GAM run 03-34

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Groundwater Availability Modeling Section
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May 14, 2004

REQUESTOR:

Hays Trinity Groundwater Conservation District

DESCRIPTION OF REQUEST:

The Hays Trinity Groundwater Conservation District (GCD) requested that analytical groundwater modeling be performed to calculate the water-level drawdown imposed by several well spacing and production rate scenarios in the Trinity aquifer. The district requested modeling runs for both the Middle and Lower Trinity aquifers in Hays County, Texas. The modeling is designed to provide insight into the impact of a hypothetical residential development where each lot has its own water-supply well.

PARAMETERS AND ASSUMPTIONS:

The following parameters and assumptions were used to answer the request:

- It was assumed that groundwater was the sole source of water for a hypothetical residential development in Hays County. Each household in the development has its own well.
- The hypothetical residential development is a 256 acre square. Four well center spacings provided by the GCD were used in the modeling: 0.25 acres (1024 total wells), 0.50 acres (529 total wells), 1.5 acres (169 total wells), and 3.0 acres (81 total wells).
- From Texas Water Development Board estimates, water consumption per capita in Hays County is 136 gallons per day. The maximum consumption per household is 1700 gallons per day as provided by the GCD. A family of four was assumed to occupy each residence.
- Transmissivity and storativity derived from several well tests were provided by the GCD for both the Middle and Lower Trinity aquifers. The transmissivity and storativity used for the Middle Trinity was 1962 gallons per day per foot and 1.1×10^{-4} respectively. The transmissivity and storativity used for the Lower Trinity was 1782 gallons per day per foot and 4.0×10^{-5} respectively.
- The groundwater drawdowns were calculated using a verified analytical model, THWELLS (van der Hiejde, 1990). THWELLS is a Theis equation based solver for drawdown from single or multiple wells.
- The Theis equation assumes that:
    - The aquifer is confined and of infinite extent;
    - The aquifer is homogenous and isotropic with respect to hydrogeologic properties;

- The aquifer is bounded on the top and bottom by impervious strata;
- Flow is radial through a porous medium;
- The aquifer is horizontal with a constant thickness.
- Recharge is not included in the model.

METHODS:

- Geometric mean transmissivity and storativity values were determined from selected well test analyses provided by the GCD.
- The model well location grids were generated and input to the model using the information provided by the GCD regarding well spacing.
- The per capita water consumption of 136 gallons per day was multiplied by four to represent the average daily household consumption. This value was rounded up to 550 gallons per day and used as the average rate for a single well for each of the well spacing scenarios. 1700 gallons per day was used as the maximum rate for each well.
- Model runs were performed for each well spacing scenario using hydraulic parameters for the Middle and Lower Trinity aquifers. A separate run was performed for each well spacing using the average rate of 550 gallons per day and the maximum rate of 1700 gallons per day. The result was 8 sets of outputs for each aquifer (4 spacings x 2 rates).
- The models were run for a 30-year time frame with continuous pumping. This was designed to provide a conservative estimate of the long term effects of pumping.

RESULTS:

Transmissivity and Storativity

The GCD provided transmissivity (T) and storativity (S) values derived from several well tests in the Middle and Lower Trinity aquifers. The information was reviewed and the test results selected for use in the model are shown in Table 1. The source data references for these tests are provided in Appendix A. Observation well data are usually superior in quality to pumping well data. Therefore, observation well derived T and S values were used when available. The geometric mean of the data set was calculated to provide a single T and S value for modeling the Middle and Lower Trinity aquifer. The calculated geometric mean T and S values are in good agreement with those used in the Hill Country Trinity GAM model (Mace and others, 2000).

Table 1. Aquifer test results for the Middle and Lower Trinity aquifers in Hays County.

Test	Well	Aquifer (Formation)	Test Rate (gpm)	Transmissivity (gal/day/ft)	Storativity
High View Ranch	OW-1	Middle Trinity (Cow Creek)	12	525	7.34×10^{-5}
Bridlewood Ranch	TW-2	Middle Trinity (Cow Creek)	28.9	6630	1.0×10^{-4}
Shady Valley	OW2/3	Middle Trinity (Hensell and Cow Creek)	40	13043*	2.0×10^{-4}*
Sierra West	Obs.	Middle Trinity (Cow Creek)	230	3127	2.7×10^{-5}
Deerfield	Obs.	Middle Trinity (Cow Creek)	20	200*	2.0×10^{-4}*
West Ridge	Obs.	Middle Trinity (Cow Creek)	30	2007*	5.5×10^{-4}*
				1962 Geometric Mean M. Trinity	**1.1×10^{-4} Geometric Mean M. Trinity**
Polo Club	PC-3	Lower Trinity (Hosston)	108	3327*	2.6×10^{-5}*
Polo Club	PC-4	Lower Trinity (Hosston)	108	4658*	NA
Heather Hills	Obs.	Lower Trinity (Hosston)	7.3	163*	3.5×10^{-5}*
Mt. Sharp Ranch	"New Well"+	Lower Trinity (Hosston)	34	4000	7.0×10^{-5}
				1782 Geometric Mean L. Trinity	**4.0×10^{-5} Geometric Mean L. Trinity**

NOTES:
*Geometric mean of 2 analyses.
+Pumping well.
gpm = gallons per minute.
All wells are observation wells (Obs.) unless noted.
Data sources are provided in Appendix A.

Model Calculated Drawdown

The drawdowns calculated by the model are contoured in Figures 1 through 8 for the Middle Trinity aquifer and in Figures 9 through 16 for the Lower Trinity aquifer. A cross in the figures denotes the individual well locations. The drawdown is greatest for the runs using a pumping rate of 1700 gallons per day per well. The drawdown is slightly higher for the Lower Trinity runs due to the lower T and S.

Saturated thickness in the Middle and Lower Trinity aquifers is presented in Ashworth (1983; Figures 10 and 14). The Lower Trinity saturated thickness is approximately 300 to 400 feet. Mace and others (2000; Figure 17) provide a more recent thickness map of the Middle Trinity aquifer also with a range of 300 to 400 feet. Mace and others (2000) report that the water levels in the Middle Trinity aquifer remained unchanged between 1980 and 1999 with the exception of a 40 feet decline near the city of Wimberley. No more recent information is available for the Lower Trinity aquifer.

The Middle and Lower Trinity aquifers are confined, and therefore, the predevelopment water levels are higher than the elevation of the top of the aquifer. However, the saturated thickness does provide a conservative measure of the available resource. Based on the available information, the drawdown calculated in the quarter acre scenarios with a rate of 1700 gallons per day exceeds the saturated thickness of the Middle and Lower Trinity aquifers. The calculated drawdown is close to the total saturated thickness in the 0.5 acre runs that use the 1700 gallon per day rate. The drawdown calculated using the 1.5 acre and 3.0 acre spacing is less than the saturated thickness for both the Lower and Middle Trinity aquifers.

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The model calculates the theoretical drawdown imposed by the well spacing and pumping scenarios. The model does not reflect current water levels or simulate current water level drawdown in the Trinity aquifer.

REFERENCES:

Ashworth, J. B., 1983, Ground-Water Availability of the Lower Cretaceous Formations in the Hill Country of South-Central Texas, R273, Texas Department of Water Resources, Austin, Texas, 173 p.

Mace, R. E., A. H. Chowdhury, R. Anaya, and Shao-Chih Way, 2000, Groundwater Availability of the Trinity Aquifer, Hill Country Area, Texas: Numerical Simulations through 2050, R353, Texas Water Development Board, Austin, Texas, 117 p.

van der Heijde, P., 1990, THWELLS, International Ground Water Modeling Center, Colorado School of Mines, Golden, CO.

