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CONCEPTUAL HYDROLOGIC SYSTEMS FOR SANTA FE COUNTY

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Abstract—Santa Fe County is divided into three major aquifer or hydrologic systems: the north Santa Fe County aquifer system, the mid-Santa Fe County hydrologic system, and the Estancia Valley aquifer system. The primary aquifer in the north Santa Fe County aquifer system is composed of Santa Fe Group sediments and is bounded to the east by Precambrian crystalline rocks and to the west by Tertiary basalts. Water quality is generally very good, although very hard. The saturated thickness probably exceeds 3500 ft and the aquifer contains sufficient water to supply existing demands for many hundreds of years if legal and administrative issues are ignored. The mid-Santa Fe County hydrologic system consists of sedimentary rocks from Permian to Tertiary age. The hydrogeology of this system is poorly understood, but water quality is generally poor throughout. The primary aquifer in the Estancia Valley aquifer system in southern Santa Fe County is composed of valley fill deposited in a structural trough, with thicknesses up to 350 ft. The formations that either underlie or crop out along the margins of the basin include Pennsylvanian to Triassic sedimentary rocks. Water quality deteriorates toward the center of the basin (from 300 to almost 3000 ppm TDS), but is suitable for irrigation even in the worst areas. The quantity in storage is estimated to be over 1,000,000 ac-ft and is sufficient to supply existing demands for at least 80 yrs.

INTRODUCTION

For regional planning purposes, Daniel B. Stephens & Associates, Inc. (DBS&A) has divided Santa Fe County into three major conceptual aquifers or hydrologic systems (Fig. 1). The north Santa Fe County (NSFC) aquifer system, the mid-Santa Fe County (MSFC) hydrologic system and the Estancia Valley (EV) aquifer system were defined, in part, based upon the hydrogeologic conditions. Conceptual models of the aquifer systems were developed from an understanding of the hydrologic processes occurring in the system and the elements that affect these processes. These new conceptual hydrologic models of the county will provide insight necessary for eventually updating the county plan, which since 1980 has incorporated consideration of water availability in determining lot sizes of proposed developments.

The discussions of the aquifer systems are intended for regional planning purposes; the scale of interest is on the order of tens of miles. The following sections discuss the geohydrologic framework and the hydrologic characteristics of each of the aquifer or hydrologic systems.

GEOHYDROLOGIC FRAMEWORK

The geohydrologic units constitute the plumbing of the aquifer system, and recharge provides the driving force that causes ground water to flow through the system.

North Santa Fe County aquifer system

The NSFC aquifer system is defined here as the late Tertiary Santa Fe Group (the principal aquifer) and hydraulically associated rocks (Precambrian rocks and Tertiary basalts). The area is bounded on the north by the Santa Fe County line and on the south where the Santa Fe Group is truncated by erosion associated with the creation of the Galisteo Creek drainage basin. Bounding the Santa Fe Group to the east are primarily Precambrian crystalline rocks and minor Pennsylvanian rocks (Fig. 2). Tertiary volcanic rocks bound the Santa Fe Group to the southwest. The nature of the rocks beneath the Santa Fe Group is generally unknown because few wells have penetrated the entire saturated thickness of the Santa Fe Group. However, based on the interpretation of gravity data by Cordell (1977), it is likely that older sediments are present.

The principal aquifer in the NSFC system occurs within the Tertiary to Quaternary Santa Fe Group described by Spiegel and Baldwin (1963), as expanded by Manley (1979). The Santa Fe Group comprises the Tesuque and overlying Ancha and Puye Formations. Although all three formations are in hydraulic communication, the Tesuque Formation forms the main aquifer in the NSFC aquifer system. The Tesuque depositional environment (coalescing alluvial fan deposits) has resulted in a discontinuity of its deposits, causing it to be very heterogeneous locally.

The complex nature of the Tesuque Formation depositional environment, coupled with discontinuities created by faulting, has resulted in an aquifer with considerable heterogeneity. In most areas, the level of heterogeneity is so high locally that when the Tesuque Formation is viewed on a regional scale, it appears to be essentially homogeneous. In other areas, the local discontinuities in permeable strata are of a sufficient scale that they are detectable on water level contour maps. For example, the flattening of the water table contours in the graben (structural valley) suggested by Consulting Professionals, Inc. (unpubl. report, undated) in the area of the Santa Fe well field is the result, in part, of higher transmissivity.

The Ancha Formation, which overlies the Tesuque Formation east of the Rio Grande, is more homogeneous in composition and has fewer low-permeability layers than the Tesuque Formation. Conceptually, the problem of scale dependence is less significant for the Ancha Formation than for the Tesuque Formation. In most areas Ancha sediments lie above the water table, but where it is saturated, the Ancha Formation is generally in hydraulic communication with the Tesuque Formation. However, the rate of ground-water flow between the two is limited, because the Tesuque Formation is approximately ten times less permeable than the Ancha Formation (W. Fleming, unpubl. report for Santa Fe County, 1993). Therefore, where both formations are water-bearing, ground water will flow preferentially through the more permeable Ancha Formation.

The Puye Formation overlies the Tesuque Formation west of the Rio Grande. The Puye is substantially coarser than the Tesuque or Ancha Formations and consists primarily of sand and pebbles. Although the Puye is predominantly above the water table, near the Rio Grande the lower portion is saturated and provides water to the Los Alamos well field. Faulting in the basin has further disrupted any original continuity of the NSFC aquifer system. The Tesuque Formation has been subjected to faulting during at least two periods of tectonic activity (Baltz, 1978).

The three formations of the Santa Fe Group are also in hydraulic communication with the formations along the basin edge and beneath the Santa Fe Group. The bounding rocks are generally of lower permeability than the Santa Fe Group, although higher-permeability zones occur in localized areas primarily as a result of fracturing.

