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Discovering a World-Class Aquifer: The Evolving Understanding of Albuquerque Basin Hydrogeology

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DISCOVERING A WORLD-CLASS AQUIFER: THE EVOLVING UNDERSTANDING OF ALBUQUERQUE BASIN HYDROGEOLOGY

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Abstract—The Albuquerque Basin contains one of the thickest and most productive basin-fill aquifer systems in the southwestern United States, yet recognition of its extent, hydraulic properties, and water-quality variability developed only gradually and incrementally. Early municipal, exploratory, and academic investigations in the late nineteenth and early twentieth centuries provided fragmentary insights that were constrained by an incomplete understanding of the Rio Grande rift structure and sediment thickness. Initial water-quality studies and water-level observations distinguished river-derived from mountain-front recharge and introduced early conceptual models of groundwater flow, but did not anticipate the great depth of saturated basin fill. Deep exploratory drilling during the 1930s demonstrated that Santa Fe Group sediments locally exceed 1,524 m (5,000 ft) in thickness, prompting a shift toward a rift-basin aquifer framework. By the mid-twentieth century, synthesis studies characterized the Albuquerque Basin aquifer as regionally extensive and highly productive, and subsequent groundwater-flow models quantified hundreds of millions of acre-feet of water in storage while incorporating river–aquifer interaction and interstate compact constraints. This paper synthesizes the historical evolution of hydrogeologic understanding in the Albuquerque region, emphasizing how early misconceptions were replaced by a basin-scale conceptual model that now underpins groundwater management, compact compliance, and numerical modeling. Even though the aquifer is large and productive, hydrologic observations and modeling have shown that careful management of the groundwater is, and will continue to be, necessary for long-term sustainability.

INTRODUCTION

The Albuquerque Basin contains one of the thickest and most productive basin-fill aquifer systems in the southwestern United States (e.g., Todd, 1983). Groundwater from the Santa Fe Group aquifer system has supplied Albuquerque, New Mexico, for more than a century, yet its enormous thickness, lateral continuity, and hydraulic complexity were recognized only incrementally. Early municipal, academic, and exploratory wells provided limited, localized information on groundwater occurrence and quality, while contemporaneous geologic interpretations (e.g., Darton, 1922) underestimated the extent of sediment accumulation within the Rio Grande rift.

Recognition of the extent, hydraulic properties, and water-quality variability of this regional aquifer system emerged gradually from the 1890s onward through well drilling, geologic mapping, geochemical analyses, and evolving structural interpretations. This paper traces the historical development of hydrogeologic understanding in the Albuquerque region, emphasizing how early conceptual limitations (Herrick and Johnson, 1900; Weinzirl, 1905) were replaced by a robust rift-basin aquifer framework that now underpins groundwater management, interstate compact compliance, and basin-scale numerical modeling. This paper summarizes a report by Shomaker (2025) on the history of groundwater exploration and management in the Albuquerque region.

EARLY RECOGNITION OF GROUNDWATER RESOURCES (1890s–1905)

Awareness of groundwater beneath the East Mesa, in what is now the Northeast Heights (Fig. 1) began during the 1890s, when homesteaders installed shallow windmill-powered wells to support domestic use and small-scale irrigation. Contemporary accounts reported groundwater at depths of 61–76 m (200–250 ft) and described the water quality as excellent (Albuquerque Journal, May 5, 1895). The author of the Albuquerque Journal article speculated that "with a hundred or so windmills and engines pumping water on the thirsty soil of that district, it would not be long until the landscape would be dotted with some of the most thriving orchards, gardens, and beautiful homes to be seen in the southwest." During that time, Major W. A. Rankin (1832–1897) recognized the potential for developing groundwater on the East Mesa and proposed drilling a deep (305 m [1000 ft]) well to support additional settlement, although no documentation of such a well has survived to confirm this.

At that time, only a few wells were known to exist on the East Mesa, and none penetrated more than the shallowest portion of the aquifer. These early wells provided no indication of the great thickness of saturated basin-fill sediments beneath Albuquerque. The basin fill was known to contain conglomerate, sandstone, siltstone, shale, and volcanic rocks, collectively referred to in early literature as the "Santa Fe marl" (Hayden, 1869), and now recognized as the Santa Fe Group (Spiegel and Baldwin, 1963). Although surface exposures had been described by Hayden (1869) and Herrick and Johnson (1900), the great thickness of these deposits in the subsurface was not yet appreciated. The then-current geologic interpretations of the valley were as a shallow structural depression rather than a deep basin (Herrick and Johnson, 1900).