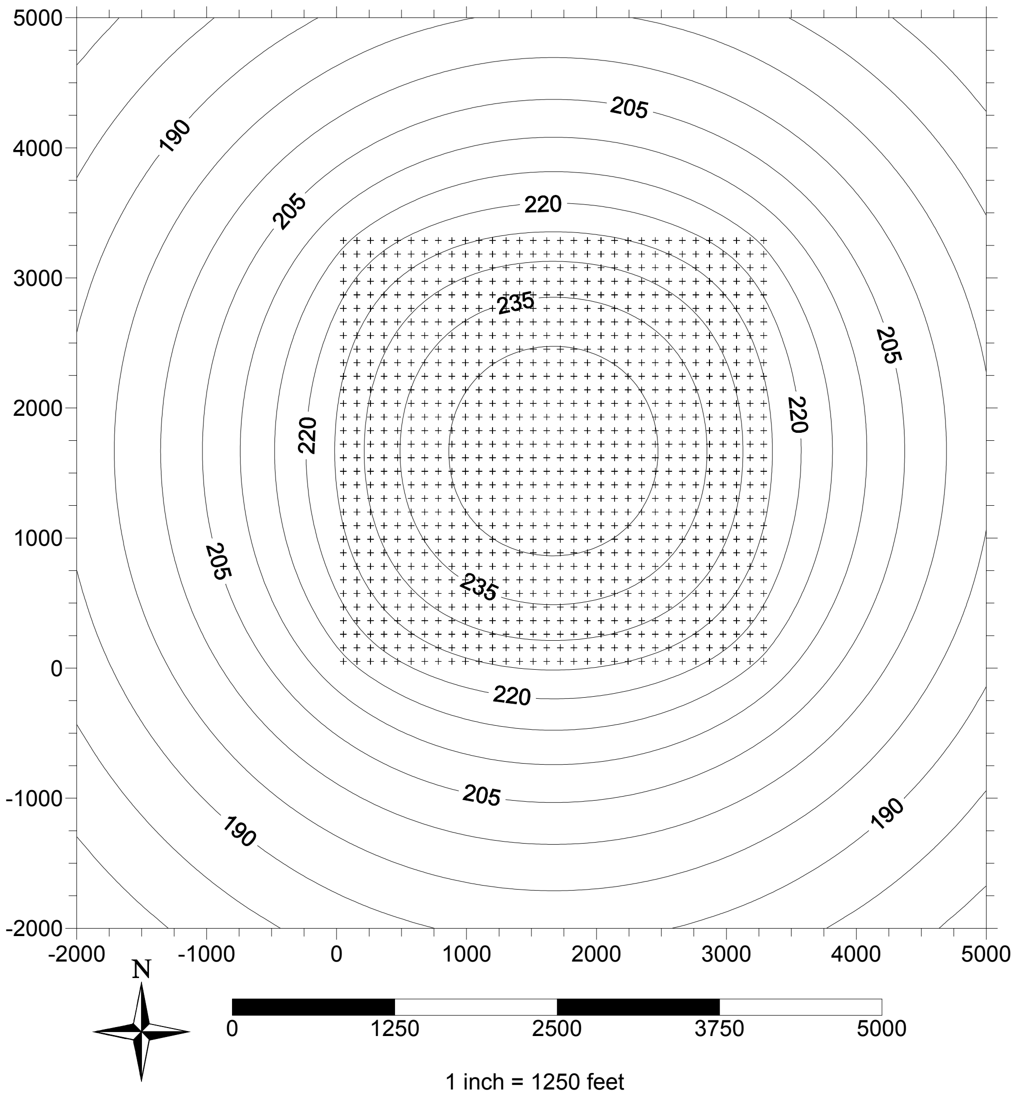

Figure 1. Contours of drawdown (feet) after 30 years of pumping at 550 gallons per day in the Middle Trinity aquifer. There are 1024 domestic supply wells (crosses) with quarter acre spacing in a hypothetical 256 acre development.

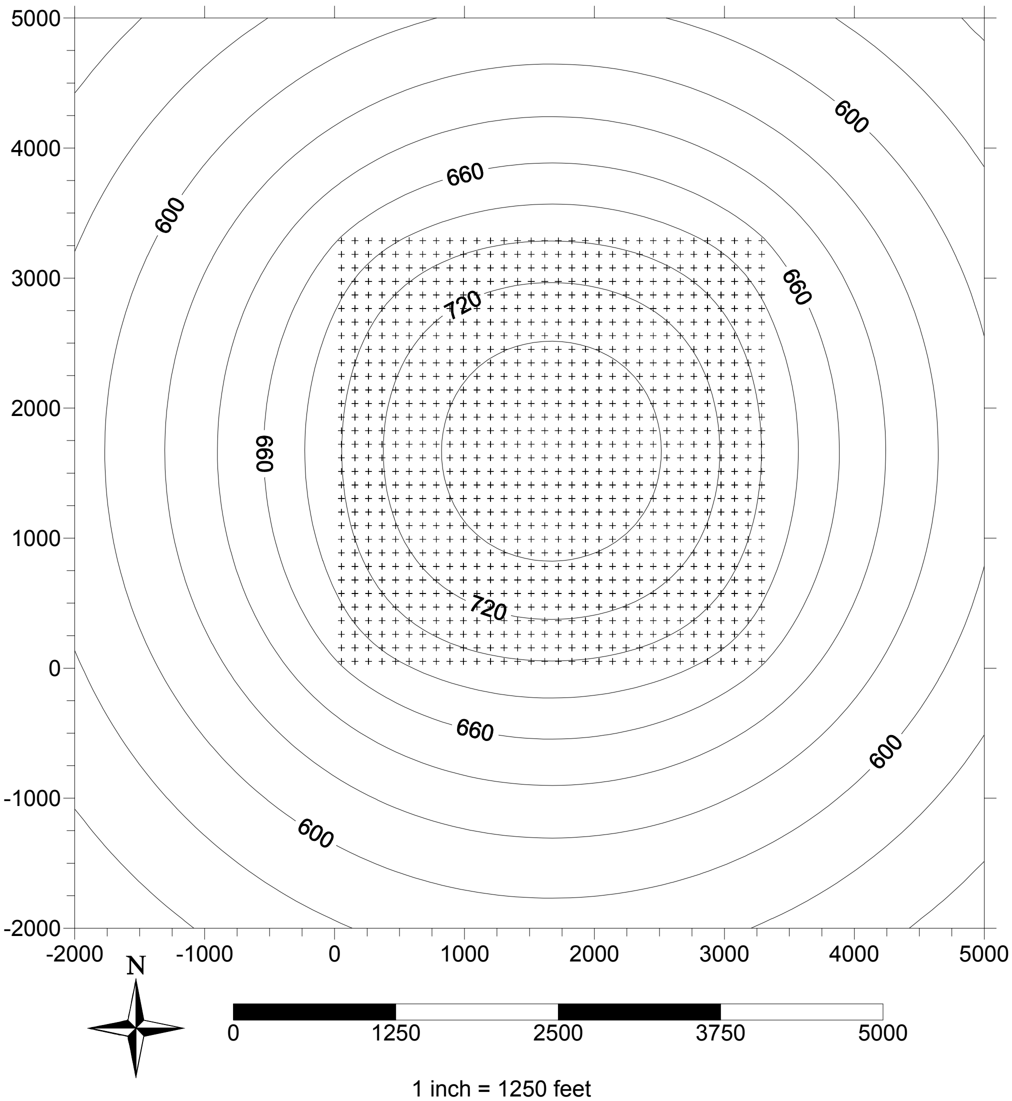

Figure 2. Contours of drawdown (feet) after 30 years of pumping at 1700 gallons per day in the Middle Trinity aquifer. There are 1024 domestic supply wells (crosses) with quarter acre spacing in a hypothetical 256 acre development.

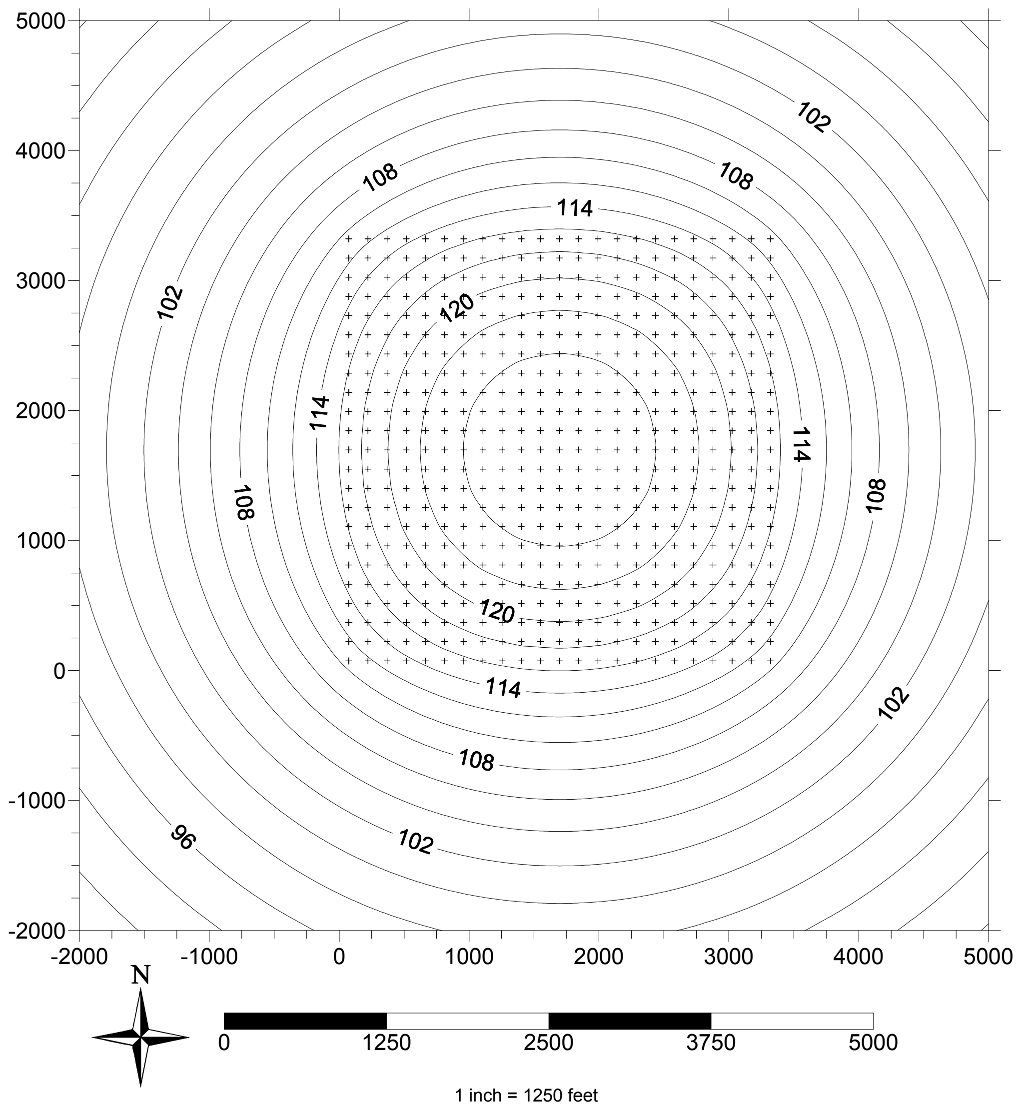

Figure 3. Contours of drawdown (feet) after 30 years of pumping at 550 gallons per day in the Middle Trinity aquifer. There are 529 domestic supply wells (crosses) with half acre spacing in a hypothetical 256 acre development.

