Attachment E – Hydrogeologic Evaluation Report

January 27, 2023

Mr. James Brien
6617 Springwood Court
Temple, TX 76502

Re: Aquifer Evaluation Report –
Mr. James Brien Permit Application for Proposed Two (2) Wells
To Be Completed in the Simsboro Aquifer, Robertson County, Texas

Dear Mr. Brien:

Per your request and in compliance with the rules of the Brazos Valley Groundwater Conservation District (BVGCD), Thornhill Group, Inc. (TGI) provides herein an evaluation of the projected effect of producing 4,115 acre-feet of water per year from two (2) proposed new production wells to be completed in the Simsboro aquifer on the property identified as Mr. Brien's located in western-southwestern Robertson County. TGI conducted its evaluations and prepared this report in compliance with the rules and guidelines provided by the BVGCD, specifically in Rule 8.4(b)(7)(B) for wells (and multiple wells) capable of producing 800 or more acre-feet per year. TGI's evaluations focused on assessing local aquifer conditions and parameters, and the extent to which production from the subject wells may influence other groundwater users in the BVGCD. TGI's evaluations are based on previous investigations conducted, including permit applications and field-testing associated with the nearby Brazos Valley Farms well field. Additionally, TGI relied upon reported data, published reports, the applicable groundwater availability model (GAM), and TGI's extensive experience with and knowledge of the Simsboro aquifer in Central Texas, within the BVGCD, and particularly in Robertson County. Specifically, TGI's work was conducted to accomplish the following goals:

- Assessing the local hydrogeologic setting, focusing on the physical characteristics and hydraulic parameters of the local Simsboro aquifer;
- Estimating and calculating the potential short-term and long-term drawdown at each of the wells, including interference drawdown between wells;
- Establishing a target maximum proposed pumping rate for each well and for the aggregated well field;
- Modeling to assess the feasibility of the targeted pumping rate and the potential impacts (e.g., artesian pressure reduction) to the aquifer and other nearby well owners (e.g., drawdown); and,
- Providing this Hydrogeological Evaluation Report in compliance with District rules.

For convenience, applicable illustrations and supporting documentation are included in the following attachments:

Attachment 1 – Figures
Attachment 2 – Tables
Attachment 3 – Reference Materials
Attachment 4 – Selected References

Proposed Pumping Location and Permit Pumping Rates

Figure 1 provides a map showing the locations of the proposed wells and the outline of the approximately 687-acre contiguous tract owned by Mr. Brien. Proposed well identifications, coordinates, and estimated land-surface elevations in feet above mean sea level (AMSL) as obtained from the National Elevation Dataset (NED) are as follows:

Well Identification	Latitude*	Longitude*	NED Land Surface Elevation
Brien_1	30° 54’ 46.678” N	96° 41’ 54.556” W	284 feet AMSL
Brien_2	30° 54' 53.374" N	96° 41' 13.257" W	280 feet AMSL

*Coordinate system is NAD83 State Plane Texas Central (feet) (EPSG 32039) converted to NAD83 (EPSG 4269)

The proposed wells are located between the Brazos River and State Highway 6 (HW6), located between 6.3 and 6.8 miles from the center of the City of Hearne and between 4.4 and 4.7 miles from the center of the City of Calvert.

The proposed production capacities in gallons per minute (gpm) and requested permit allocations in acre-feet per year are as follows:

Well Identification	Maximum Pumping Rate	Annual Permit Allocation
Brien_1	1,700 gpm	2,186 acre-feet
Brien_2	1,500 gpm	1,929 acre-feet
Total	**3,200 gpm**	**4,115 acre-feet**

The proposed well sites are spaced 3,660 feet apart, and both wells are sited to comply with the ½ foot per GPM spacing from the subject property line rule, as well as the 1 foot per GPM spacing from other registered Simsboro wells rule. Therefore, the proposed well locations comply with the BVGCD rules regarding spacing between wells and allocation of acreage per well. Figure 2 in the attachments shows all BVGCD registered Simsboro wells within 1 (one) mile of the proposed wells at a 1-inch to 1,000-foot scale. Figure 3 shows all BVGCD wells within 5 miles of the proposed wells.

