivity values than the Middle Rio Rancho HSU. However, there are also lateral changes in the Middle Rio Rancho HSU, being highest to the southwest, lowest in the northwest, and with medium values in the east. Lateral trends are not apparent in the Upper Rio Rancho HSU, but consistent, relatively larger circles in the Upper Rio Rancho HSU strongly suggest it has higher permeabilities than the Middle Rio Rancho HSU.

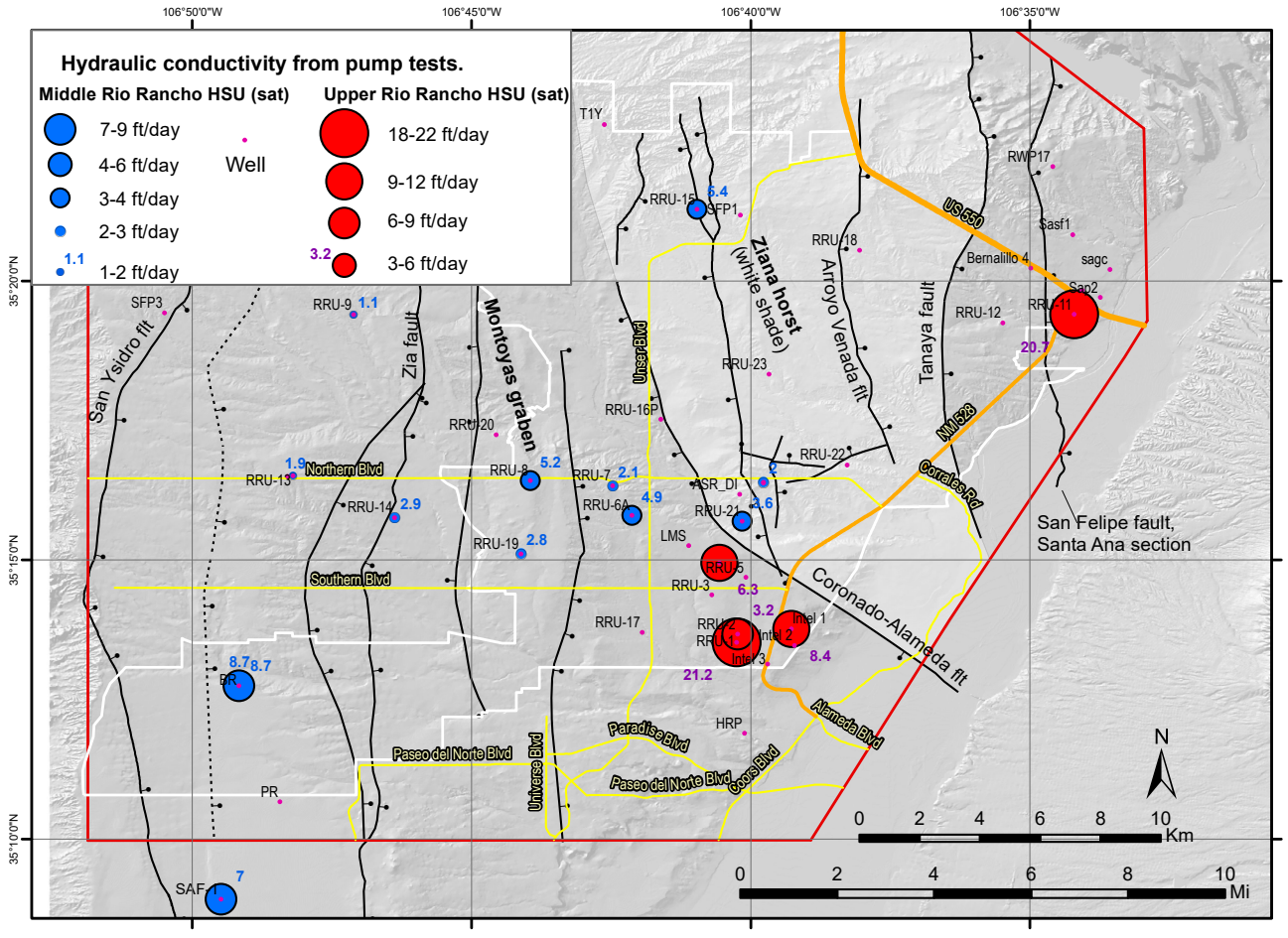


**Figure 3.** Map illustrating differences in hydraulic conductivity between the Upper and Middle Rio Rancho hydrostratigraphic units. The size of the circle scales with the value of hydraulic conductivity.

## DEPTH TO GROUNDWATER AND PRELIMINARY ASSESSMENT OF WATER QUALITY

Figure 4 shows the approximate depth to groundwater below land surface in the study area. Note how the depth to groundwater gets deeper to the west, with increasing distance from the Rio Grande. One proxy of groundwater quality is TDS (total dissolved solids). The size of the circles, which increases with higher TDS values (likely correlating with overall poorer groundwater quality), is largest over a buried geologic structure called the Ziana horst (or uplift zone), where groundwater is sourced from the Lower Rio Rancho HSU and the Ziana HSU.