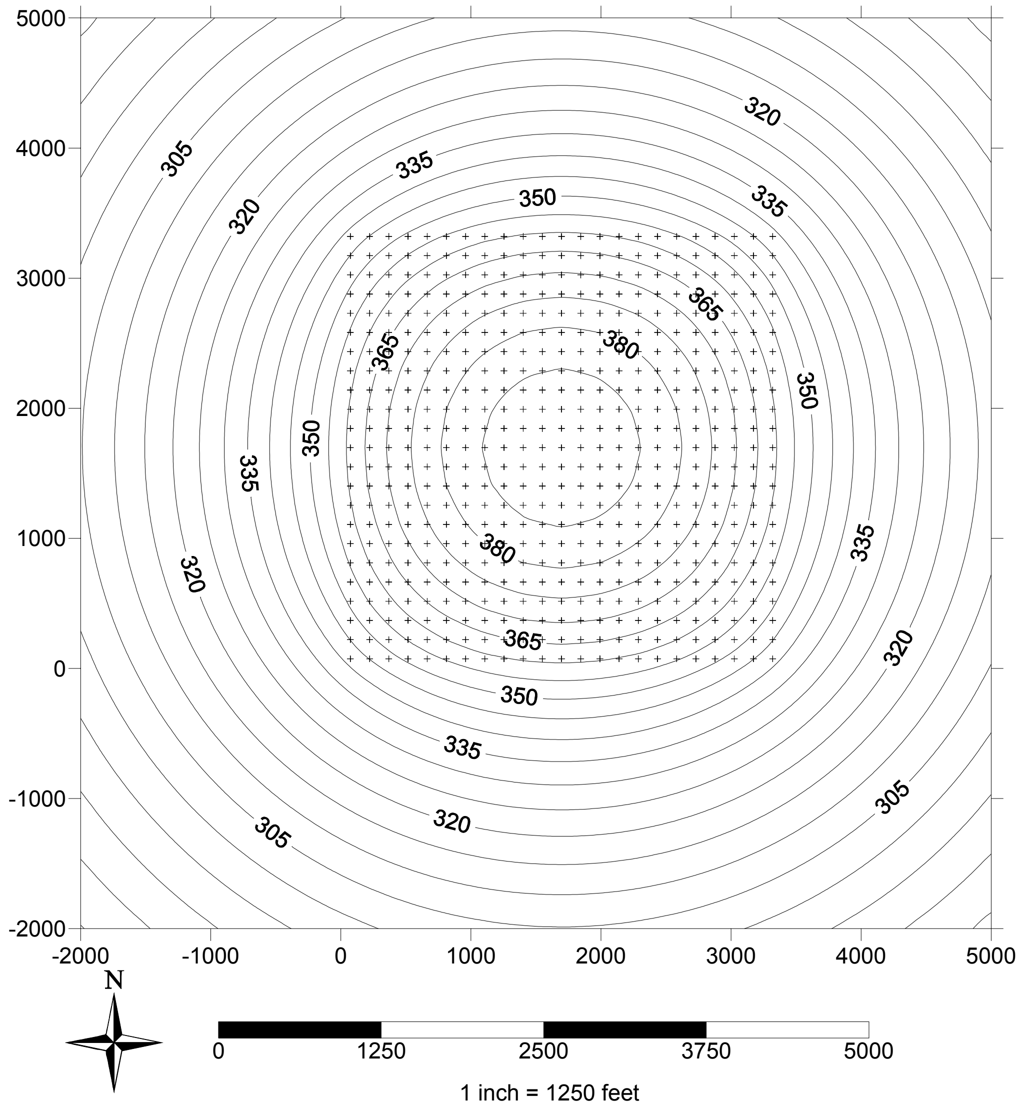

Figure 4. Contours of drawdown (feet) after 30 years of pumping at 1700 gallons per day in the Middle Trinity aquifer. There are 529 domestic supply wells (crosses) with half acre spacing in a hypothetical 256 acre development.

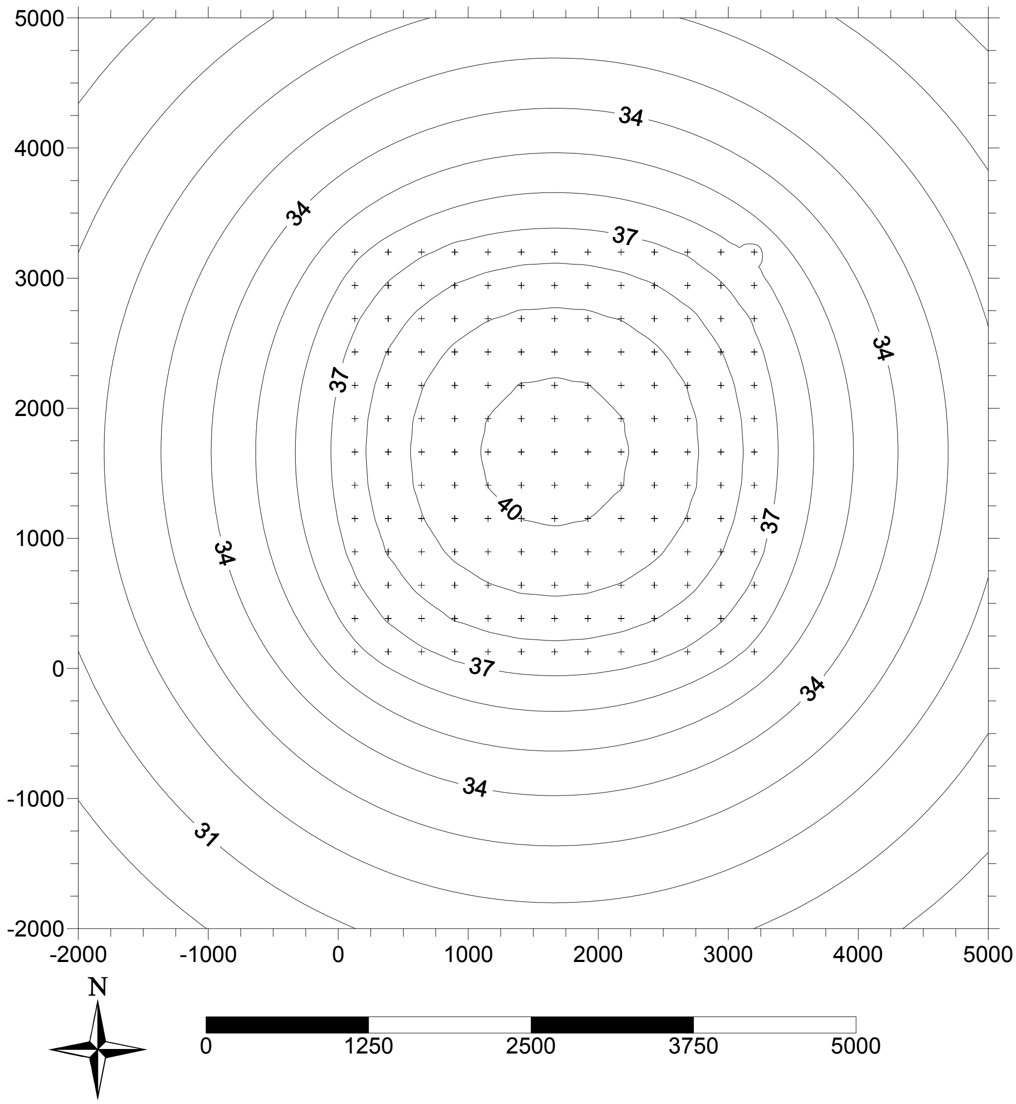

Figure 5. Contours of drawdown (feet) after 30 years of pumping at 550 gallons per day in the Middle Trinity aquifer. There are 169 domestic supply wells (crosses) with 1.5 acre spacing in a hypothetical 256 acre development.