Early Geologic and Hydrologic Interpretations

Herrick and Johnson (1900) produced the first comprehensive geologic map of the Albuquerque area and concluded that

the basin represented a down-dropped structural block containing geologically young sediments. However, they assumed groundwater was limited to shallow zones near river level and explicitly stated that the East Mesa aquifer did not extend far below the elevation of the Rio Grande. Their descriptions of East Mesa wells, which penetrated only tens of feet into water-saturated sediment, reinforced this interpretation and obscured the presence of a much thicker and deeper aquifer system.

The University of New Mexico (UNM) drilled its first water-supply well in 1903 to a depth of approximately 73–76 m (240–250 ft), encountering water at about 61 m (200 ft) below ground surface (Fig. 2). This well supplied campus needs and tapped only the uppermost portion of what was later to be called the Santa Fe Group aquifer. As with earlier wells, it provided no indication of the deeper basin-fill system that would later be recognized. A military post was proposed by Albuquerque boosters on the East Mesa, and another well was drilled (probably in 1904) about seven miles (11 km) east of town to supply the proposed post (Weinzirl, 1905, p. 10). The military post never materialized; however, the Military Well, as it was then known, encountered groundwater 128 m (420 ft) below the ground (Lee, 1907, p. 34), approximately 40 meters (130 ft) above the level of the Rio Grande. The water had 197 ppm total dissolved solids and was considered of good quality.

Water-Quality Studies and Early Conceptual Advances

A major conceptual advance occurred with the publication of UNM Professor John Weinzirl's (1905) investigation of Albuquerque's water supply. Although motivated primarily by public-health concerns, Weinzirl's work incorporated chemical analyses, water-level observations, and interpretations of groundwater flow and recharge sources. He distinguished chemically between river-derived groundwater and water recharged from the Sandia Mountains and recognized that the municipal supply, derived from a battery of wells at the old Main Plant, at the corner of Tijeras Avenue and Broadway Boulevard (Fig. 1), represented a mixture of these sources.

Weinzirl introduced one of the earliest conceptual cross sections of groundwater flow across the Albuquerque Basin, extending from the Rio Grande eastward to the Sandia Mountains (Fig. 3). His interpretation identified multiple water-bearing intervals and tentatively depicted a basal "granite wall," representing bedrock beneath the basin fill. Although the depth and geometry of this surface were poorly constrained, the cross section marked an important step toward



FIGURE 1. Map showing the Albuquerque area and locations mentioned in the text. The black star denotes the location of the original City water wells at Tijeras and Broadway. The East Mesa, north of Central Avenue, is informally termed the Northeast Heights.

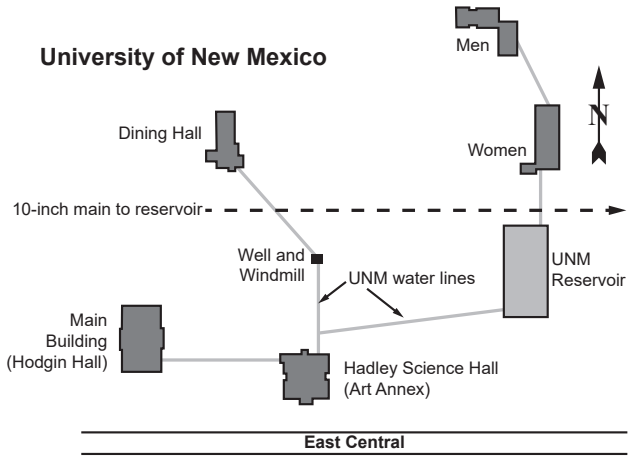


FIGURE 2. Map of UNM campus, *circa* 1908, with labels added, showing the university well and reservoir. Hodgin Hall is the only building still in existence. Map source: Library of Congress, Geography and Map Division, Sanborn Maps Collection.

conceptualizing the aquifer as a laterally extensive system rather than a shallow alluvial deposit.

Weinzirl also recognized that deeper groundwater beneath the inner valley was chemically softer than shallow groundwater, reflecting differences in calcium and magnesium concentrations, even where total dissolved solids were similar (Fig. 4 and Table 1). Weinzirl also proposed mitigation measures for long-standing issues related to water stagnation during reservoir storage, including draining and cleaning reservoirs every three months and treating algae with a 1 ppm solution of copper sulfate (Weinzirl, 1905, p. 16). His work established the fundamental distinction between valley-floor and mountain-front recharge that remains central to modern hydrogeologic interpretations.