Two bedrock outcrop areas east and southwest of the Santa Fe Group appear to be hydraulically connected to ground water in the Santa Fe Group. On the east are Precambrian rocks that comprise the primary recharge area of the Santa Fe Group. To the southwest, along the southwestern margin of the Española Basin (Fig. 3) in the Cerrillos to Cieneguilla area, the underlying rocks include the Tertiary Espinaso volcanics and Galisteo Formation, and undifferentiated Cretaceous rocks. The extent and hydrologic properties of the basalts are poorly understood. However, these volcanic rocks are included in the NSFC aquifer system because previous investigators, such as Spiegel and Baldwin (1963) and McAda and Wasiolek (1988), interpreted these geologic units to be hydraulically connected to the Santa Fe Group.

The Santa Fe Group extends beyond the northern and northwestern county line into Rio Arriba and Los Alamos Counties. Conveniently,

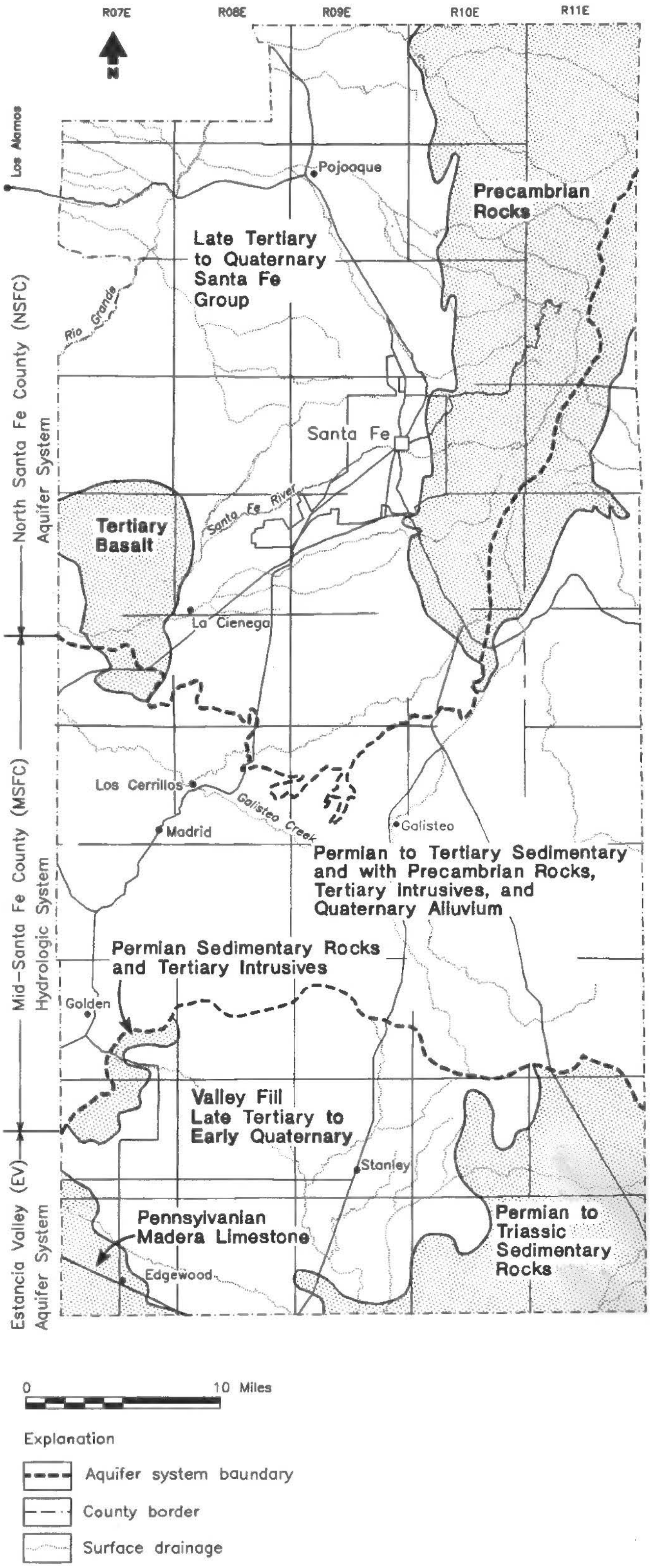

FIGURE 1. Generalized geologic map of the aquifer systems in Santa Fe County.

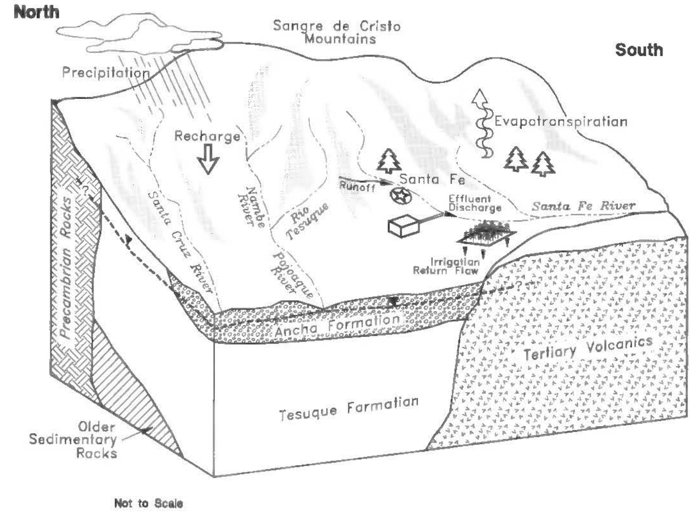

FIGURE 2. Schematic block diagram of the north Santa Fe County aquifer system.

these administrative boundaries are reasonably appropriate hydrologic boundaries. Ground water in the area east of the Rio Grande flows roughly parallel to the northern county line and discharges to the Rio Grande at the northwestern county line.

Mid-Santa Fe County hydrologic system

The MSFC hydrologic system is dramatically different from the NSFC and EV aquifer systems, both in geologic structure and lithology. The extent of the MSFC hydrologic system generally coincides with that of the Galisteo basin, excluding the area of Santa Fe Group in the northern part of the basin (Fig. 1). The eastern boundary of the MSFC system extends into the Pecos basin.