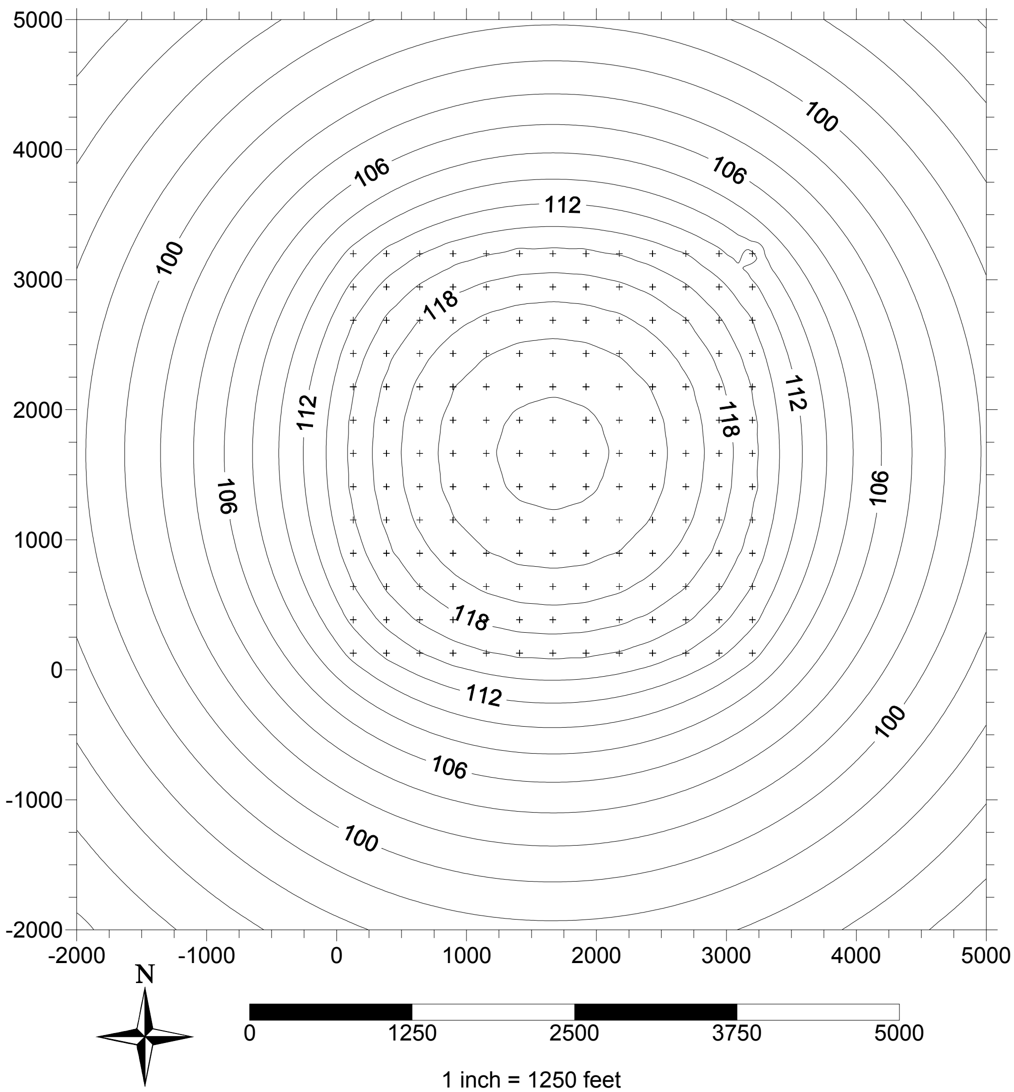

Figure 6. Contours of drawdown (feet) after 30 years of pumping at 1700 gallons per day in the Middle Trinity aquifer. There are 169 domestic supply wells (crosses) with 1.5 acre spacing in a hypothetical 256 acre development.

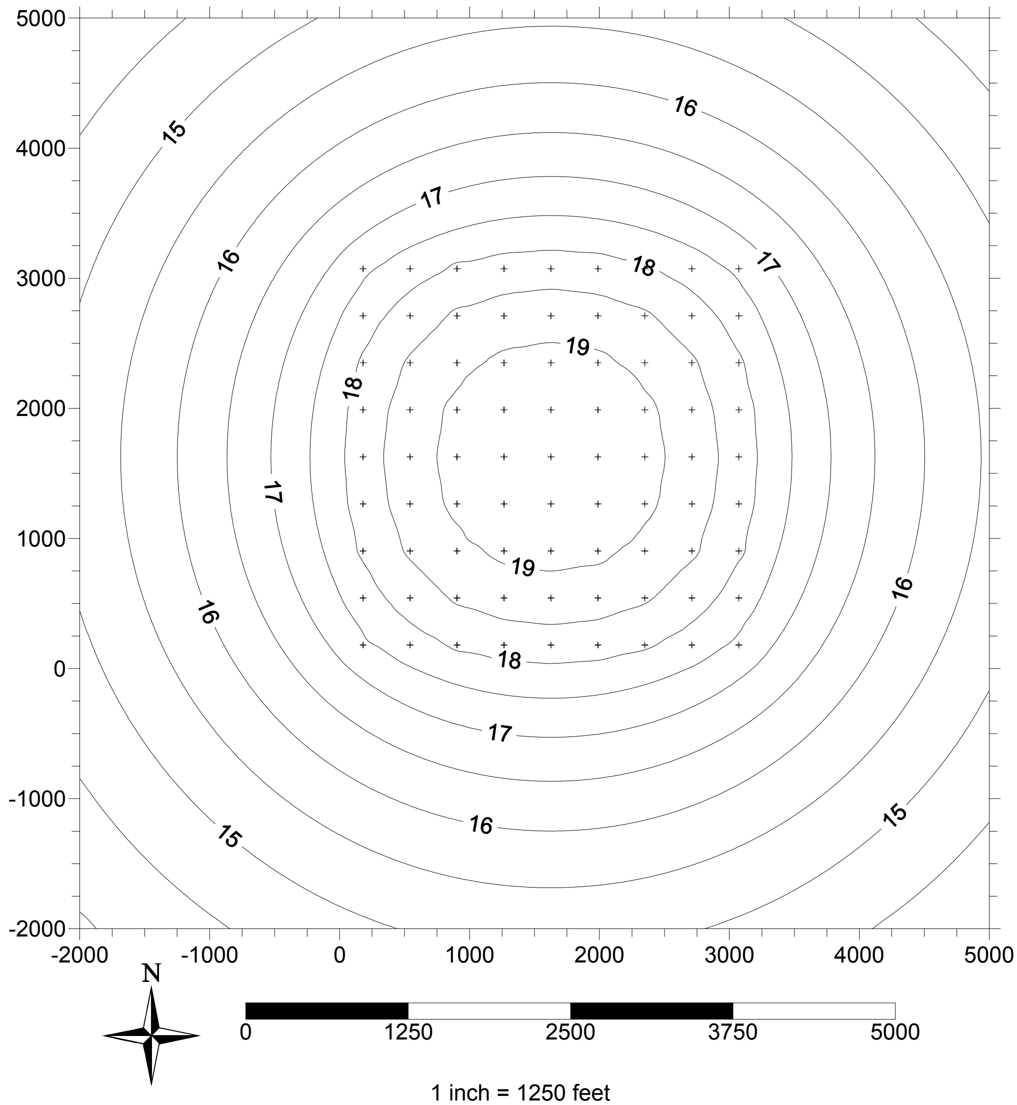

Figure 7. Contours of drawdown (feet) after 30 years of pumping at 550 gallons per day in the Middle Trinity aquifer. There are 81 domestic supply wells (crosses) with 3.0 acre spacing in a hypothetical 256 acre development.