EMERGENCE OF A DEEP-BASIN AQUIFER MODEL (1906–1930s)

Despite these early conceptual advances in understanding the regional aquifer system, early twentieth-century geologic interpretations continued to underestimate basin depth. Darton (1922), for example, interpreted the Sandia Mountains as part of a broad anticline and the Rio Grande valley as a syncline containing relatively shallow bedrock units. Although he recognized faulting along the front of the Sandia Mountains, he did not appreciate the magnitude of displacement nor the great thickness of basin-fill sediments.

Kirk Bryan (1888–1950), in his Senior Thesis at UNM (Bryan, 1909) provided a log of the 1903 "soft water" well and summarized the geology of the valley as it was known at the time. Bryan reasoned that "…there existed at Albuquerque a deep trough…that it was erosional and caused by a strong through-flowing river seems evident…" The trough is now understood, not to be an eroded canyon that had been partly refilled with sediment, but rather to be a structurally complicated, down-dropped basin created by tectonic forces, bounded on the east at the foot of the Sandia Mountains by faults, and on the west by the many faults of the Rio Puerco fault zone (see Kelley, 1977). The basin had been filled with sediment by a through-flowing ancestral river, which had at times been blocked naturally so that playa lakes formed, which then were reconnected by the Rio Grande (Hawley and Haase, 1992; see also Connell et al., 2005). Erosion cut down a few hundred feet through the accumulated sedimentary beds. Recent geophysical studies indicate that the Rio Grande trough beneath Albuquerque contains 1.8–3.0 km (6,000–10,000 ft) of river-borne sediments (e.g., Grauch and Connell, 2013).

A clearer understanding of the basin size emerged during the 1930s with deep exploratory drilling for oil and gas as part of a land development in which purchasers of lots would also be entitled to an interest in royalties associated with the entire tract. Two test wells drilled by the Norins Realty Company of Los Angeles, California, in North Albuquerque Acres demonstrated that basin-fill sediments exceed 1,524 m (5,000 ft) in thickness. The Norins North Albuquerque Acres No. 1 (API No. 30-001-00505) and Norins North Albuquerque Acres No. 2 (API No. 30-001-05005) provided the first unequivocal evidence that the Albuquerque Basin is a deep, fault-bounded rift filled with a thick succession of Santa Fe Group sediments. By the late 1930s, it had become evident that Albuquerque was underlain by an extensive, highly productive basin-fill aquifer system.

REGIONAL SYNTHESIS AND QUANTIFICATION (1930s–1980s)

Kirk Bryan's later work (Bryan, 1938) was an important step in regional synthesis and led to wider appreciation of the Albuquerque basin's character as part of a series of linked rift basins, although Bryan did not provide a detailed analysis of the basin or its aquifer.

By the mid-twentieth century, regional studies had firmly established the Santa Fe Group as the principal aquifer system beneath Albuquerque. Bjorklund and Maxwell (1961) presented a comprehensive conceptual model depicting a thick,

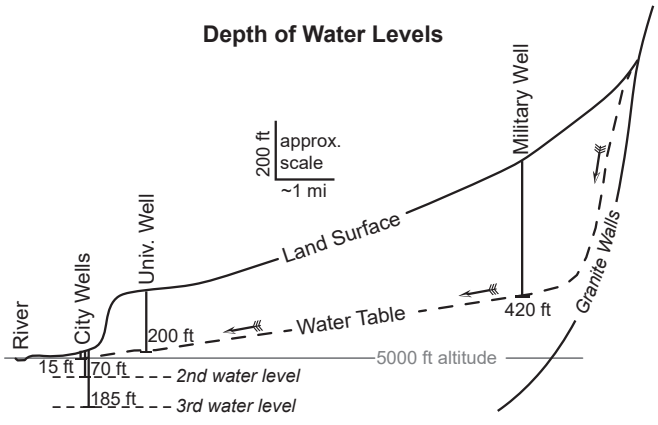


FIGURE 3. Weinzirl's (1905, p. 12) cross-section from the Rio Grande on the left (west) to the foot of the Sandia Mountains on the right (east), showing the position of the water table in wells on the East Mesa. The "Granite Walls" label presumably represents his interpretation of a bedrock boundary beneath valley-fill sediments that constitute the aquifer.

laterally continuous, and highly permeable basin-fill aquifer extending across the valley (Fig. 5). The nature and extent of the aquifer became better understood as more wells were drilled. Based on well data, the shallowest deposits in the valley-fill aquifer were weakly consolidated, and the prevailing well-construction methods were not effective in preventing sand from entering a well during pumping. In contrast to the shallow, river-reworked alluvial sands and gravels, deeper deposits contained water-saturated conglomerate, sandstone, siltstone, shale, and lava flows. Much of this deeper succession, originally named the Santa Fe marl by Hayden (1869), is now called the Santa Fe Group, which has been subdivided into numerous units in the Albuquerque area (see Connell, 2008).

