HYDROLOGIC IMPACTS OF PUMPING GROUND WATER FROM THE CITY OF SANTA ROSA MUNICIPAL WELL FIELD NEAR COLONIAS, NEW MEXICO

by

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Introduction

The city of Santa Rosa has a municipal well field about 12 miles northwest of the city near the community of Colonias, within the Anton Chico Land Grant. There are three wells in the well field, W-24, W-25 and W-26 as shown on Map Sheet No. 9 in the Upper Pecos River Groundwater Hydrographic Survey Report, Volume 2, Upper Pecos River Underground Water Basin Section.

The purpose of this study is to determine hydrologic impacts to the Pecos River flows and to the water levels in existing wells as a result of an assumed 400 acre-feet per year of ground water pumping from the Santa Rosa municipal well field.

The well field is approximately one and a quarter miles southwest of the Pecos River. Wells closest to the well field are farming wells in Colonias, nearly three miles northwest of the well field.

The Lower Las Colonias Community Ditch has some surface water diversion rights from the Pecos River near Colonias with a priority date of 1862 as reflected in the final Hope decree, Cause No. 712 Equity, United States District Court for the District of New Mexico. The diversion point for this surface water right is approximately 20 miles upstream of the present city of Santa Rosa surface water diversion point (T9N.R21E.35.12). According to the Hydrographic Survey Section Staff, however, the diversion dam was washed out in 1941 and no surface water has been diverted since then. At present, water is pumped from the supplemental wells and distributed using the ditch.

Hydrologic information used in this study is taken from or based on existing literature.

Hydrology and Hydrogeology

The San Andres Limestone and Glorieta Sandstone together represent the principal aquifer in the study area. The wells in the Santa Rosa municipal well field are completed in the San Andres Limestone (Risser, 1987, p. 21). Recharge to the San Andres-Glorieta aquifer takes place by seepage from the Pecos River, by precipitation on outcrop areas, and by leakage from adjacent formations. An important part of the recharge occurs from flow lost by the Pecos River between Anton Chico and Canon del Uta. The water moves in a southeasterly direction approximately along the dip, until it becomes confined by the much less permeable Bernal formation. Southeast of this boundary, water in the San Andres Limestone is under artesian pressure as encountered in the Santa Rosa municipal well field (Fowler, 1964, p. 4).