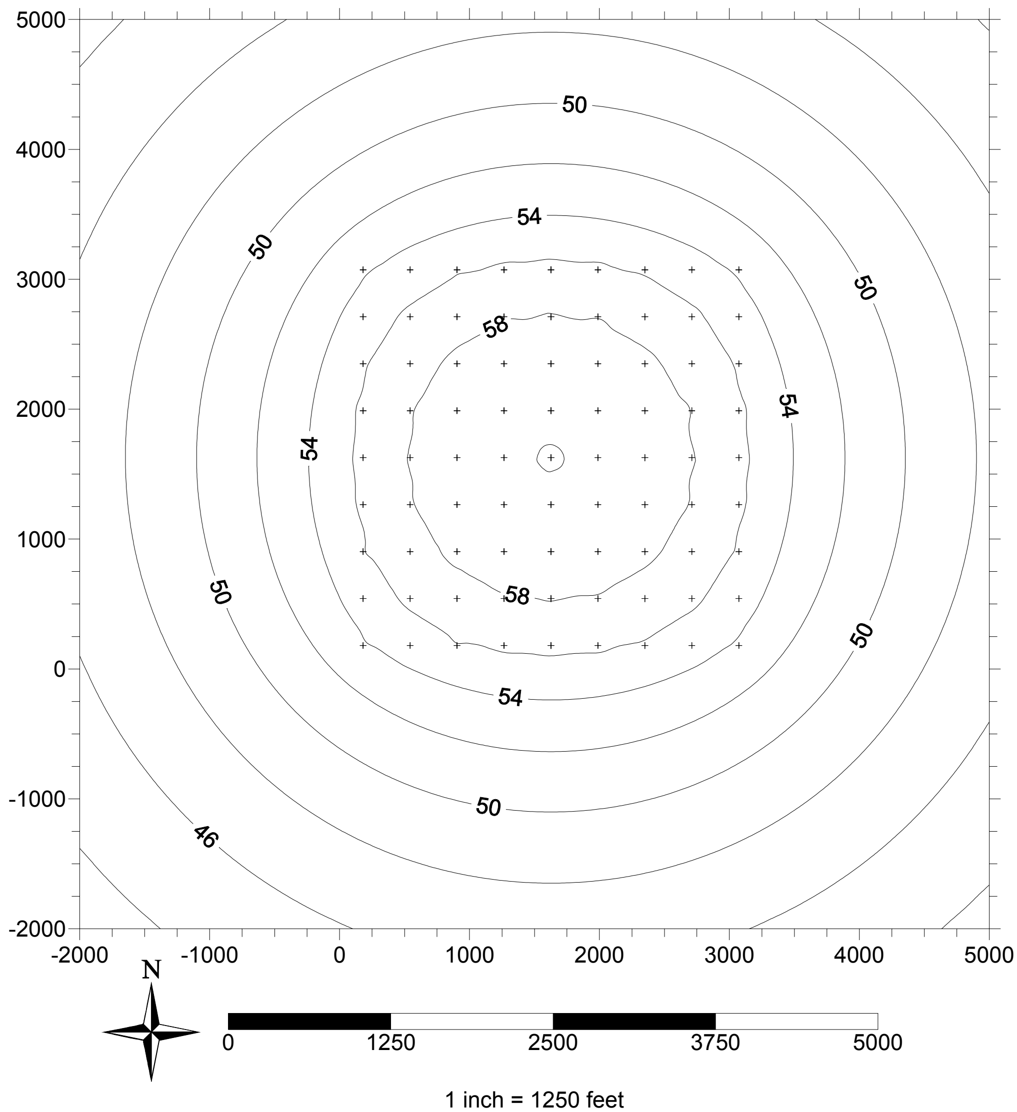

Figure 8. Contours of drawdown (feet) after 30 years of pumping at 1700 gallons per day in the Middle Trinity aquifer. There are 81 domestic supply wells (crosses) with 3.0 acre spacing in a hypothetical 256 acre development.

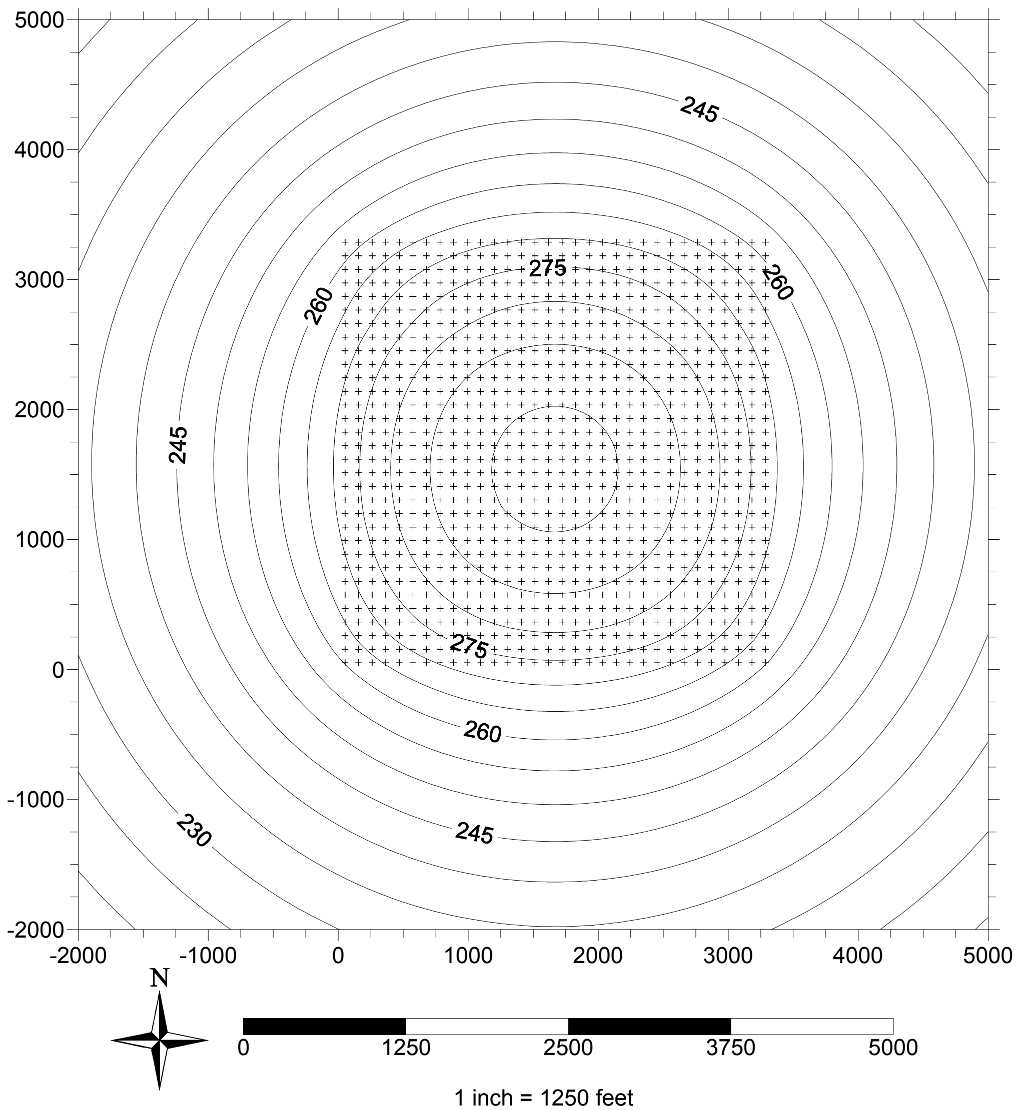

Figure 9. Contours of drawdown (feet) after 30 years of pumping at 550 gallons per day in the Lower Trinity aquifer. There are 1024 domestic supply wells (crosses) with quarter acre spacing in a hypothetical 256 acre development.