Subsequent groundwater assessments quantified the enormous volume of water stored within the basin. U.S. Geological Survey analyses in the 1970s estimated as much as 2.8 billion acre-feet of fresh water in storage within the "Albuquerque region" (West and Broadhurst, 1975), although practical groundwater development was recognized to be constrained by river-aquifer interaction and interstate compact obligations. Misinterpretations of these storage estimates in public discourse undoubtedly blurred the vital distinction between the volume of water in storage and the sustainable yield. Misunderstanding of the distinction led to an incautious degree of exploitation of the aquifer, largely by the City of Albuquerque.

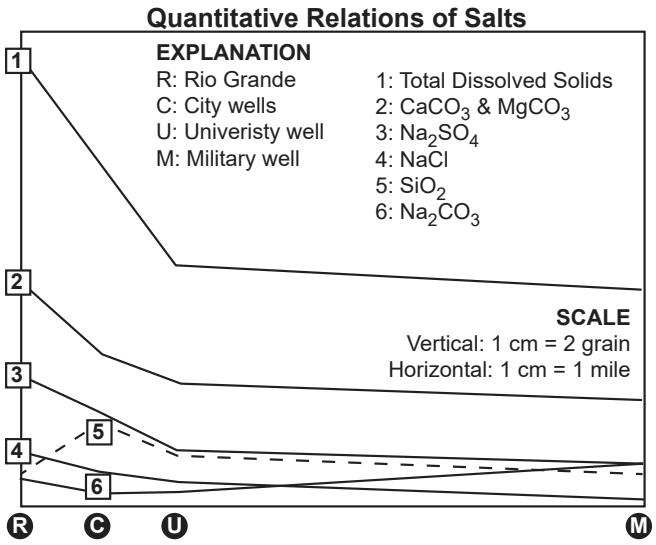


FIGURE 4. Weinzirl's (1905, p.13) graphic summary of water analyses for the Rio Grande (R), the City water-supply system (C), the UNM 1903 well (U), and the Military well (M). The horizontal scale is the distance from the Rio Grande to the Military well. The vertical scale represents concentrations of major chemical constituents in grains per gallon. This reproduction is not at the same scale as the original. The horizontal axis represents a distance of about 15 km (9.5 mi). The vertical axis range is from zero to approximately 24 grains per gallon (411 ppm).

TABLE 1. Water analyses (A), for the 1903 deep "soft water well," sampled in July 1903, and (B) of a sample taken in late 1904 from the water distribution system and representing a composite of producing wells (from Weinzirl, 1905, p. 6 and 8). Although the total dissolved solids concentrations are similar, the composite hardness of the system is significantly higher.

Well and constituent analysis	Concentration (ppm)	Concentration (grains/U.S. gallon)
A 1903 "soft water" well	–	–
Sodium chloride		1.03
Sodium sulfate		5.25
Sodium carbonate		1.71
Calcium carbonate		3.71
Magnesium carbonate		1.70
Iron and aluminum oxides		0.25
Silica		4.92
Cryst. Water, etc.		0.18
Total solids		18.75
B 1904 composite system sample	–	–
Sodium chloride	25.34	1.48
Sodium sulfate	78.49	4.58
Sodium carbonate	5.89	0.34
Calcium carbonate	103.95	6.06
Magnesium carbonate	24.68	1.44
Iron and aluminum oxides	1.20	0.07
Silica	67.20	3.92
Total solids	306.75	17.89
Total residue heated to 150°C for 1 hour	304.00	17.72
Free ammonia	trace	Trace
Albuminoid	0.13	0.0076
Hardness (soap method)	-	7.19°

Noting that with a then-current rate of withdrawal of about 95,000 acre-ft per year (Sorenson, 1977, p. 17), geologist and NM State Representative Philip R. ("Bob") Grant calculated that the volume of recoverable fresh groundwater within the Albuquerque subregion was approximately 70% of the volume of Lake Michigan (e.g., Albuquerque Tribune, April 12, 1977). Grant's statement was widely adopted in public discourse and promotional materials as evidence of an effectively inexhaustible water supply, and in some cases the comparison was later expanded to Lake Superior, further exaggerating the perceived abundance of groundwater.