Hydrogeologic Conditions and Aquifer Characteristics

Surface Geologic Setting

Figure 4 shows the surface geology at the subject property. The entire tract is located atop the Brazos River Alluvium aquifer, a Minor Aquifer in Texas. The Brazos River Alluvium was deposited in the ancient and present-day floodplains of the Brazos River and consists of sedimentary deposits of various grain sizes, along with lenses and structures typical of riverine deposits. The geophysical log of nearby well CS-2, which is approximately 2 miles southeast from the subject property, shows the alluvium to be approximately 60 feet thick. The Carrizo-Wilcox aquifer occurs immediately below the Brazos River Alluvium. Geologically updip and present to the southeast of the property is the Queen City Aquifer, separated by the generally confining Reklaw Formation. Because the property is located within the ancient and recent floodplains of the river and because the fields have been leveled for cultivation, the land surface is relatively flat across most of the property.

While the Carrizo-Wilcox is mapped as a single Major Aquifer by the Texas Water Development Board (TWDB), it does not behave as a single aquifer within the BVGCD boundaries. In fact, it is comprised of four geologic units including, from deeper to shallower (older to younger), the Hooper formation, the Simsboro formation, the Calvert Bluff formation and the Carrizo Sand. Geologic units dip generally from northwest to southeast and dip angles generally increase downdip and with depth. Locally, the dip of the base of the Wilcox Group is approximately 75 feet per mile (see Attachment 3). A representative hydrostratigraphic column for the region follows:

Period	Series	Strata	Hydrogeologic Unit
Tertiary	Eocene	Jackson Group	Yegua-Jackson Aquifer
		Yegua Fmn.	
		Cook Mountain Fmn.	Confining Unit
		Sparta Sand	Sparta Aquifer
		Weches Fmn.	Confining Unit
		Queen City Sand	Queen City Aquifer
		Reklaw Fmn.	Confining Unit
		Carrizo Sand	Carrizo-Wilcox Aquifer
		Calvert Bluff Fmn.	
		Simsboro Fmn.	
	Paleocene	Hooper Fmn.	
		Miday Fmn.	Confining Unit

In Figure 4 it is visible that the strike of the bed contacts indicate that were it not for incision of the Brazos River the property would lie at the contact of the Carrizo Sand and the Calvert Bluff formations. However, the action of the Brazos River has likely removed any presence of the Carrizo from underneath the property. Therefore the Calvert Bluff underlies the alluvium, and based on nearby geophysical logs is approximately 700 to 750 feet thick.

The Calvert Bluff is a thick unit characterized by numerous and alternating relatively thin layers of clay, silt and sandy clays. The Calvert Bluff formation also contains numerous lignite seams ranging in thickness from less than one foot to more than 10 feet. Surface mining operations are ongoing in Robertson County in which lignite seams from the Calvert Bluff are mined to feed power plants. In some areas, the Calvert Bluff includes discontinuous sand channel deposits, with sand layers ranging from a few feet to more than 50 feet in thickness. Generally, the Calvert Bluff formation is considered a confining layer or aquitard between the Carrizo and Simsboro aquifers. However, the intermittent sand layers in the Calvert Bluff can be tapped locally to produce small to moderate quantities of water with variable water quality. Generally, between 10 and 20 percent of the total thickness of Calvert Bluff consists of sand. Most Calvert Bluff wells are small-capacity and used for domestic or stock purposes. Probably, most local wells are completed in zones of the Calvert Bluff formation that are under artesian conditions due to the significant stratification of the formation and discontinuity of sand layers.

There are no faults mapped at land surface across the subject property, although faulting associated with the Milano Fault Zone may occur updip and downdip of the property (see Figure 4).

Simsboro Aquifer Conditions and Hydraulic Parameters

Underlying the Calvert Bluff formation at the subject property is the Simsboro, which is the target aquifer for the proposed wells. Locally, the Simsboro dips (i.e., slopes) structurally from northwest to the southeast at an incline of between 70 and 80 feet per mile, and crops out (i.e., occurs at land surface) about 10 miles northwest of the proposed well sites. Based on GAM datasets, geologic maps, cross sections from the University of Texas Bureau of Economic Geology (BEG), and nearby geophysical logs, the elevation of the top of the Simsboro ranges from 375 to 500 feet below MSL across the subject property, or 650 to 780 feet below ground level (bgl).