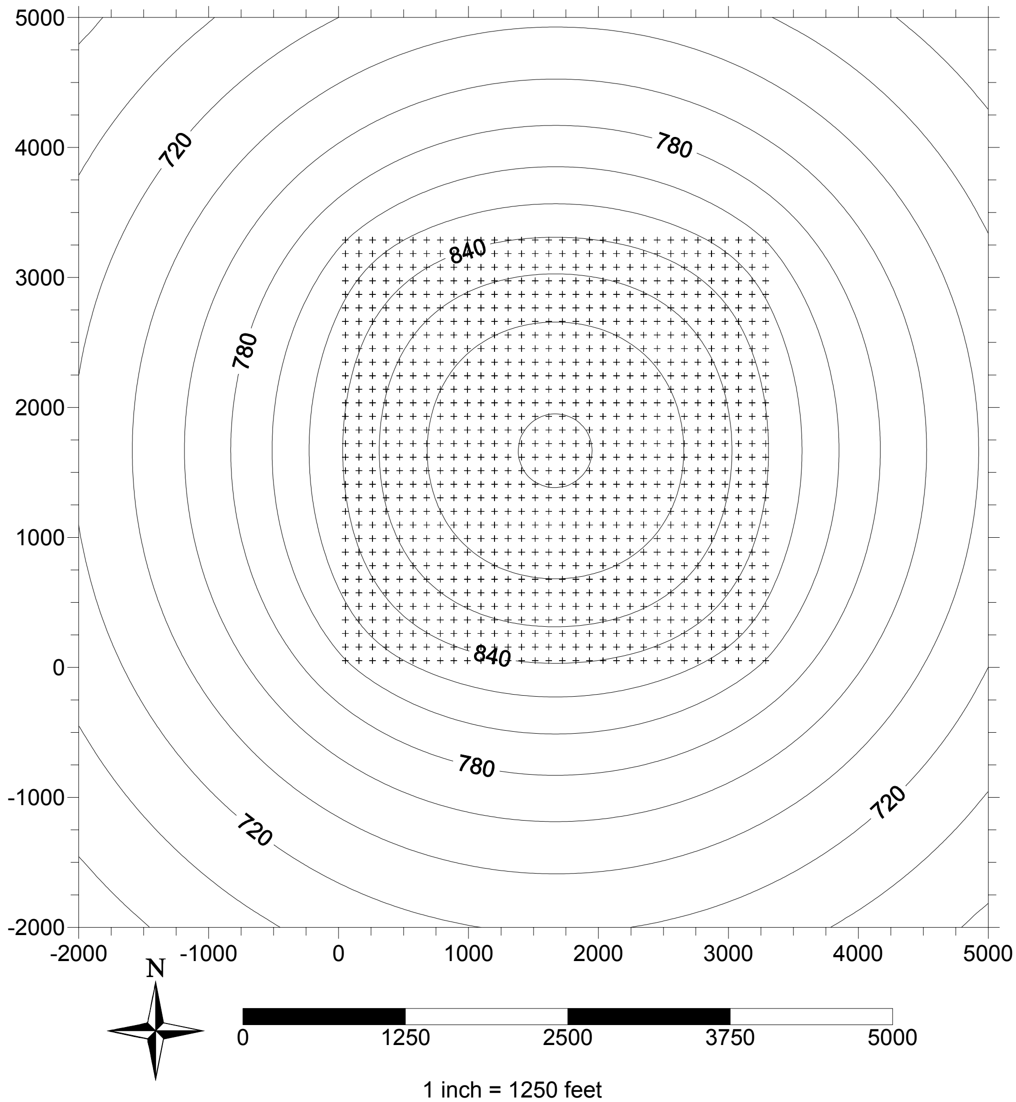

Figure 10. Contours of drawdown (feet) after 30 years of pumping at 1700 gallons per day in the Lower Trinity aquifer. There are 1024 domestic supply wells (crosses) with quarter acre spacing in a hypothetical 256 acre development.

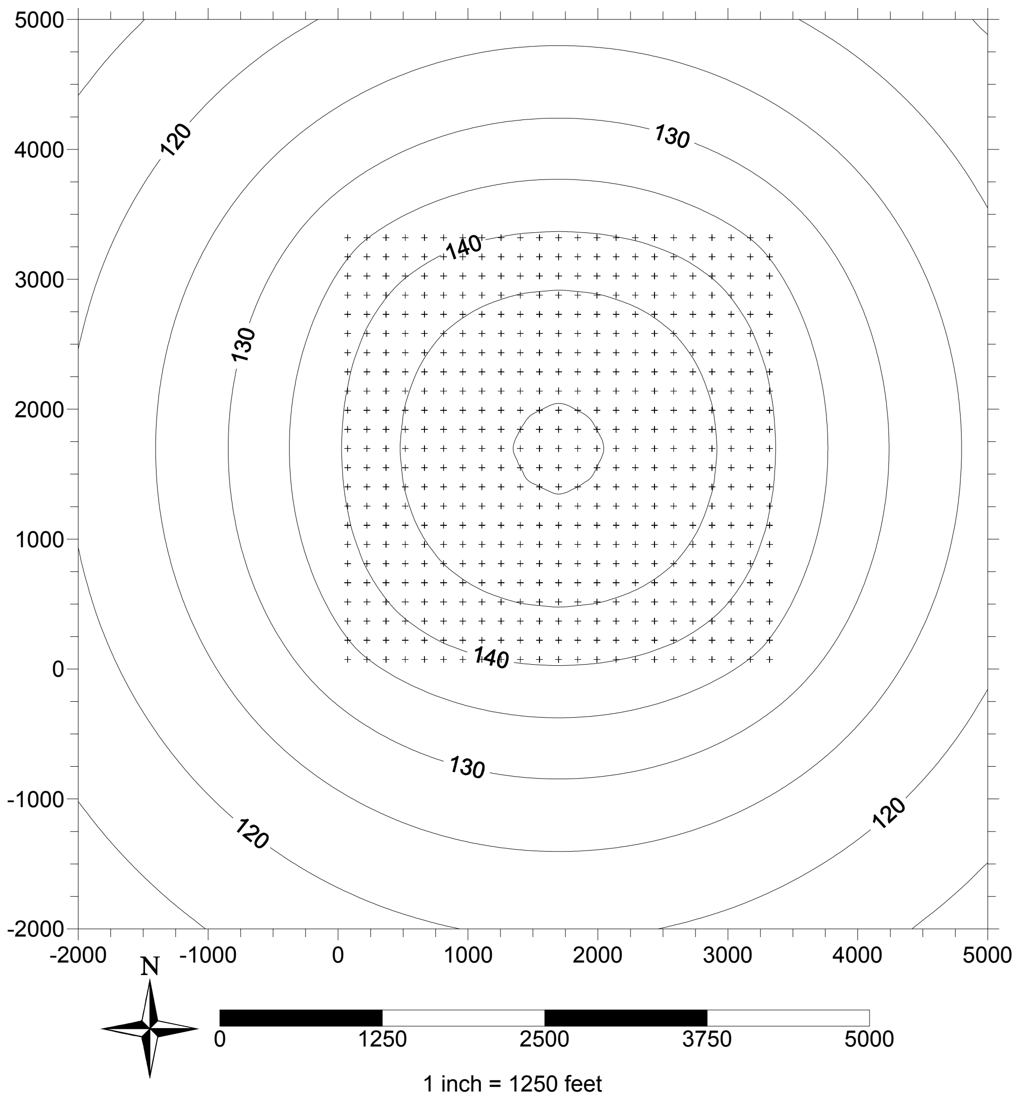

Figure 11. Contours of drawdown (feet) after 30 years of pumping at 550 gallons per day in the Lower Trinity aquifer. There are 529 domestic supply wells (crosses) with half acre spacing in a hypothetical 256 acre development.

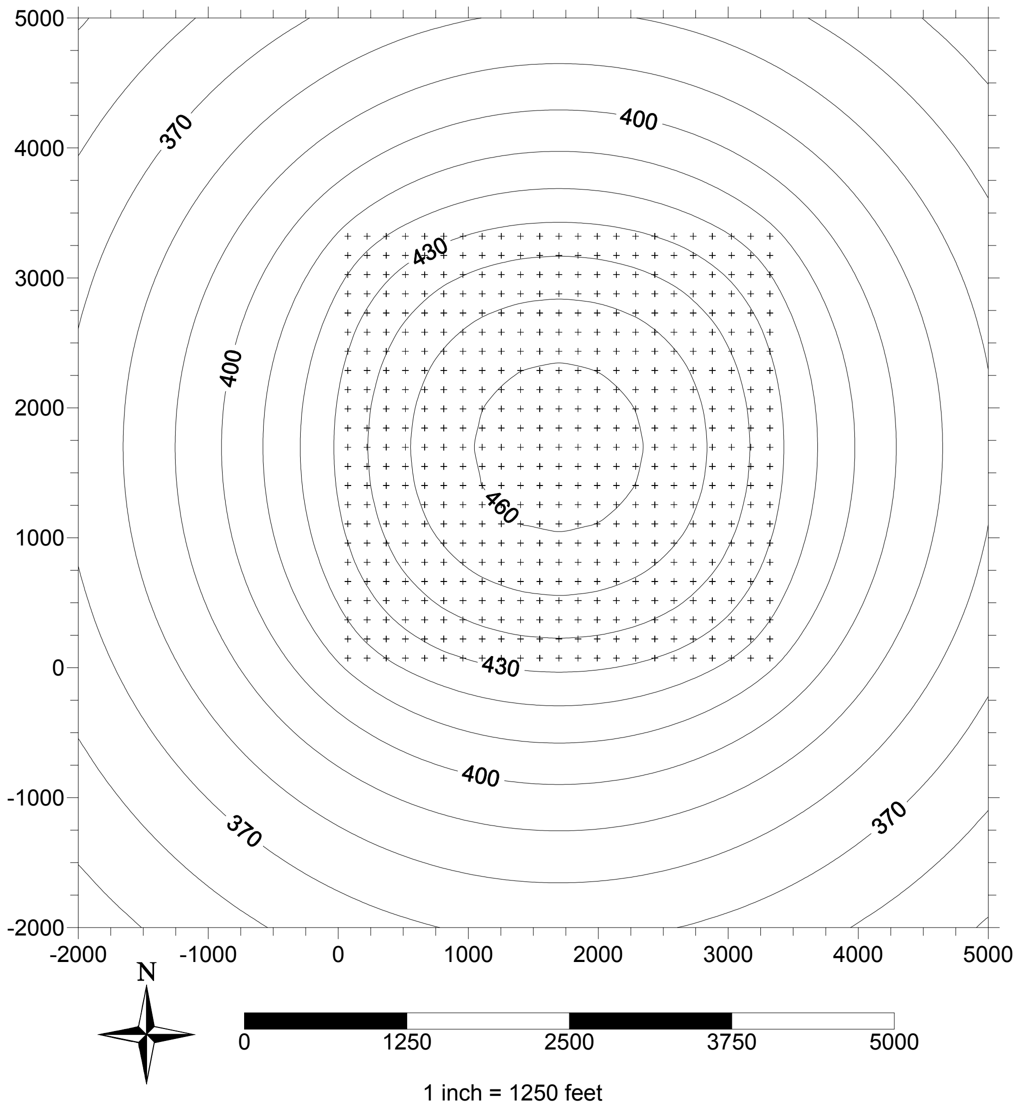

Figure 12. Contours of drawdown (feet) after 30 years of pumping at 1700 gallons per day in the Lower Trinity aquifer. There are 529 domestic supply wells (crosses) with half acre spacing in a hypothetical 256 acre development.