As the Santa Fe Group aquifer underwent development through the completion of numerous municipal water-supply wells, an understanding of Albuquerque's water constraints emerged. For example, it became clear that groundwater availability is not determined solely by total aquifer storage, but by legally enforceable limits under the terms of the interstate compact with Colorado and Texas on depletions to the Rio Grande, due to substantial groundwater withdrawals.

The practical availability of the groundwater resource is far more limited than its volumetric magnitude alone would suggest. Constraints include the substantially lower rate of aquifer recharge as compared with groundwater withdrawal, which has resulted in large water-level declines; the substantial decrease in permeability of aquifer sediments with depth and with distance from Albuquerque, where particularly permeable sediments are present; the economic viability of withdrawing water from large depths; and the low quality of groundwater available across large areas and depths of the basin-fill aquifer. The relatively poor connection between the river and the aquifer, as indicated by later studies, results in less aquifer recharge from induced river infiltration than initially thought.

MODERN VIEW OF THE SANTA FE GROUP AQUIFER SYSTEM (1990s–2013)

By the late twentieth century, the Albuquerque Basin aquifer was recognized as a regionally extensive, highly productive, and complicated hydrogeologic system. Deep municipal test wells drilled during the 1980s confirmed the presence of good-quality groundwater in permeable strata at depths exceeding 1 km (3,000 ft) beneath the Northeast Heights. Oil-and-gas exploration further demonstrated that Santa Fe Group sediments locally extend to depths exceeding 6 km (20,000 ft) without encountering crystalline basement. However, recent studies have shown that the most productive sediments are limited to the upper 518 to 610 m (1,700–2,000 ft) of the Santa Fe Group beneath northeast Albuquerque, and sediments generally become substantially less productive with depth and with distance from the Albuquerque area (Hawley and Haase, 1992; Thorn et al., 1993; Connell, 2008)." Hawley et al. (1995) make the important point that "lower and middle Santa Fe units do