TGI extracted hydraulic data for the subject property from the most recent version of the groundwater availability model (GAM) for the Central Portion of the Sparta, Queen City, and Carrizo-Wilcox Aquifers (Young, et al., 2018) which are presented in the following table. For comparison, hydraulic properties from previous GAM versions have been included in the tabulation. TGI estimates based on recently conducted pumping tests for the neighboring Brazos Valley Farms are also included.

Parameter	Previous GAM Avg. Estimates	Updated GAM Estimates Range	TGI Estimates*
Sand Thickness	450 feet	450 to 500 feet	450 to 500 feet
Hydraulic Conductivity	210 gpd/ft^2	75 to 150 gpd/ft^2	125 to 200 gpd/ft^2
Transmissivity	94,200 gpd/ft	35,000 to 75,000 gpd/ft	60,000 to 70,000 gpd/ft
Storage Coefficient	1.2 x 10^{-4}	1.44 x 10^{-4} to 1.56 x 10^{-4}	10^{-4}

The asterisk (*) in the above table indicates that TGI's estimates are based on and are consistent with previous hydrologic investigations and include adjustments to local transmissivity values to account for producing from the entire aquifer thickness.

Figure 5 provides a hydrograph illustrating water-level measurements collected for nearby TWDB/BVGCD Simsboro monitoring well (State Well No. 59-04-701) which is located near the City of Hearne and is about 4 miles southeast from the nearest proposed well. The water level in 1979 was less than 10 feet below land surface and has declined over 40 years to its current depth at roughly 150 to 175 feet bgl. Nearby BVGCD monitoring wells BVR-1506 and BVDO-0055 show similar depths to water of 125 and 150 feet bgl. Water-level elevations on the Brien property will likely be in general agreement with these nearby wells and is anticipated around 125 to 175 feet bgl. Therefore, water levels will probably rise between 475 and 650 feet above the top of the aquifer in the new wells, verifying that the local Simsboro is under artesian or confined conditions with hundreds of feet of artesian head. Water-level data presented by INTERA indicate that there is a slight cone of depression near Hearne, although the overall gradient is from northwest to southeast.

Projected Effects of Proposed Pumping

The immediate impacts from production will be drawdown at the pumping wells (i.e., a reduction in artesian pressure). As the wells pump, artesian pressure or potentiometric head around the wells will decline forming a cone of depression. As production continues the cone of depression will extend radially from the well field until an aquifer boundary is reached or the production rate reaches equilibrium with the captured groundwater flows. Due to the distance of the proposed wells from the outcrop of the aquifer, reduction in artesian pressure is the only anticipated measurable effect from the proposed pumping. The aquifer will remain completely full and there will be only an infinitesimal reduction in storage. There may be some inter-aquifer leakage induced from the overlying Calvert Bluff confining layer, Carrizo aquifer and Brazos River Alluvium aquifer; however, the amount of leakage will serve to lessen the artesian drawdown in the Simsboro and will likely not result in any identifiable water-level changes in the Calvert Bluff, Carrizo or alluvium due to the stratification in the geologic layers. In order to assess effects from the pumping of the proposed wells, analytical and numerical models were utilized that incorporated only the two new wells to calculate their corresponding drawdown.

Drawdown Simulations Using the GAM

TGI utilized the recently released revision and update of the Central Portion of the Sparta, Queen City, and Carrizo-Wilcox Aquifers GAM to calculate drawdown due to the proposed pumping from the two wells for continuous pumping periods of one (1) year and 10 years. Figure 6 and Figure 7 provide maps showing modeled drawdown contours after one (1) year and 10 years of pumping at the maximum authorized rate, respectively. Table 1 provides modeled drawdown at specific registered and permitted Simsboro well sites after one (1) year and 10 years of continuous pumping, respectively. Table 2 provides casing and screen depth information for registered BVGCD wells within one mile of the proposed wells.