The MSFC hydrologic system (Fig. 4) is composed predominantly of sedimentary rocks of Tertiary, Cretaceous, Jurassic, Triassic, and Permian age, including sandstone, mudstone, conglomerate, shale, limestone, dolomite, siltstone and evaporite rocks. Precambrian crystalline rocks, intrusive rocks, and recent alluvial deposits are also present within the area. The MSFC hydrologic system is structurally complex and most of the rock formations are generally not considered aquifers. The MSFC hydrologic system contains or is part of several structural features shown on Figure 3 including, from east to west, the Glorieta slope (Baltz, 1978), the Galisteo basin (Kelly, 1979), the Cerrillos uplift (Disbrow and Stoll, 1957), and the Santo Domingo basin (Baltz, 1978). The area has been described as an accommodation zone (Cather, 1992) because it is where the northern section of the Rio Grande depression becomes offset eastward relative to the southern part of the Rio Grande depression. Although numerous local structural features exist, the general dip of the rocks is toward the west (Read and Andrews, 1944; Stearns, 1953; Disbrow and Stoll, 1957; Budding, 1972).

It is not appropriate to describe the MSFC hydrologic system as an aquifer system because most of the rocks are not considered to be aquifers due to their low permeability and storage capacity. Some of the geologic units do form aquifers, but generally they are thin and entirely bounded laterally by low-permeability rocks that receive little recharge; thus, on a regional scale, they are not considered to be significant water-bearing units.

Estancia Valley aquifer system

The EV aquifer system (Fig. 5) is defined as the Estancia Valley surface drainage basin within Santa Fe County. This system is probably the simplest one in the county to conceptualize, in that it may be thought of as a bathtub filled with sand, where the tub itself is capable of collecting recharge and transmitting it to the sand filling the tub. The structure of the rocks underlying the valley fill is poorly understood and more complex than depicted in Figure 5.

The EV aquifer system occurs within a structural trough (Smith, 1957) that lies between the Sandia uplift (Titus, 1980) to the west and the Glorieta slope (Baltz, 1978) to the east. The axis of this trough is aligned north-south and is probably associated with the same regional deformation that created the Galisteo and Española basins to the north. Beds of sand, gravel, silt and clay were deposited in the trough in thicknesses up to 350 ft in the middle of the valley. The formations that either underlie the valley fill or crop out along the margins of the basin include, from oldest to youngest, the Pennsylvanian Madera Limestone, the Permian Abo Formation, Yeso Formation, Glorieta Sandstone and San Andres Formation, and the Triassic Dockum Group (Fig. 5).

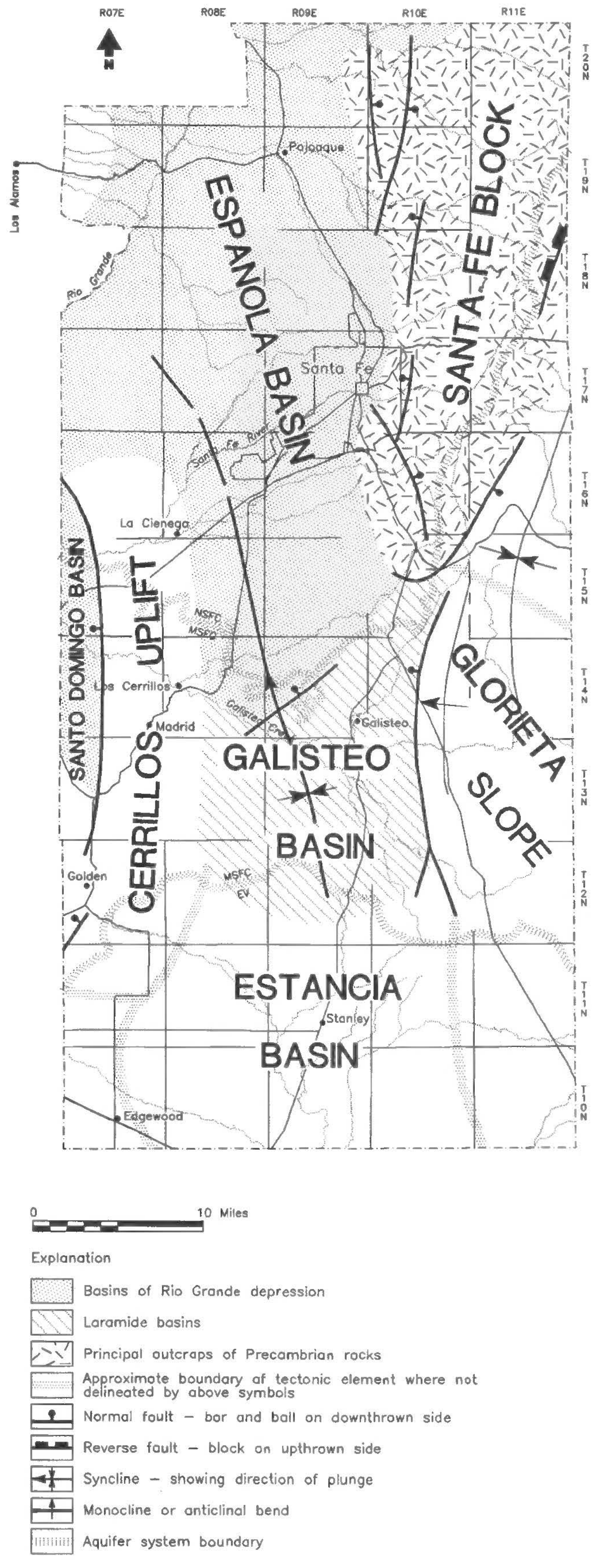

FIGURE 3. Major tectonic elements in Santa Fe County (Baltz, 1978).