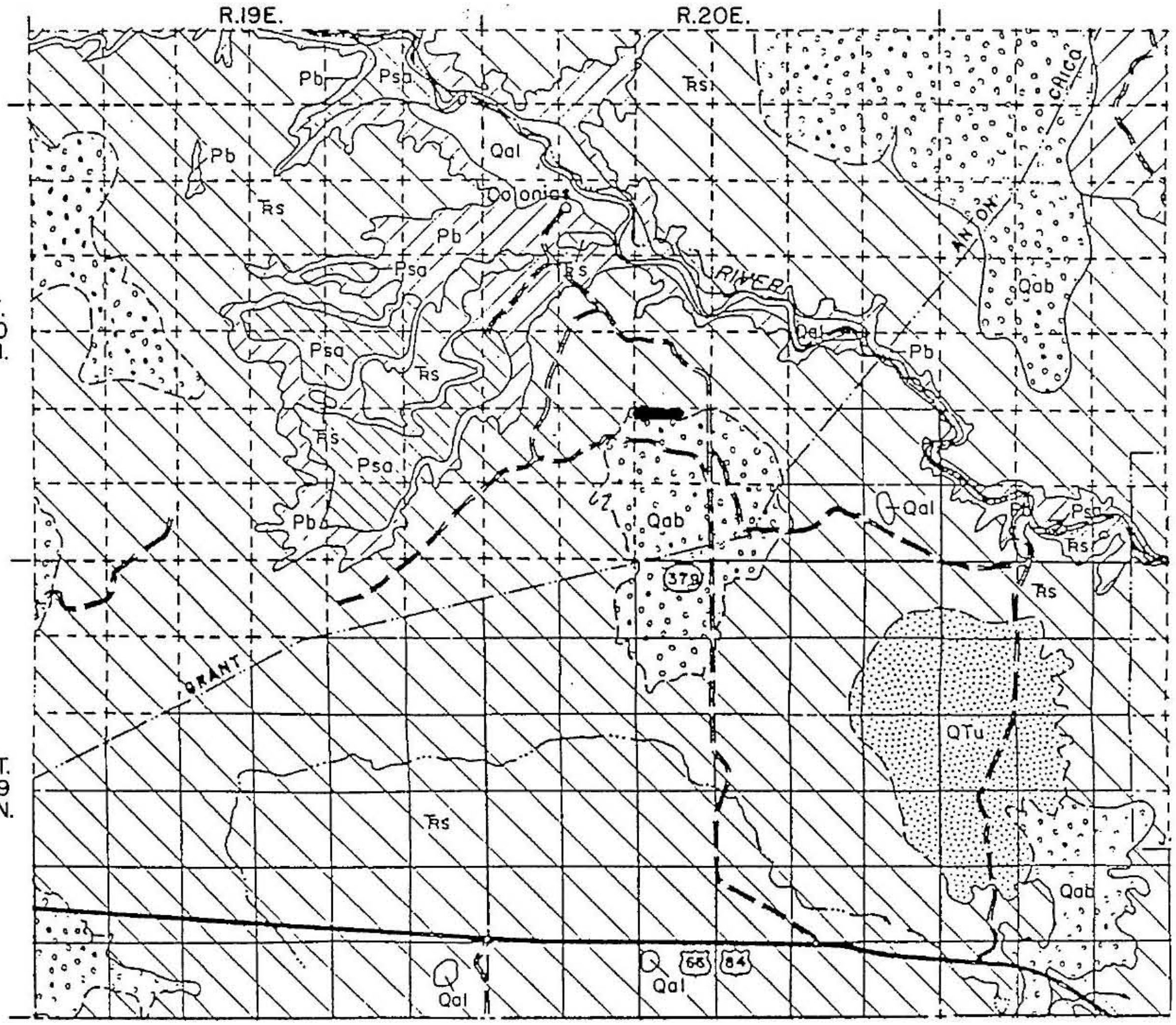

Figure 1. Geologic map of the area near Colonias, New Mexico (From Dinwiddie and Clebsch, 1973)

Explanation

Municipal well field

Stratigraphic units

Qal - Alluvium
Qab - Terrace and pediment gravels and older alluvium
QTu - Upland surficial deposits
To - Ogallala Formation
Kmt - Tucumcari Shale and Mesa Rica Sandstone
Je - Entrada Sandstone
Rc - Chinle Formation
Rs - Santa Rosa Sandstone
Pb - Bernal Formation
Psa - San Andres Limestone
Pg - Glorieta Sandstone
Py - Yeso Formation