Due to the grid scale (i.e., one mile) and configuration in the model, the GAM does not provide an accurate spatial representation of drawdown at the well sites within the well field and in the immediate surrounding area, and the simulation likely predicts less drawdown than will actually occur near the pumping wells. The GAM drawdown results at some distance from the proposed well field are probably more representative of the actual aquifer conditions and the potential results from pumping. For the nearest Simsboro wells located off of the subject property, the GAM runs predicted between 25 and 30 feet of drawdown after one (1) year, and a total of between 30 and 35 feet after 10 years. The GAM simulated less than 10 feet of drawdown at Hearne and 12 feet of drawdown at Calvert after 10 years of pumping from the two (2) proposed wells.

Note that several of the wells designated by the BVGCD as “Simsboro” wells may not actually be deep enough to penetrate the Simsboro aquifer. TGI did not attempt to verify the completion intervals of those wells, but simply reported the dataset as provided by BVGCD. Based on the geologic structure, estimates of current artesian head, and drawdown calculated from the GAM simulations, the Simsboro aquifer will remain full and under artesian conditions in the well-field area and within the five-mile radius.

Drawdown Simulations Using Analytical Modeling

As stated previously, due to the scale and configuration of the GAM grid, the GAM probably does not provide accurate drawdown calculations for the specific well sites and areas in the immediate vicinity of the proposed well field. Therefore, for comparison purposes and per the BVGCD rules TGI used an analytical modeling program based on the Theis non-equilibrium equation to calculate theoretical potentiometric head declines at and surrounding the proposed production wells. TGI has used the Theis model for several submittals to the BVGCD as well as for evaluations and submittals to numerous districts across the State of Texas. The

Theis model incorporates many assumptions, most of which are sufficiently satisfied in the local Simsboro aquifer. However, the Theis model assumes an aquifer that is uniform over an infinite area. To account for recharge boundaries and possible inter-aquifer leakage into the Simsboro, TGI modeled long-term pumping (i.e., from one to 10 years) by incorporating a leaky artesian storage coefficient. However, it is likely that, while the Theis model likely provides more reliable results within and near the well field, it probably overstates drawdown at distance from the pumping center. Also, the Theis model is more accurate for shorter pumping durations; therefore, the 10-year calculation likely overestimates drawdown from the well field. Analytical modelling hydraulic parameters were the same for both proposed wells with a transmissivity of 65,000 gallons per day per foot (gpd/ft), and 1- and 10-year storage coefficients of 0.0001.

Figure 8 and Figure 9 provide the Theis-modeled drawdown contours for pumping periods of one (1) year and 10 years, respectively. Table 1 provides the tabulated drawdown at specific Simsboro well sites, based on the locations and designations of aquifers provided by BVGCD in their database files.

Assuming properly completed and highly efficient production wells, the Theis model predicted drawdown in the proposed pumping wells of between 55 to 65 feet after one (1) year of continuous pumping, with an additional 5 to 15 feet of drawdown at each well with continuous pumping for 10 years. The Theis calculation resulted in one-year interference drawdown of about 23 feet at the City of Hearne and approximately 27 feet at Calvert. The analytical model predicted drawdown after 10 years of 36 feet and 40 feet at Hearne and Calvert, respectively, assuming continuous pumping of the maximum permitted volume. Predicted drawdown at Simsboro wells between one (1) and five (5) miles from the proposed wells will be less than 100 feet.

Conclusions

Based on our review of the BVGCD rules and the work conducted as described herein, TGI concludes the following:

- The proposed wells and pumping amounts can be completed and produced in accordance with the well spacing and production-based acreage (i.e., allocation) rules set forth by the BVGCD;
  - Specific capacities determined from existing well records, testing conducted by BVGCD representatives on nearby wells (March 18, 2009), current available drawdown, and predicted drawdown all demonstrate that the wells will be capable of easily sustaining pumping rates of up to 1,700 gpm;

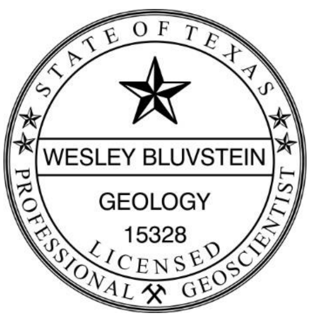
- ❖ The predicted drawdown derived from the Theis analytical model are more accurate than the GAM predictions for the proposed well sites and areas near the well field;
- ❖ GAM-predicted drawdown probably provides a more reasonable estimate of future impacts at greater distances from the proposed well field and for longer time periods. The updated GAM predicts significantly less drawdown regionally than the previous version of the GAM; and,
- ❖ Production from the proposed pumping will cause only infinitesimal reduction in aquifer storage as the Simsboro will stay completely full and groundwater in the formation will remain under considerable artesian pressure within the well-field area and the five-mile study radius.