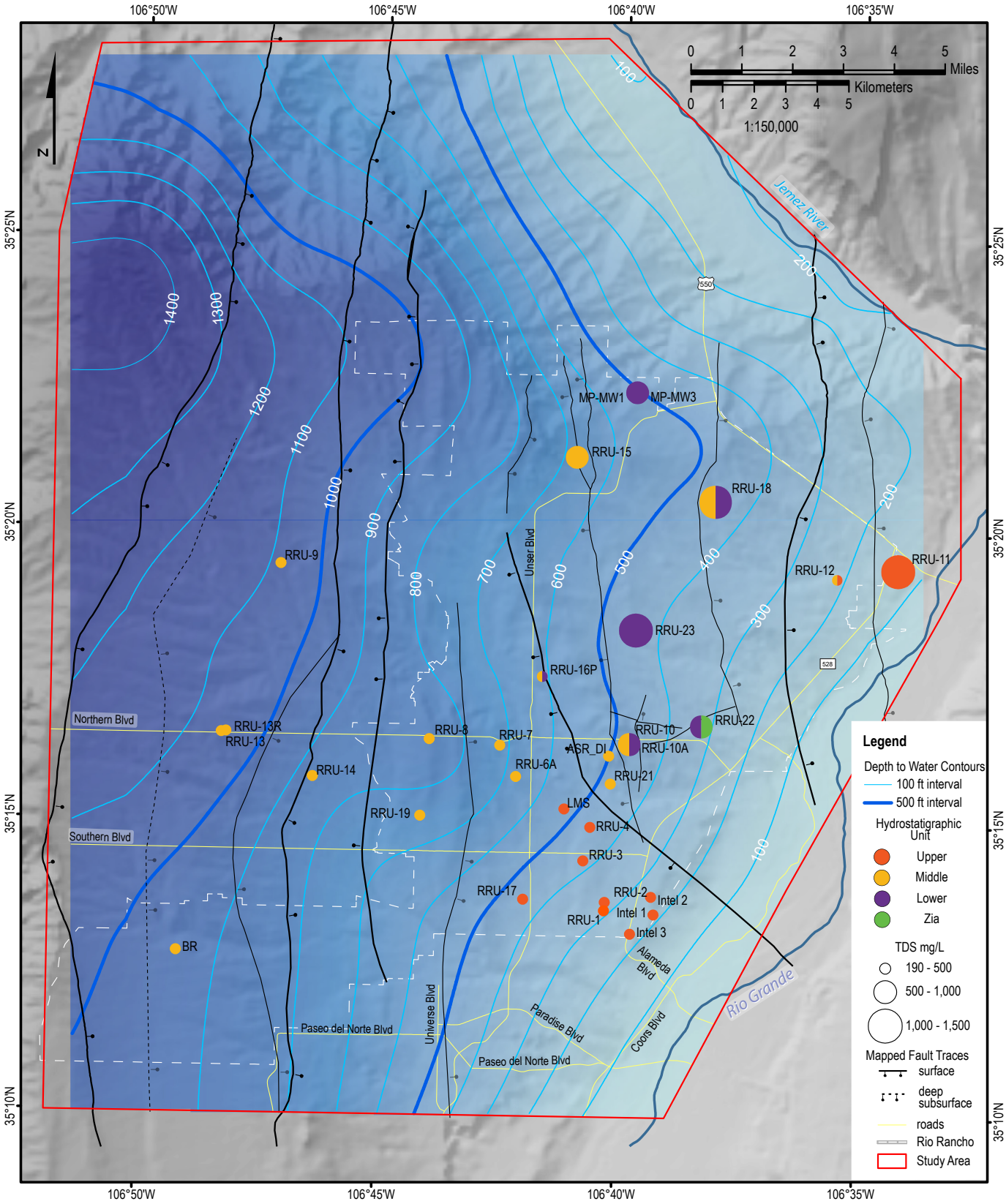


**Figure 4.** Depth to groundwater below land surface and total dissolved solids (TDS). The map shows water table depth in shades of blue. Colored ellipses show TDS values for the four hydrostratigraphic units, scaled according to the TDS value. Circles with more than one color are completed in multiple hydrostratigraphic units.

## KEY TAKEAWAYS

- Based on our assignment of compiled hydraulic conductivity values to individual HSUs, the Upper and Lower Rio Rancho HSUs can be expected to have higher permeabilities (by a factor of 2 to 3) compared to the Middle Rio Rancho HSU. But the Middle Rio Rancho HSU's extent and greater saturated thickness mean it is still an important source of groundwater.
- Aquifer thicknesses are greatest in the southeast and slightly thicker northward between the Zia and Coronado fault zones. Most aquifers shallow over a north-trending geologic structure called the Ziana horst.
- There is increased likelihood of poor-quality groundwater in wells on or near the Ziana horst.
- Available pumping-test data suggest the Middle Rio Rancho HSU may be slightly more permeable in the extreme southwest of the study area, but more data points are needed to confirm this apparent lateral trend.


**Figure 5.** Well-exposed badlands 13 miles northwest of Rio Rancho; view is to the northwest. Hydrostratigraphic units (HSU) are labeled. The younger Middle Rio Rancho HSU is down-dropped against older strata (i.e., Zia HSU) by the east-down San Ysidro fault. In order to make the hydrostratigraphic model, contacts corresponding to HSU boundaries were projected from these badland exposures southward into the subsurface. *Photo by Dan Koning*

AQUIFER MAPPING PROGRAM

For more information on this project:
https://bit.ly/RioRanchoAquifers

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