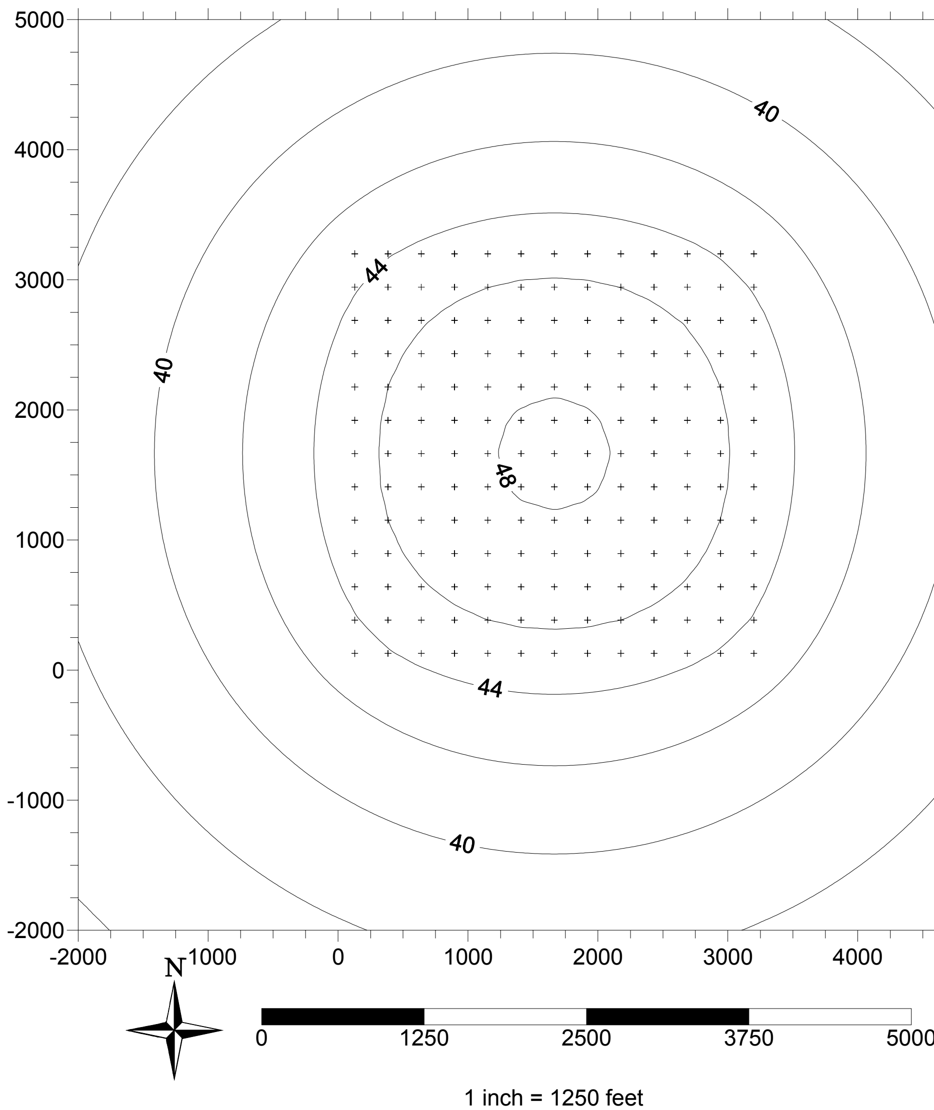

Figure 13. Contours of drawdown (feet) after 30 years of pumping at 550 gallons per day in the Lower Trinity aquifer. There are 169 domestic supply wells (crosses) with 1.5 acre spacing in a hypothetical 256 acre development.

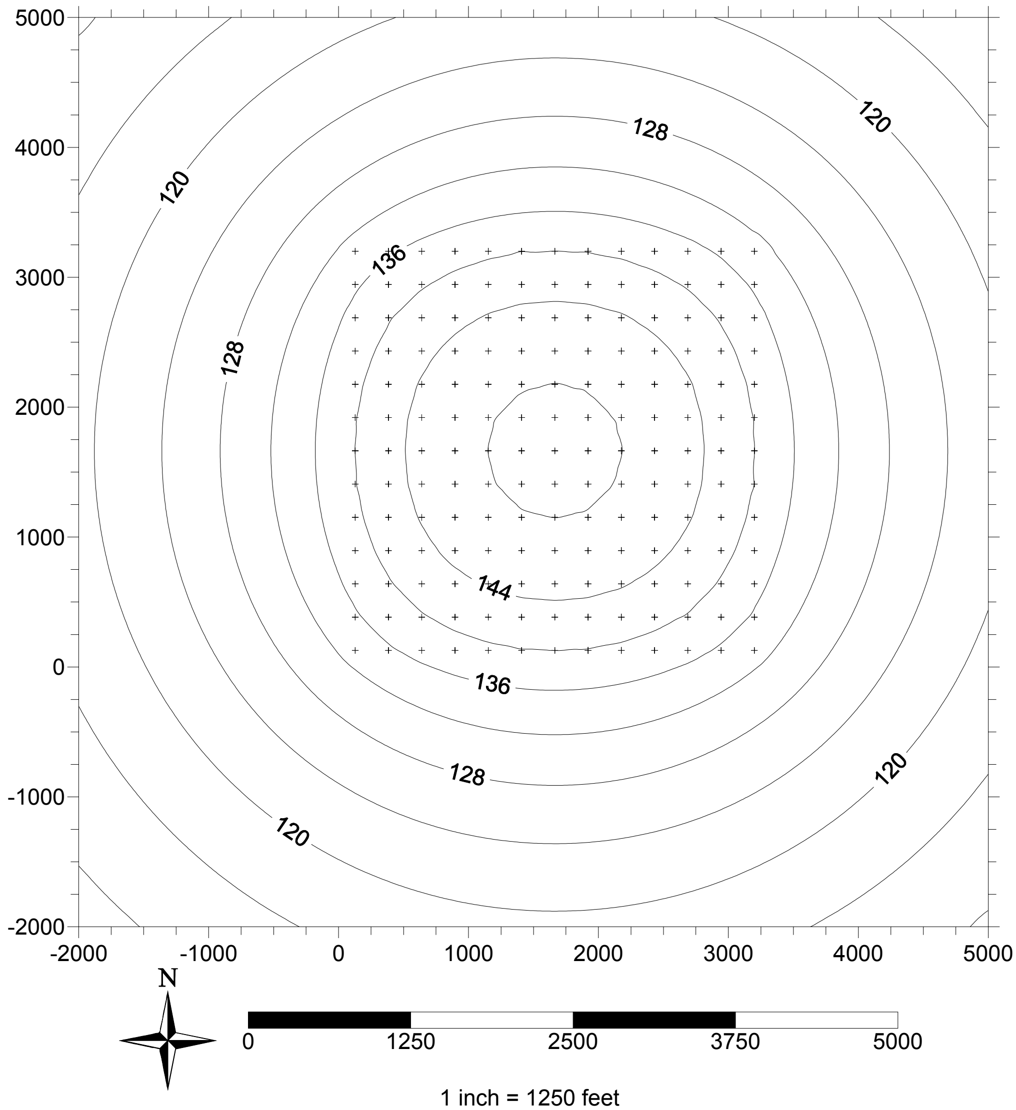

Figure 14. Contours of drawdown (feet) after 30 years of pumping at 1700 gallons per day in the Lower Trinity aquifer. There are 169 domestic supply wells (crosses) with 1.5 acre spacing in a hypothetical 256 acre development.