We very much appreciate the opportunity to assist you in our specialty. If you have any questions, please call.

Sincerely,
THORNHILL GROUP, INC.

Wesley Bluvstein

Wesley Bluvstein, P.G.

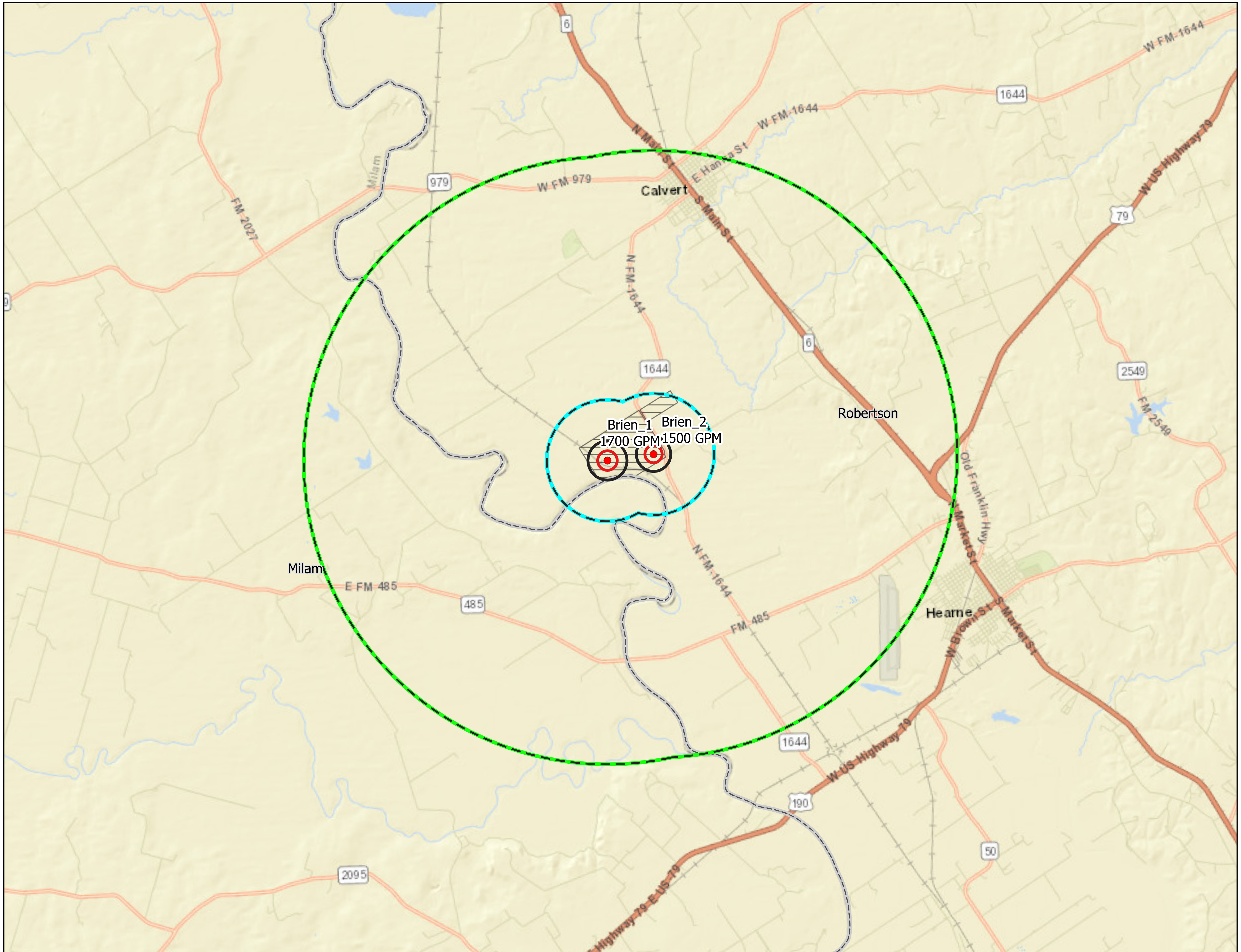


Wesley Bluvstein

The seal appearing on this document was authorized by Wesley Bluvstein, P.G. on January 27, 2023.