The western side of the EV aquifer system, where the Madera Limestone is exposed, is a dip slope off the Sandia Mountains. In this area the formations stratigraphically above the Madera Limestone have been stripped away by erosion. Eastward toward the center of the EV, the east-dipping Madera Limestone becomes covered by an increasing thickness of valley fill. In the vicinity of Moriarty, the Glorieta Sandstone crops out or immediately underlies the valley fill. Farther eastward, the Abo and then Yeso Formation underlie the valley fill and are exposed as a slightly west-dipping slope off the Glorieta slope.

The valley fill is generally an excellent aquifer, and where the saturated thickness is sufficient, it will supply water to wells in quantities required for irrigation. The Madera Limestone has an inherently low permeability at the local scale, except where it has been fractured and subsequently subjected to the formation of solution channels. In some areas where the Madera crops out, the fracture permeability is sufficiently high that surface water drainage across it essentially disappears due to piracy of surface runoff into underground solutional conduits (Titus, 1980).

East of Moriarty, the Glorieta Sandstone supplies water to irrigation wells, but a little farther east the aquifer is less fractured and is only capable of producing enough water for domestic or stock wells. This wide range in well production capacities from essentially dry holes (Titus, 1980) to irrigation wells (1000 to 2000 gpm) is characteristic of both the Madera Limestone and the Glorieta Sandstone.

The Abo and Yeso Formations are generally of low permeability and do not supply large quantities of water either to wells or to recharging the valley fill. However, in the northwestern portion of the EV near South Mountain, many shallow wells tap the Abo Formation, with typical well yields ranging from 1 to 20 gpm (D. N. Jenkins, unpubl. report for Entranosa Water Corporation, 1980).

HYDROLOGIC CHARACTERISTICS OF THE AQUIFER SYSTEMS

The data used for this evaluation were obtained primarily from the U.S. Geological Survey Ground Water Sites Inventory (GWSI) and the National Well Inventory System (NWIS). DBS&A supplemented these databases with information from various technical reports to fill in data not available from these sources.

Potentiometric surface and water level fluctuations

The potentiometric surface of the NSFC aquifer system (Fig. 6) is fairly uniform and generally slopes from east to west. The recharge area is evident on the potentiometric map as the region of highest water levels. Precipitation falling on the higher elevations (in the east) recharges the ground water and provides the driving force for ground-water flow throughout the basin. Ground water flows in a westwardly direction and, if not intercepted by wells, ultimately discharges at the Rio Grande, at perennial tributaries to the Rio Grande, or at La Cienega or other springs. A minor component of ground-water flow may discharge to the southwest into the MSFC hydrologic system, but water level data are insufficient to determine the exact nature of this boundary.

Several features of the potentiometric surface are notable. A flattening of the water table gradient west of Santa Fe, in T16N, R08E, also evident on potentiometric maps of Spiegel and Baldwin (1963) and Mourant (1980), is probably a result of several factors. First, recharge from the Santa Fe River and associated irrigation ditches, as well as seepage from Arroyo Hondo and from Santa Fe treated municipal sewage water, may increase the saturated thickness of the aquifer in this area, causing flattening of the water table surface. This hypothesis is supported by hydrographs for this area, which show a steady rise in water levels since at least 1955 (DBS&A, unpubl. report for Santa Fe County, 1994). Second, the highly permeable Ancha Formation is saturated in this area. Highly permeable units are characterized by gently sloping water tables. Finally, a structural trough may also contribute to the formation of this feature if the west side of the trough is relatively impermeable.

Ground-water flow may be more complex at a specific site than is depicted by the unconfined potentiometric map. Perched water occurs locally in the vicinity of Santa Fe and the Santa Fe River. The depth to water in several wells near the river is less than 25 ft, whereas most wells in the Santa Fe area encounter water at depths greater than 200 ft. At

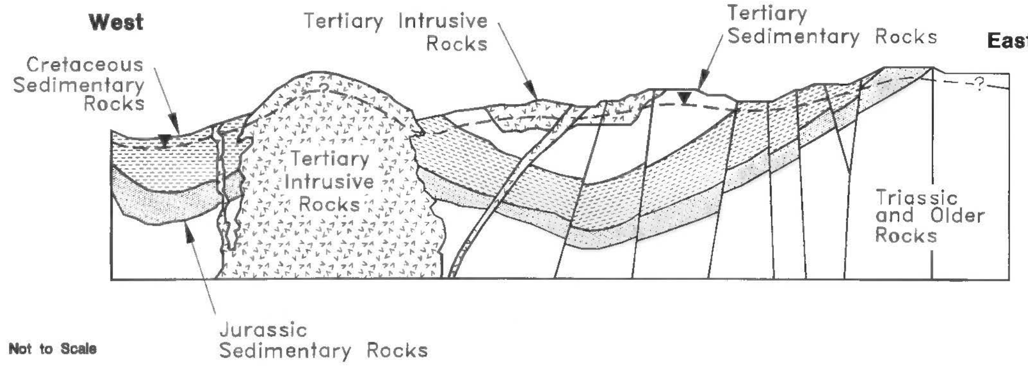

FIGURE 4. Schematic east-west cross section of the mid-Santa Fe County hydrologic system.

greater depths ground water in the Santa Fe group may be confined, especially in the western portion of the aquifer system. As ground water flows down dip, it may become partially confined by clay-rich layers as it moves into the valley. Wells that penetrate the confined portion of the aquifer may flow at the surface. The old flowing railroad well at Buckman is an example of this phenomenon.

Examination of hydrographs for the NSFC aquifer system revealed no large-scale general trends for the NSFC aquifer system, except that the water level fluctuations appear to be very localized. This is based on the fact that many hydrographs (DBS&A, unpubl. report for Santa Fe County, 1994) show no decline in water levels from the mid-1950s to 1993, and several show an increase in water levels. Wells that show long-term water level declines are often located near wells that show little or no decline. For instance, water level declines southwest of Santa Fe (sec. 27 and 28, T17N, R9E) range from 0 to 2.6 ft/yr.