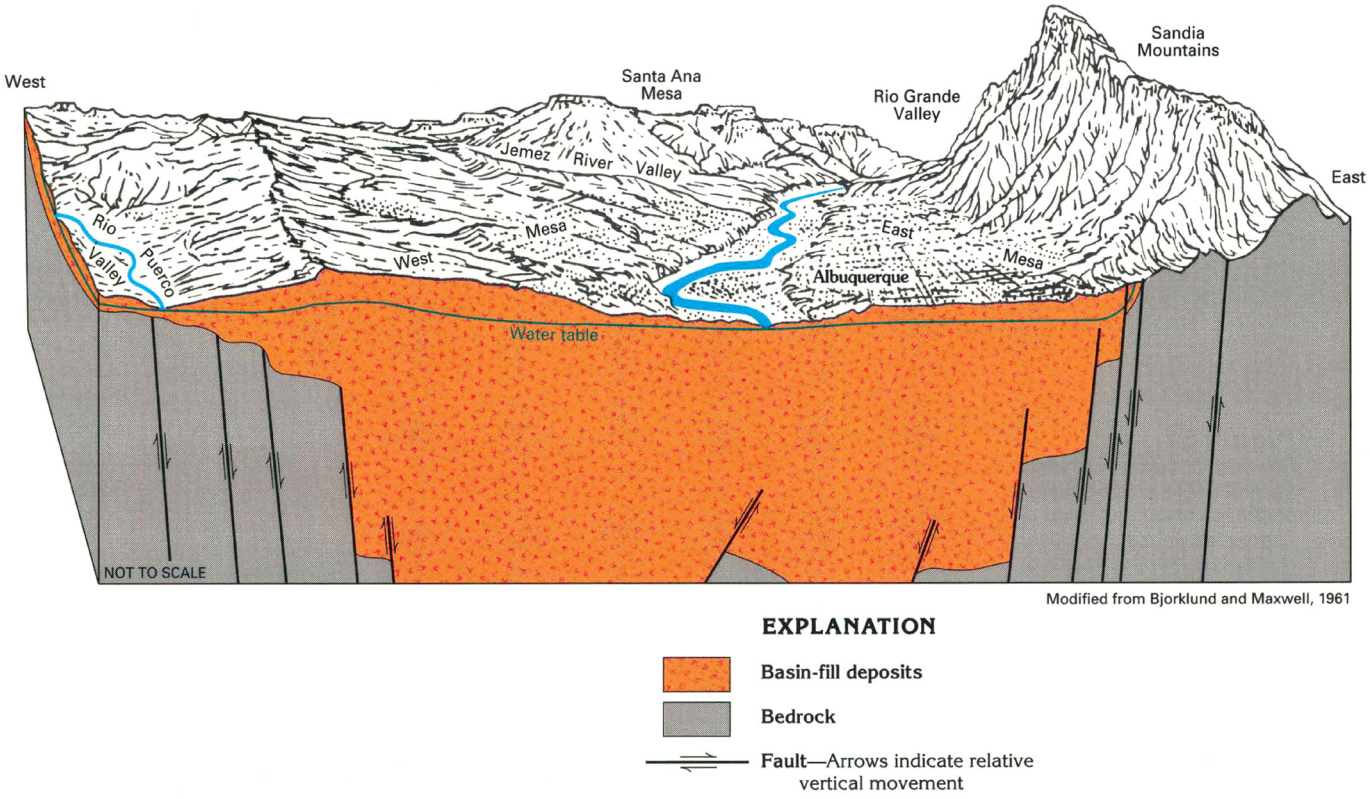


FIGURE 5. Block diagram of the Albuquerque area, illustrating the regional Santa Fe Group aquifer as understood in the 1960s (Bjorklund and Maxwell, 1961, redrawn by Robson and Banta, 1995). The Rio Puerco is on the left side of the diagram; Sandia Crest is on the right. The central business district and Old Town areas are in the inner valley of the Rio Grande, at the center of the diagram. The bottom of the diagram is at sea level. A thin layer of alluvium, which also serves as an aquifer, overlies the Santa Fe group. All other geologic units shown in the cross-section have relatively low permeability.

not produce significant amounts of good quality groundwater even though they constitute the bulk of the basin-fill fill sequence. “

Modern hydrogeologic investigations integrate stratigraphic, geophysical, geochemical, and numerical modeling approaches to characterize aquifer heterogeneity, recharge processes, and river-aquifer interactions. These include the stratigraphic studies of Hawley and Haase (1992), which corrected the previous hydrogeologic model of the basin, as illustrated in Figure 5, showing that most of the deeper sediments were not productive sands and gravels but rather tight playa-lake and other clay-rich sediments that contained mostly poor-quality water. This, and some other studies about the same time, stimulated a sobering reassessment of the actual sustainable yield of the basin (e.g., Brown et al., 1996) and ultimately led to construction of surface-water diversions to provide the main water supply.

Mapping by Connell (2008) and geophysical studies by Grauch and Connell (2013) indicate that the basin’s main features include “three, 3–5-km-deep, interconnected structural depressions, which increase in size, complexity, and segmentation from north to south: the Santo Domingo, Calabacillas, and Belen subbasins. The increase in segmentation and complexity may reflect a transition of the Rio Grande rift from well-defined structural depressions in the north to multiple, segmented basins within a broader region of crustal extension to the south (Grauch and Connell, 2013).” The conceptual framework that emerged through more than a century of investigation now supports groundwater management, long-term supply planning, and compliance with interstate compact requirements.

Numerical groundwater-flow modeling efforts during the late twentieth century further refined understanding of basin hydraulics, recharge sources, and river-aquifer exchange. Models prepared by the U.S. Geological Survey and the New Mexico Office of the State Engineer demonstrated that hundreds of millions of acre-feet of water are stored within the upper several thousand feet of basin fill between Cochiti Lake and San Acacia (e.g., Barroll, 2001), while also emphasizing the regulatory and hydrologic limits on groundwater development. The works of Sanford et al. (2004) and Plummer et al. (2004) are outstanding examples of the use of geochemical and isotopic data to characterize large groundwater basins in ways that standard physical hydrogeology studies cannot, and it has contributed in a lasting way to the improved quantification of basin groundwater flow.

It has become evident that a serious constraint on groundwater use in the basin is not the volume of water in storage in the aquifer, but the impact of groundwater pumping on the flow of the Rio Grande, and the limits on depletions under existing water rights and the Rio Grande Compact. However, planning for direct use of surface water from the Rio Grande, by the City of Albuquerque (subsequently the Albuquerque Bernalillo County Water Utility Authority). begun in 1997, was driven primarily by knowledge that the most productive aquifer sediments were less extensive than previously believed, and that groundwater withdrawals were substantially greater than aquifer recharge, despite induced infiltration from the river. That budget imbalance and the large magnitude of the resulting water-level declines were the primary indicators that continued reliance on groundwater as the sole drinking water source for the metropolitan area was unsustainable. In addition to rapidly depleting aquifer storage, continued pumping is expected to result in higher well-drilling and pumping costs, possible land subsidence, and an overall deterioration of water quality.