Attachments

ATTACHMENT 1 –
FIGURES



Brien Proposed Wells
- Red Buffer indicates property boundary spacing requirement
- Black Buffer indicates Simsboro well spacing requirement

Brien Property Boundary

1 Mile Well Buffer

5 Mile Well Buffer

County Boundary

N

0 1 2 3 4 mi

Scale 1:100,000

Figure 1: Location Map

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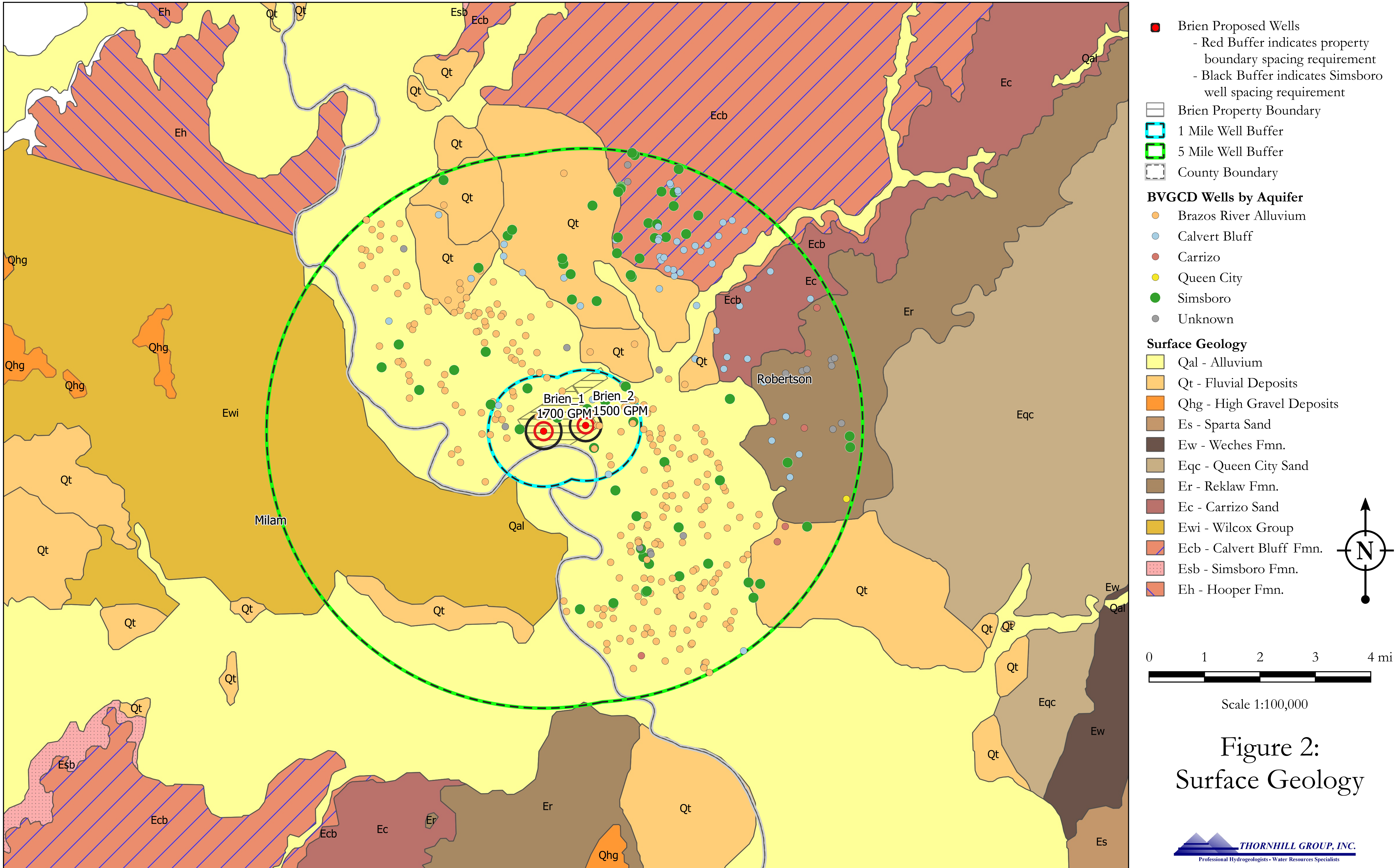