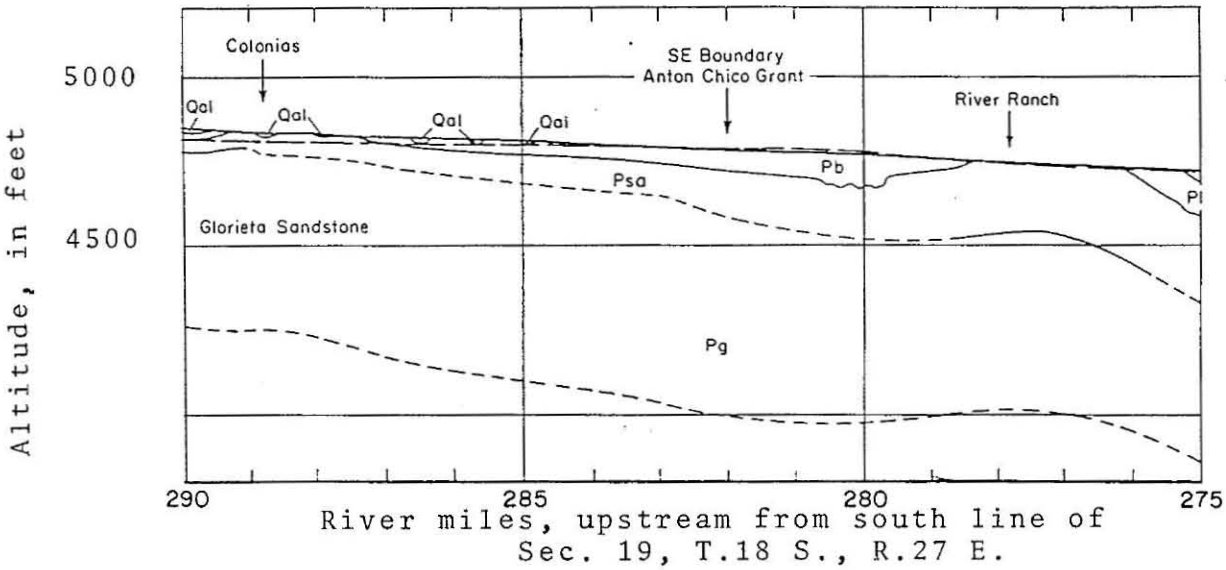

Figure 2. Geologic section along Pecos River, near Colonias, NM
(From Dinwiddie and Clebsch, 1973)

Stratigraphic units

- Qal - Alluvium
- Qab - Terrace and pediment gravels and older alluvium
- QTu - Upland surficial deposits
- To - Ogallala Formation
- Kmt - Tucumcari Shale and Mesa Rica Sandstone
- Je - Entrada Sandstone
- TRc - Chinle Formation
- TRs - Santa Rosa Sandstone
- Pb - Bernal Formation
- Psa - San Andres Limestone
- Pg - Glorieta Sandstone
- Py - Yeso Formation

Generally speaking, the Pecos River is a losing stream between Anton Chico and Canon del Uta and a gaining stream between Canon del Uta and Puerto de Luna (Risser, 1987, p. 13). The water levels in the well field area are as much as 15 feet higher than the altitude of the Pecos River in this reach (Risser, 1987, p. 23). This situation indicates that the river is a gaining stream near the well field.

A geologic map of the study area is given in Figure 1 and a generalized geologic section along the Pecos River near Colonias is given in Figure 2. Referring to Figure 2, the municipal well field is located downstream of Colonias and upstream of the southeast boundary of the Anton Chico Land Grant. From Figure 1, it can be inferred that the geologic layers penetrated by the municipal wells are Santa Rosa Sandstone, Bernal Formation and the San Andres Limestone. The San Andres Limestone is more than 500 feet deep in one of the three wells (Risser, 1987, p. 8). The Pecos River near the well field is not in direct hydraulic connection with the San Andres Limestone. The pumping stress has to travel through the less permeable Bernal Formation before affecting the river. However, along the Pecos River near Colonias, the Bernal Formation has been extensively fractured (Risser, 1987, p. 29). In the river reach near Colonias, stream gains correlate closely with depth to water in one of the municipal wells (Risser, 1987, p. 23). Ignoring the role of fractures, the observed hydraulic relationship can be explained differently. A high river stage indicates increased water availability for recharge in areas of San Andres Limestone outcrop and increased recharge results in higher water levels in wells. In the latter case, pumping stresses will have to travel longer to affect the river flows but they will travel faster in the San Andres Limestone than the Bernal Formation.

Aquifer Properties

San Andres Limestone

A pumping test was conducted on one of the Santa Rosa municipal wells in 1964. An estimated transmissivity of 94,000 feet squared per day and a storage coefficient of 0.0001 were reported for this test (Fowler, 1964). Fowler, in his letter to George Dinwiddie of U. S. Geological Survey dated July 6, 1964, wrote that he didn't believe the pumping test data meant much because of the low pumping rate used and the small drawdown recorded in the test. Note that this transmissivity value has been erroneously printed as 9,400 feet squared per day in Risser (1987, p.29). The slug-type aquifer tests and water level recovery after drilling indicate very small transmissivity for the San Andres-Glorieta aquifer (Risser, 1987, p. 30). The specific yield of the San Andres-Glorieta aquifer is not known. The thickness of the San Andres Limestone varies from featheredge up to 200 feet in the study area (Dinwiddie and Clebsch, 1973, Figure 9).