It appears that many wells exhibiting significant water level declines are completed in zones of the aquifer that are being stressed by nearby production wells. The greatest observed declines are in the vicinity of the two Santa Fe municipal well fields, one located near Santa Fe (city well field) and the other near the Rio Grande (Buckman well field). Near Santa Fe, water levels have been declining at a rate of approximately 2.5 ft/yr in the production zone of the city well field over the past 40 yrs. At the Buckman well field, water levels have declined up to 56 ft/yr in the production wells over the past 10 yrs (R. Jorgenson, personal commun., 1994). The Buckman wells tap a confined production zone that is not replenished at a rate equal to the amount produced.

The potentiometric surface of the MSFC hydrologic system appears to follow, in general, the topographic slope of the land surface. Ground water appears to flow primarily toward the drainage of Galisteo Creek from all directions within the MSFC hydrologic system. Recharge, as interpreted from the potentiometric surface map in Figure 6, appears to be attributable to infiltration of precipitation in the Ortiz and other mountains in the southwest portion of the hydrologic system, and in the eastern portion of the county. Water level declines are highly variable throughout the MSFC hydrologic system, as much as 1 ft/yr near Galisteo.

The potentiometric surface in the EV aquifer system also appears to follow the topographic surface. The water table slopes to the south and east from South Mountain and probably slopes to the west from the eastern portion of the basin. In the area of valley fill, the water table is essentially flat. The potentiometric surface in the Madera Limestone on the west side of the basin near Edgewood is also relatively flat (due to high transmissivity) and is several hundred feet higher than the water table in the valley fill to the east.

Hydrographs for wells in the valley fill of the EV aquifer system show a linear, steady rate of decline, an indication that ground-water mining is occurring in the Estancia Valley. Since 1950 water levels in the valley fill have been declining at a relatively uniform rate of about 1.4 ft/yr. This decline is attributable primarily to agricultural irrigation. Water levels appear to be declining in parts of the Madera Limestone aquifer to the west of the valley fill, at rates of as much as 1 ft/yr since 1948. Hydrographs of wells to the north and east of the valley fill (near Stanley) show no decline in water levels from the early 1970s to 1993, and one shows a rise.

Water quality

The natural water quality of each of the aquifer systems is described in this section. TDS concentrations, electrical conductivity (EC), and major cations and anions are used to define the general quality of the ground water. Overall, ground water in the NSFC aquifer system is of high quality and is suitable for domestic purposes virtually everywhere. Locally, the water quality can be variable, due to geologic conditions and minor ground-water contamination.

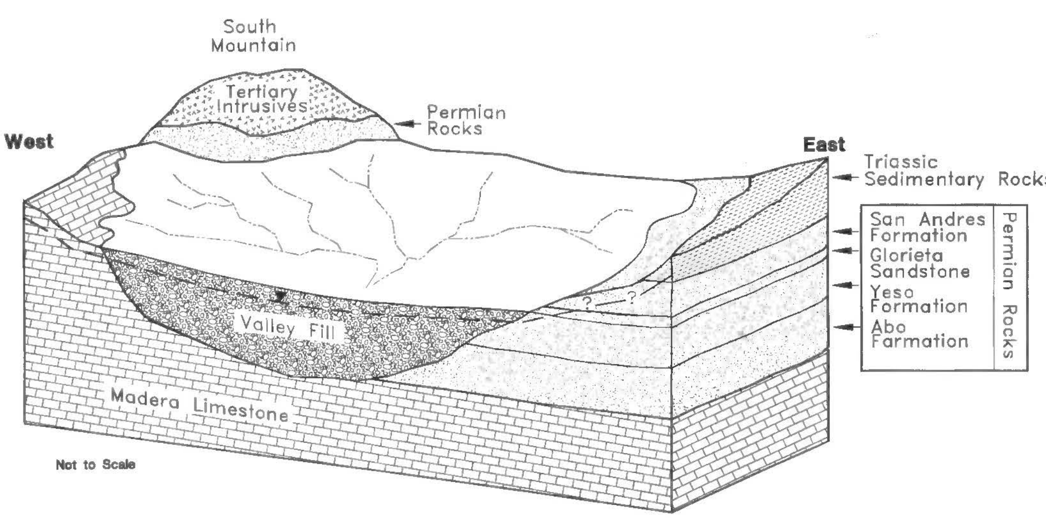

FIGURE 5. Schematic block diagram of the Estancia Valley aquifer system.