CONCLUSIONS

Recognition of the Albuquerque Basin as a world-class aquifer system developed gradually, shaped by incremental advances in drilling, geologic interpretation, water-quality analysis, and conceptual modeling. Early assumptions that groundwater was limited to shallow alluvial deposits were discarded as the basin’s true scale became understood. Deep drilling and regional synthesis revealed a thick, laterally extensive, and highly productive rift-basin aquifer. However, groundwater use, even from a deep and extensive aquifer, must be carefully managed. Today’s conceptual model—refined through decades of investigation—continues to underpin groundwater management and scientific understanding in central New Mexico.

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REFERENCES

Barroll, P., 2001, Documentation of the Administrative Groundwater Model for the Middle Rio Grande Basin: New Mexico State Engineer Technical Report TDH-99-3, 52 p.

Bjorklund, L.J. and Maxwell, B.W., 1961, Availability of ground water in the Albuquerque area, Bernalillo and Sandoval Counties, New Mexico: New Mexico State Engineer Technical Report 21, 117 p.

Brown, F.L., Nunn, S.C., Shomaker, J.W., and Woodard, G., 1996, The Value of Water: Consultant report to City of Albuquerque, 143 p. and appendix.

Bryan, K., 1909, Geology of the vicinity of Albuquerque: University of New Mexico Bulletin, Geological Series, v. III, no. 1, 24 p.

Connell, S.D., 2008, Geologic map of the Albuquerque–Rio Rancho metropolitan area, Bernalillo and Sandoval County, New Mexico: New Mexico Bureau of Geology and Mineral Resources, Geologic Map GM-78, scale 1:50,000, 2 pls. https://doi.org/10.58799/GM-78

Connell, S.D., Hawley, J.H., and Love, D.W., 2005, Late Cenozoic drainage development in the southeastern Basin and Range of New Mexico, southeasternmost Arizona, and western Texas, *in* Lucas, S.G., Morgan, G.S., and Zeigler, K.E., eds., New Mexico’s Ice Ages, New Mexico Museum of Natural History and Science, Bulletin 28, p. 125–150.

Darton, N.H., 1922, Geologic structure of parts of New Mexico: U.S. Geological Survey Bulletin 726-E, 125 p.

Grauch, V.J.S., and Connell, S.D., 2013, New perspectives on the geometry of the Albuquerque Basin, Rio Grande rift, New Mexico: Insights from geophysical models of rift-fill thickness, *in* Hudson, M.R., and Grauch, V.J.S., eds., New Perspectives on Rio Grande Rift Basins: From Tectonics to Groundwater: Geological Society of America Special Paper 494, p. 427–462, doi:10.1130/2013.2494(16)

Hawley, J.W., and Haase, C.S., 1992, Hydrogeologic framework of the northern Albuquerque Basin: N.M. Bureau of Geology and Mineral Resources Open-file Report 387, 176 p. https://doi.org/10.58799/OFR-387

Hawley, J.W, Haase, C.S., and Lozinsky, R.P., 1995, An underground view of the Albuquerque Basin, *in* Ortega-Klett, C.P., ed., The water future of Albuquerque and Middle Rio Grande Basin: Proceedings of the 39th Annual New Mexico Water Conference, November 3–4, 1994: New Mexico Water Resources Research Institute, WRRI Report No. 290, p. 37–55.

Hayden, F.V., 1869, First, second, and third annual reports of the United States Geological Survey of the Territories for the years 1867, 1868, and 1869 (1873). https://doi.org/10.3133/70038907

Herrick, C.L., and Johnson, D.W., 1900, The geology of the Albuquerque sheet: New Mexico University Bulletin 2, Geology Series, no. 23, pt. 1, 67 p.

Kelley, V.C., 1977, Geology of Albuquerque Basin, New Mexico: New Mexico Bureau of Mines and Mineral Resources, Memoir 33, 59 p. https://doi.org/10.58799/M-33

Lee, W.T., 1907, Water resources of the Rio Grande valley in New Mexico and their development: U.S. Geological Survey Water Supply and Irrigation Paper 188, 59 p.

Plummer, L.N., Bexfield, L.M., Anderholm, S.K., Sanford, W.E., and Busenberg, E., 2004, Geochemical Characterization of Ground-water Flow in the Santa Fe Group Aquifer System, Middle Rio Grande Basin, New Mexico: U.S. Geological Survey Water-Resources Investigations Report 03-4131, 395 p.