For this modeling effort, a transmissivity of 50,000 feet squared per day, a storage coefficient of 0.0001, and a specific yield of 0.15 are used. An average thickness of 100 feet is assumed.

Bernal Formation

Based on discussion in Risser (1987, p. 19 and 28-29), a vertical hydraulic conductivity of 0.05 foot per day and a thickness of 300 feet are assumed.

Santa Rosa Sandstone

Based on discussion in Risser (1987, p. 18-19 and 28), a transmissivity of 100 feet squared per day, a specific yield of 0.05, and a thickness of 200 feet are assumed for the Santa Rosa Sandstone.

Model

A three-dimensional groundwater flow model of the study area was developed. The model has a grid size of one mile by one mile and the grids coincide with the township sections. The Pecos River is modeled so that the maximum river leakage rate is equal to the measured rate of 1.47 cfs per stream mile (Risser, 1987, p. 13). The intake and discharge areas of the San Andres Limestone aquifer within the model area act as a water-table aquifer. A water-table storage coefficient is assigned to the nodes in these areas. Also, the discharge area of the San Andres Limestone is modeled as a constant head boundary. The San Andres Limestone is modeled as the deep aquifer, the Bernal Formation, as the semi-confining layer, and the Santa Rosa Sandstone, as the shallow aquifer. The model includes the area shown in Figure 1.

Results and Discussion

A pumping rate of 400 acre-feet per year is used to make the model runs to estimate the effects of ground water pumping from the Santa Rosa municipal well field on the Pecos River flows and water levels in the area.

Five different runs were made. The first run was for the set of aquifer parameter values discussed in the section on aquifer properties. These aquifer properties are not known with certainty. Therefore, the sensitivity of the model to variations in selected aquifer properties was tested. Runs 2 through 5 are sensitivity runs. Sensitivity of the model to variations in the San Andres Limestone transmissivity and the Bernal Formation (confining layer) vertical hydraulic conductivity are tested. Table 1 shows values of parameters used in the five model runs. Table 2 summarizes the calculated effects on the Pecos River flows and the water levels.

Table 1. Description of Model Runs

Run No.	San Andres Limestone Transmissivity (feet**2/day)	Bernal Formation Vertical Hydraulic Conductivity (feet/day)
1	50,000	0.050
2	50,000	0.500
3	50,000	0.005
4	94,000	0.050
5	10,000	0.050

Table 2. Effects on the Pecos River in Percent of Pumping Rate and Water Levels in Feet of Drawdown

Run No.	Type of effect	Time since beginning of pumping, in years				
		1	5	10	20	40
1	River	27	57	76	92	98
	Water level	<1	<1	<1	<1	<1
2	River	41	78	92	96	97
	Water level	<1	<1	<1	<1	<1
3	River	51	63	73	85	95
	Water level	<1	<1	<1	<1	<1
4	River	36	70	87	96	96
	Water level	<1	<1	<1	<1	<1
5	River	16	38	53	71	87
	Water level	<3	<3	<3	<3	<3

The effect on the Pecos River above the present city of Santa Rosa surface water diversion point after 40 years of pumping is between 90 and 100 percent and is not very sensitive to the aquifer parameter values. The effect on the river in earlier years is sensitive to both the vertical hydraulic conductivity of the Bernal Formation and the transmissivity of the San Andres Limestone. This condition occurs because the vertical hydraulic conductivity of the Bernal Formation controls the effect on the river nodes and the transmissivity of the San Andres Limestone controls the effect on the constant head nodes, that is, the discharge area for the San Andres Limestone aquifer. Drawdowns in all nodes were less than 1 foot for runs 1 through 4 and less than 3 feet for the fifth run.

Conclusions

The effects of ground water pumping from the city of Santa Rosa municipal well field on the Pecos River above the present city of Santa Rosa surface water diversion point at the end of 40 years is between 90 and 100 percent of the rate of pumping. Drawdown effects are less than a couple of feet of drawdown in all of the model area. Drawdowns might vary significantly depending upon the actual areal distribution of the hydraulic conductivity.

References Cited

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