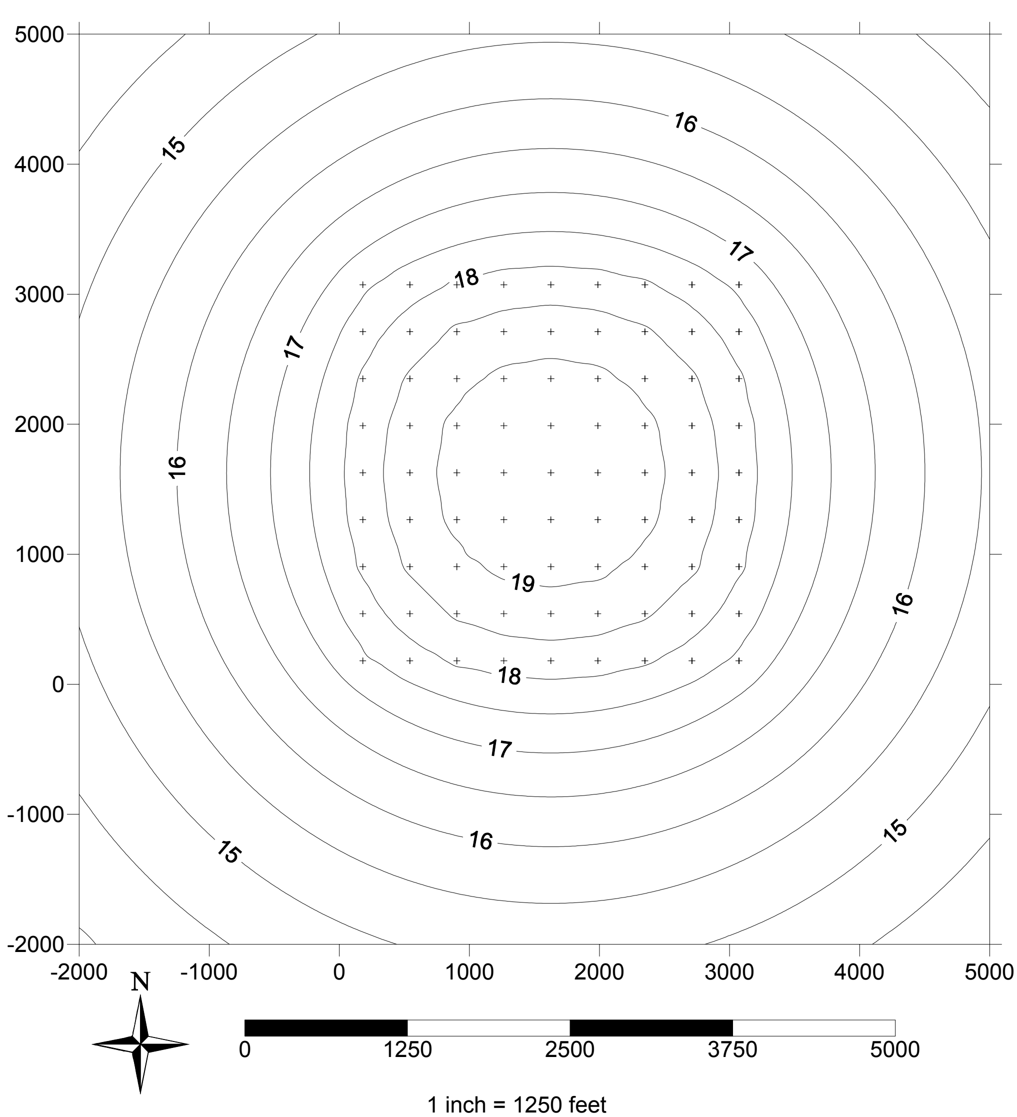

Figure 15. Contours of drawdown (feet) after 30 years of pumping at 550 gallons per day in the Lower Trinity aquifer. There are 81 domestic supply wells (crosses) with 3.0 acre spacing in a hypothetical 256 acre development.

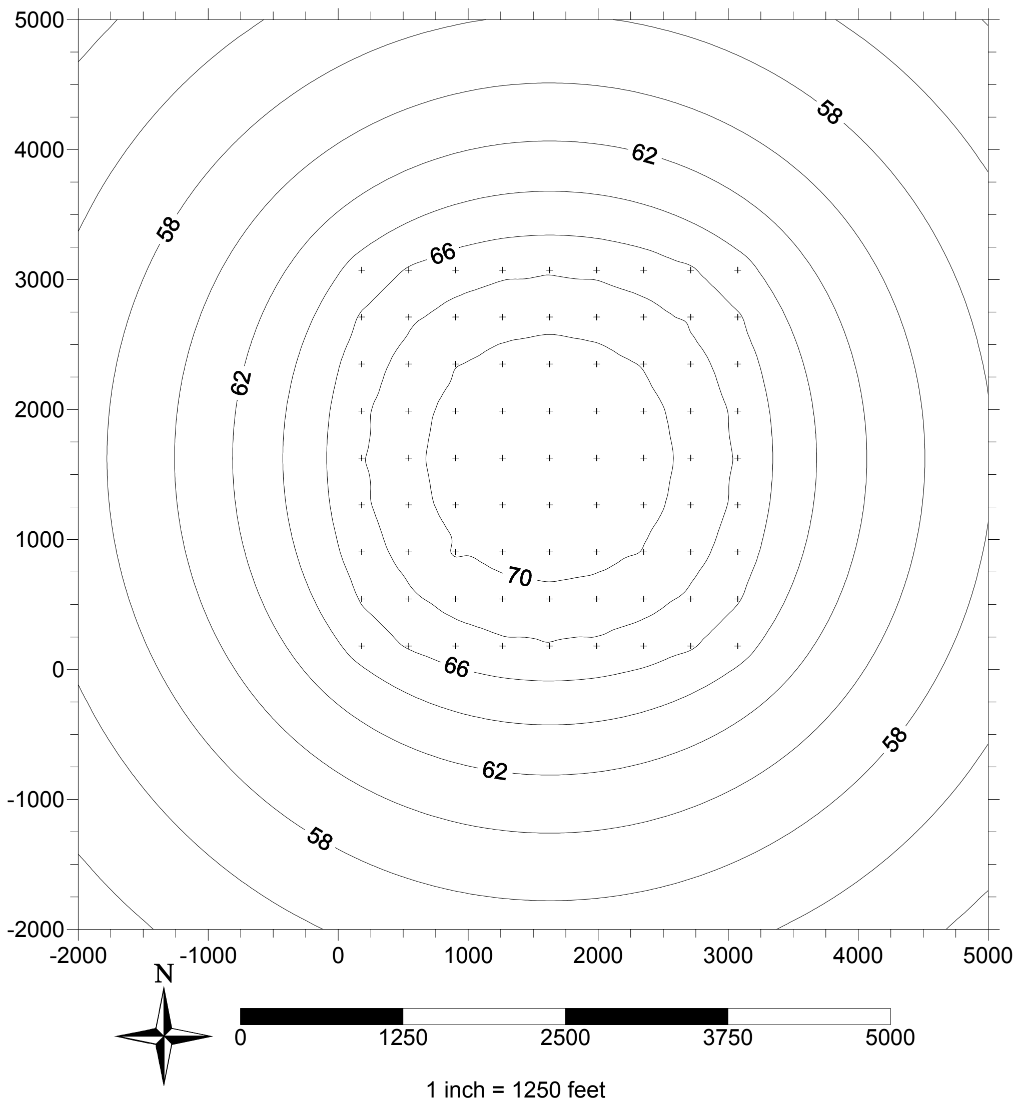

Figure 16. Contours of drawdown (feet) after 30 years of pumping at 1700 gallons per day in the Lower Trinity aquifer. There are 81 domestic supply wells (crosses) with 3.0 acre spacing in a hypothetical 256 acre development.

APPENDIX A

Pumping Test Reports on file at the Hays Trinity Groundwater Conservation District Offices as of May 21, 2004

These reports are on file with the Hays County subdivision coordinator and at the offices of the Hays Trinity Groundwater Conservation District located at: Center Lake Business Park, 14101 Hwy 290 West, Bldg. 100, Ste. 212, Austin , TX 78737 (512-858-9253).

Bridlewood Ranches Development, April 2003, LBG Guyton Associates, Austin, TX.

Deerfield Estates II, April 3, 2000; Vickers, Joe and Bond, Steven; The Wellspec Company, Dripping Springs, TX and Bond Geological Services, Wimberley, TX.

Goldenview Estates, May 16, 2001; Banks, Erin K., PE; Banks & Assoc., San Marcos, TX

Heather Hills Subdivision, March 21, 2001; Vickers, Joe and Bond, Steven; The Wellspec Company, Dripping Springs, TX and Bond Geological Services, Wimberley, TX.

High View Ranch, May 2003; Banks, Erin K., PE; Banks & Assoc., San Marcos, TX

Homestead At Gatlin Creek, June 2003; Banks, Erin K., PE; Banks & Assoc., San Marcos, TX

Mt. Sharp Ranch, Hays County, Texas, March 21, 2000; Mikels, John K., GEOS Consulting, Austin, TX

The Polo Club, June 27, 2003; Vickers, Joe and Bond, Steven; The Wellspec Company, Dripping Springs, TX and Bond Geological Services, Wimberley, TX.

River Mountain Ranch, Section 6, Phase 2, July 27, 2001; Mikels, John K.; Geos Consulting, Austin, TX.

St. Andrew's Episcopal High School, Travis County, Texas, Aquifer Pump Testing of Irrigation Wells No. 1 & 2; June 10, 2001; Mikels, John K.; Geos Consulting, Austin, TX.

Valley Verde Subdivision, September 20, 2000; Vickers, Joe and Bond, Steven; The Wellspec Company, Dripping Springs, TX and Bond Geological Services, Wimberley, TX.

Walking W Ranch Subdivision, April 12, 2002; Vickers, Joe and Bond, Steven; The Wellspec Company, Dripping Springs, TX and Bond Geological Services, Wimberley, TX.

Westridge Subdivision, April 10, 2000; Vickers, Joe and Bond, Steven; The Wellspec Company, Dripping Springs, TX and Bond Geological Services, Wimberley, TX.