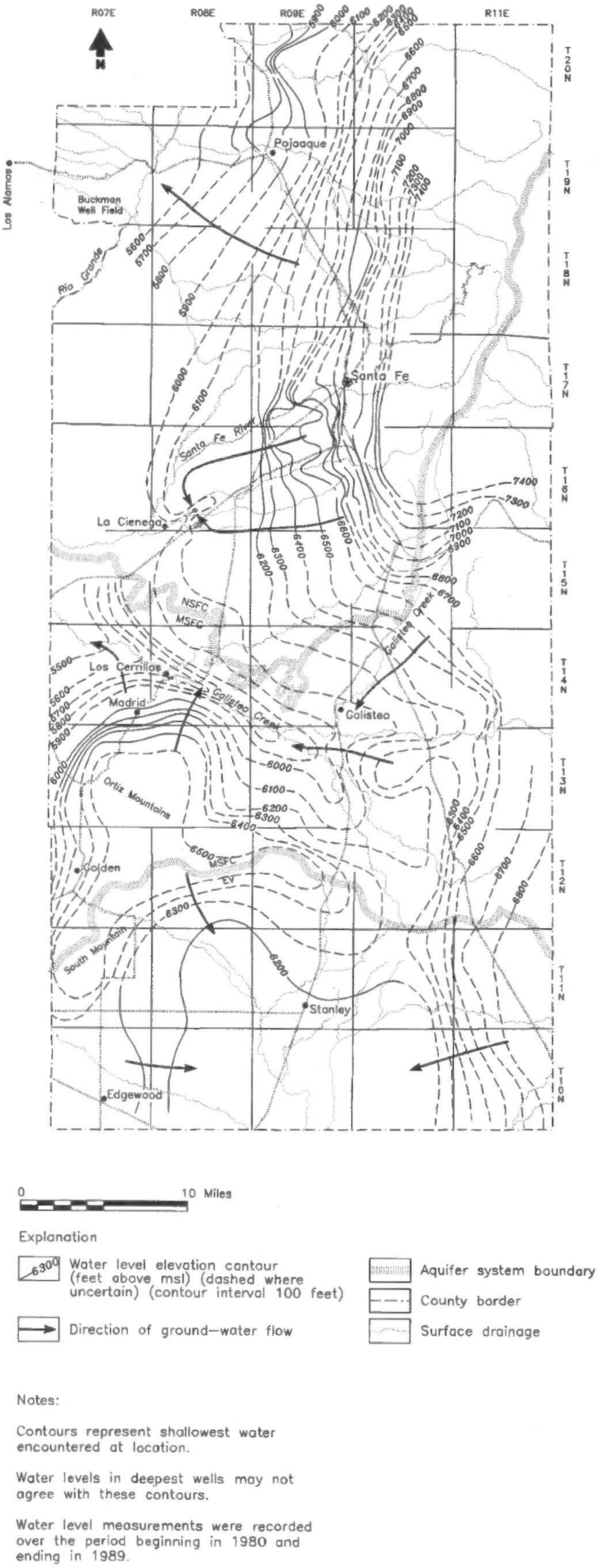

FIGURE 6. Potentiometric surface of unconfined ground water in Santa Fe County, as measured in 1980–89. Water level measurements were obtained primarily from the USGS GWSI. Where possible, the latest January measurement in the 1980s was selected as an observation point for the potentiometric contour map.

The EC of the water in the Santa Fe Group of the NSFC aquifer system is relatively low, ranging from 150 to 800 micromhos per centimeter (ìmhos/cm). These values correspond to TDS values of 90 to 500 ppm. A linear relationship between EC and TDS for ground water in the Santa Fe Group aquifers is TDS = 0.62 x EC + 12 ppm. Water quality in the Precambrian rocks in the eastern part of the NSFC aquifer system is very similar to that in the Santa Fe Group, with EC varying from about 200 to 900 ìmhos/cm. The relationship between TDS and EC for ground water in the Precambrian rocks is TDS = 0.71 x EC – 55 ppm.

With few exceptions, the predominant chemical species in ground water in the eastern portion of the NSFC aquifer system are calcium and bicarbonate, which cause the water to be very hard. However, in the western portion of the NSFC aquifer system, near the Buckman wells, the water is much softer as a result of sodium replacing calcium as the predominant cation.

The water quality detected in wells in the MSFC hydrologic system is highly variable but generally poor, as can be expected from the types of aquifer material present. Measurements of EC vary from 900 to 5,500 ìmhos/cm. These EC measurements correspond to TDS concentration ranging from 700 to 4000 ppm (using the average relationship between TDS and EC for the entire county). The water chemistry in the eastern portion of the MSFC area is similar to the chemistry observed in NSFC aquifer system; that is, the chemical nature of the water is predominantly calcium bicarbonate. However, in the western portion of the MSFC hydrologic system, sulfate replaces bicarbonate as the predominant anion. Sulfide mineralization in the Ortiz Mountains and Cerrillos Hills, sulfide and sulfate minerals in the Mancos Shale and Mesa Verde Group, and coal deposits near Madrid are likely causes of the elevated concentrations of dissolved sulfate in ground water in this area.

Water quality is marginal for domestic use in much of the EV aquifer system. The EC of ground water in the EV varies from about 500 ìmhos/cm in the northwestern portion (recharge area) to 3800 ìmhos/cm in the central area where wells are completed in the Glorieta Sandstone. TDS varies from 300 ppm to 2750 ppm. Based on water samples from wells completed in the Madera Limestone, Glorieta Sandstone and valley fill, the relationship between TDS and EC in the EV aquifer system is TDS = 0.75 EC – 100 ppm. The chemical quality of the ground water in the EV, as elsewhere in the county, appears to be controlled predominantly by lithology. The water quality varies from calcium bicarbonate in the west, where wells are completed in the Madera Limestone and valley fill, to calcium sulfate in the central area where wells are completed in the Glorieta Sandstone. Sodium is a predominant cation in the eastern portion of the basin.

Aquifer parameters

Aquifer parameter data such as transmissivity, hydraulic conductivity, specific yield and storativity were compiled from consulting reports and are presented in detail in a recent report submitted by the authors to Santa Fe County (DBS&A, unpubl. report for Santa Fe County, 1994). The following sections summarize the compiled data.

Aquifer transmissivity of the Santa Fe Group as calculated from aquifer tests varies from 0.05 to 11,000 ft^2/d. A similar range is observed for Precambrian rocks in the NSFC aquifer system, which have reported transmissivity estimates ranging from 2 to 7100 ft^2/d, although most transmissivity values are less than 70 ft^2/d. The high value of 7100 ft^2/d was estimated from a well adjacent to Arroyo Hondo, which is in a highly fractured zone.

Few storage coefficient values from aquifer tests have been reported for the Santa Fe Group. Of those reported, the values range from 0.000085 to 0.17, but most are less than 0.05. Storage coefficient values reported for Precambrian rocks in the NSFC aquifer system range from 0.00044 to 0.1, and most are less than 0.02.

Very few transmissivity estimates are available for the MSFC hydrologic system. Of the five reported values, the transmissivity estimates range from 0.4 to 1700 ft^2/d. Because the hydrogeology is so variable, no regional values can be assumed, and site-specific data would be necessary for reasonable predictions of water level changes.