Robson, S.G., and Banta, E.R., 1995, Groundwater atlas of the United States—Segment 2, Arizona, Colorado, New Mexico, Utah: U.S. Geological Survey Hydrologic Investigations Atlas 730C, 34 p. https://doi.org/10.3133/ha730C

Sanford, W.E., Plummer, L.N., McAda, D.P., Bexfield, L.M., and Anderholm, S.K., 2004, Use of environmental tracers to estimate parameters for a predevelopment ground-water-flow model of the Middle Rio Grande Basin, New Mexico: U.S. Geological Survey Water-Resources Investigations Report 03-4286, 102 p. https://doi.org/10.3133/wri034286

Shomaker, J.W., 2025, The beginnings and early history of Albuquerque's water supply, 1880-1960: New Mexico Water Resources Research Institute, Miscellaneous Report No. 35, 106 p.

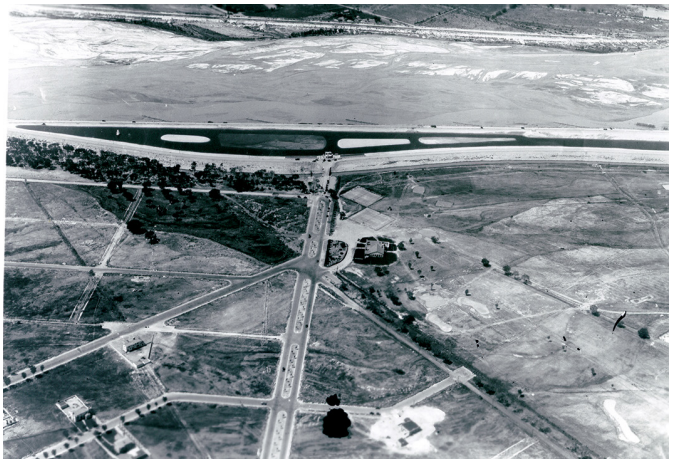
Sorensen, E.F., 1977, Water use by categories in New Mexico counties and river basins, and irrigated and dryland cropland acreage in 1975: New Mexico State Engineer Office, Technical Report 41, 11 p, 11 tables.

Spiegel, Z., and Baldwin, B., 1963, Geology and water resources of the Santa Fe area, New Mexico: U.S. Geological Survey Water Supply Paper 1525, 258 p. https://doi.org/10.3133/wsp1525

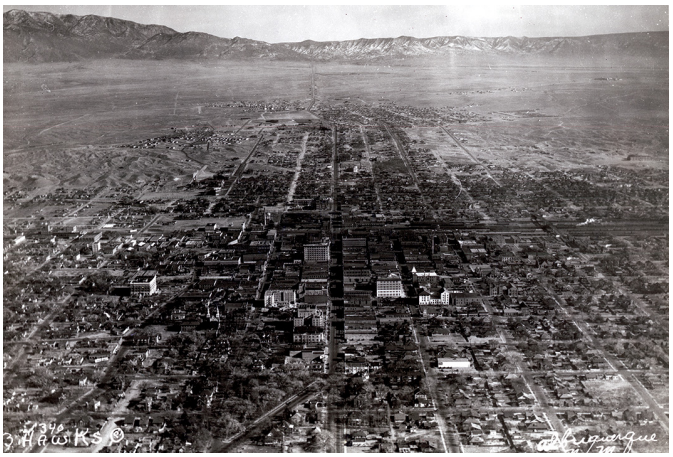
Thorn, C.R., McAda, D.P., and Kernodle, J.M., 1993, Geohydrologic framework and hydrologic conditions in the Albuquerque Basin, central New Mexico: U.S. Geological Survey Water-Resources Investigations Report 93-4149, 106 p.

Todd, D.K., 1983, Groundwater Resources of the United States: Berkeley, CA, Premier Press, 749 p.

Weinzirl, J., 1905, The potable waters of New Mexico, with special reference to the city water supply: University of New Mexico Bulletin, Biological Series, v. 2, no. 11, Bulletin of the Hadley Climatological Laboratory of the University of New Mexico, v. 2, no. 11, 28 p. https://digitalrepository.unm.edu/unm_bulletin/16/



Aerial view looking west towards Tingley Beach and the Rio Grande along Laguna Boulevard SW in 1930 (PA1968.001.293, Albuquerque Museum, gift of Clark Speakman).



Aerial view looking east along Tenth Street SW in 1932 (PA1978.141.340, Albuquerque Museum, transfer from Albuquerque Public Library).



Aerial view looking north across Albuquerque in 1969 (PA1996.029.002, Albuquerque Museum).



Aerial view looking northeast from Interstate 40, November 29, 1969 (PA1996.006.356, Albuquerque Museum).

Historical aerial imagery of the Albuquerque area taken from 1930, 1932, and 1969 (courtesy of Albuquerque Museum).