Figure 2: Surface Geology

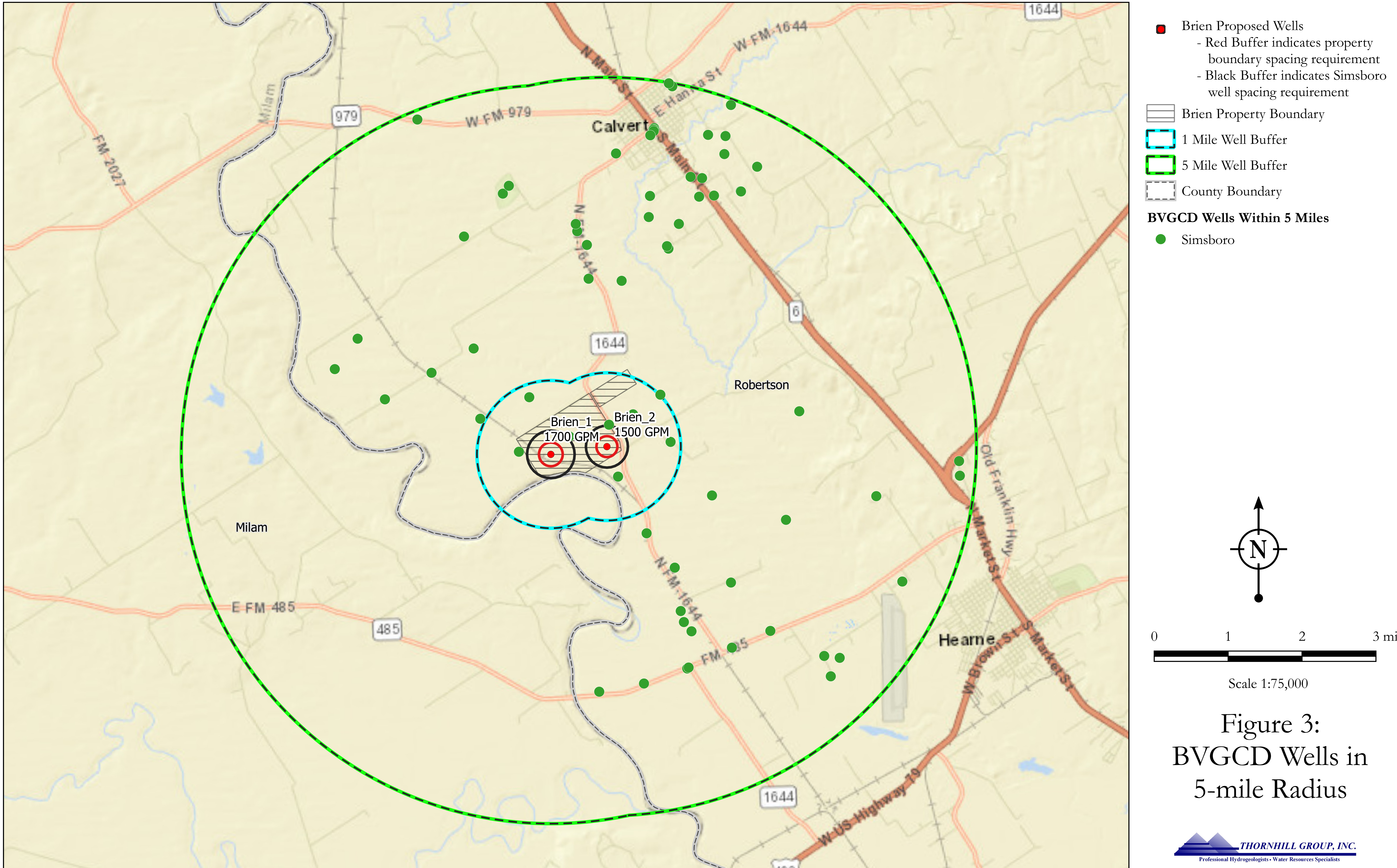

Figure 3: BVGCD Wells in 5-mile Radius