Only two estimates of storage coefficients, 0.015 and 0.02, are reported in the entire MSFC. If these values are reliable, and if the aquifer is under water table conditions, they suggest that much of the ground water occurs in fractured bedrock. As with transmissivity, site-specific storage estimates would be required for any predictive analysis.

Available transmissivity estimates for the EV aquifer system are all based on tests conducted in the western portion of the basin, where the tested wells are probably completed in the Madera Limestone. The transmissivity estimates range from 15 to nearly 86,000 ft^2/d, but the wells that exhibit very high transmissivity values most likely tap a large cavern or solution cavity within the limestone. A transmissivity of 4000 ft^2/d was used by the New Mexico State Engineer Office (SEO) to develop the administrative criteria for mining the valley fill aquifer.

Storage coefficients estimated in consultant reports submitted to Santa Fe County vary from 0.00038 to 0.05 for the western portion of the EV aquifer system in the Madera Limestone. A value of 0.125 was used by the SEO to develop administrative criteria for mining the valley fill.

Quantity of water in storage

The quantity of water in storage is estimated here for the NSFC and EV aquifer systems. An estimate for the MSFC hydrologic system is not provided due to insufficient data. The estimate of the quality of water in storage for the NSFC is based on our review of well logs and geophysical data for the Santa Fe Group. The estimate for the EV is a revision of a 1965 SEO estimate, which has been adjusted for water level declines since 1965. The quantity of water in storage for both estimates is based on the area, thickness, and storage coefficient of the aquifer system.

In determining the quantity of water in storage in the NSFC aquifer system, DBS&A restricted the estimate to the ground-water resources of the Santa Fe Group. The volume of water contained in the bounding rocks is probably either small in comparison to that contained in the Santa Fe Group, or is too deep to be a viable consideration for current water resource evaluations.

In general, most water wells have not penetrated the full thickness of the Santa Fe Group, so they can only be used to obtain minimum thicknesses. To gain insight as to the probable thickness of the Santa Fe Group, several additional sources of information were used, in particular, the results of geophysical studies and deep exploration boreholes. Cordell (1977) inverted maps of the gravity field in the area to obtain a map of the configuration of the underlying, relatively high-density Precambrian basement rock. This map was used as a guide for the probable configuration of the bottom of the Santa Fe Group. However, over much of the area it is likely that a substantial thickness of older sedimentary rocks lies between the Santa Fe Group and the underlying Precambrian basement rock.

The existence of this intervening layer of sedimentary rock is suggested by seismic profiles conducted in two studies (Black, 1984; Biehler et al., 1991). The overall thickness of the sedimentary sequence (Santa Fe and underlying sedimentary rocks) is supported by the interpretation of the distribution of the density of sediments above the Precambrian rocks. Some confirmation of the thicknesses interpreted from the gravity data is suggested by deep-penetrating electrical studies (Biehler et al., 1991).

The depositional thickness of the Santa Fe Group was controlled by existing topographic features such as the Cerrillos uplift. Insight as to the extent of the northwest-trending Cerrillos Uplift (Disbrow and Stoll, 1957) was gained by interpreting the aeromagnetic map of Cordell (1977) using the method suggested by Gay (1972). Studies based on field observations of the stratigraphy suggested a total maximum thickness of the Santa Fe Group of 4500 ft (Galusha and Blick, 1971).

The logs of 106 deep test holes drilled by Nuclear Dynamics provided particularly useful data (on file at Oil Conservation Division) regarding the thickness of the Santa Fe Group. Additionally, the 4755-ft-deep oil test well in Sec. 24, T17N, R8E, the deepest well in the NSFC aquifer system, provided the best information on the thickness of the Santa Fe Group. This well penetrated 3100 ft of Santa Fe Group sediments and was completed in the Espinaso Volcanics.

Using all this information, a conservative estimate of the saturated thickness of the Santa Fe Group ranged from 0 to at least 3500 ft (Fig. 7). The 0-foot contour line is based on the outcrop of Santa Fe Group, since the exact location of limit of water in the Santa Fe Group is not well

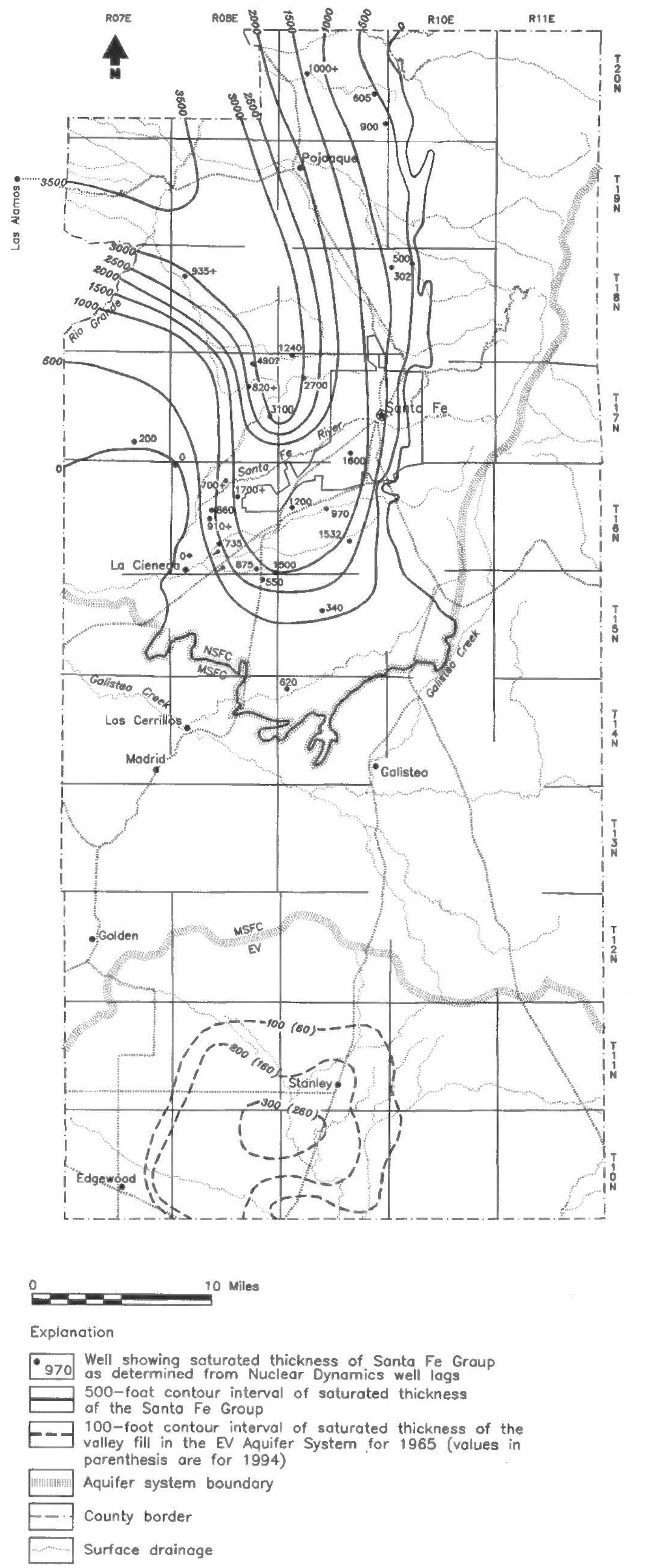

FIGURE 7. Saturated thickness of the Santa Fe Group in the NSFC aquifer system and the valley fill in the EV aquifer system.

TABLE 1. Summary of data used to estimate the quantity of water in storage in the Santa Fe Group of the North Santa Fe County aquifer system.

Thickness Interval (feet)	Average Thickness (feet)	Area (acres)	Specific Yield	Quantity of Water in Storage (acre-feet)
0-500	250	92,165	0.1	2,304,125
500-1,000	750	61,202	0.1	4,590,150
1,000-1,500	1,250	39,174	0.1	4,896,750
1,500-2,000	1,750	58,764	0.1	10,283,700
2,000-2,500	2,250	21,282	0.1	4,788,450
2,500-3,000	2,750	19,023	0.1	5,231,325
3,000-3,500	3,250	53,045	0.1	17,239,625
3,500+	3,500	19,823	0.1	6,938,050
TOTAL		364,478	NA	56,272,175

known. Therefore, the thickness in the fringe area (0 to 500 ft) is highly uncertain, and site-specific data are therefore essential for estimating the thickness in this area.

Using the estimated volume of saturated sediments and a value of 0.10 for the specific yield, the volume of water potentially drainable from saturated sediments in the NSFC aquifer system is estimated to be 56,000,000 ac-ft. Table 1 summarizes the data used to obtain the total volume of water in storage. The value of specific yield is a function of the stress on the system. Even though a value of 0.10 has not been observed in any substantial aquifer test in the Santa Fe Group, it is likely that if the aquifer were eventually dewatered, the value would be this high.

Table 2 summarizes the parameters used by previous investigators to determine the amount of water in storage. Because each investigator examined different size areas, we have converted their storage estimates, given in ac-ft, to a value of ac-ft per square mile investigated. The estimate by DBS&A falls within the range reported by previous investigators.

The ground-water reserves in the NSFC aquifer system appear to be sufficient to sustain the present depletion rate for many hundreds of years. However, continued decline will contribute to decreased stream and spring flow that may not be acceptable.

The quantity of water in storage in the Estancia Valley aquifer system was based on the thickness and extent of the valley fill. Figure 7 shows the saturated thickness of the valley fill in the EV for 1965 and 1994. The 1965 values were estimated by the SEO (D. Akin, unpubl. memorandum to Steve Reynolds, 1975) by examining numerous well logs. The 1994 values were obtained by subtracting the amount of water level decline from the 1965 values. The water level has dropped at a relatively constant rate of 1.4 ft/yr throughout the valley fill, which amounts to a total drop of roughly 40 ft from 1965 to 1994.

Assuming a specific yield of 0.125, a present total of approximately 1,055,000 ac-ft of recoverable water remain in storage in the Estancia Valley aquifer system. This estimate is conservative because the volume of water in the rocks surrounding the alluvial fill (e.g., Glorieta Sandstone) is not included. Also, water levels in some areas of valley fill have declined at a rate of less than 1.4 ft/yr. If the current rate of depletion is not increased, the existing supply is projected to last at least 80 yrs.

SUMMARY

In summary, the extent of the water resources throughout Santa Fe County is highly variable. In the NSFC aquifer system the resource is substantial and of good quality but its use may have to be limited in order to maintain stream and spring flow. The water resource of the MSFC hydrology system is poorly defined but most likely very limited and generally of poor quality. The Estancia Valley aquifer system is clearly in a state of ground-water mining, which is projected to last at least 80 yrs if the current demand does not increase. The water quality is variable, but suitable for irrigation in the worst areas.

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TABLE 2. Estimates of recoverable water in storage in the Santa Fe Group.

Source of Estimate	Area (mi^2)	Thickness (ft)	Specific Yield	Reliability Factor	Storage (acre-ft)	Storage (acre-ft/mi^2)
L. Wilson, 1984[a]	234	500	0.01	---	750,000	3200
Spiegel and Baldwin (1963)	234	1,000	0.2	---	30,000,000	128,000
Woodward-Clyde, 1980[b]	140	2,640	0.05	---	12,000,000	84,500
DBS&A, 1994 (see Table 1)[c]	570	250-3,500	0.10	---	56,300,000	99,000
Consulting Professionals, Inc., 1974[d] (Santa Fe Area)	108	250	0.15	0.12	311,040	2900
Koopman (1975) (Pojoaque Area)	122	3,500	0.2	---	55,000,000	448,000

[a] Unpubl. report for Santa Fe Metropolitan Water Board
[b] Unpubl. report for Public Service Company of New Mexico
[c] Unpubl. report for Santa Fe County
[d] Unpubl. report for Santa Fe County

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