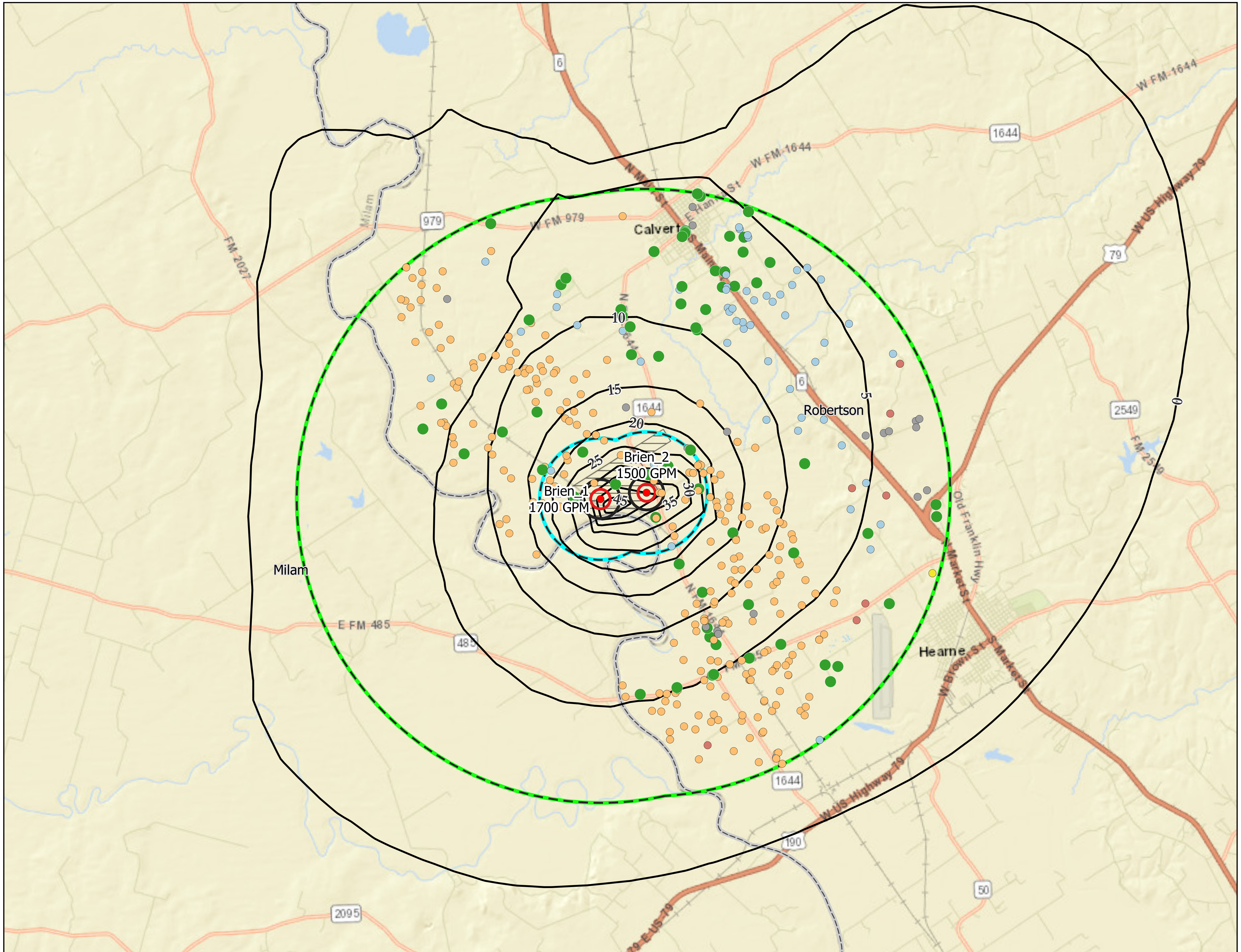

Figure 4:
1-Year QCSP GAM Drawdown Contours

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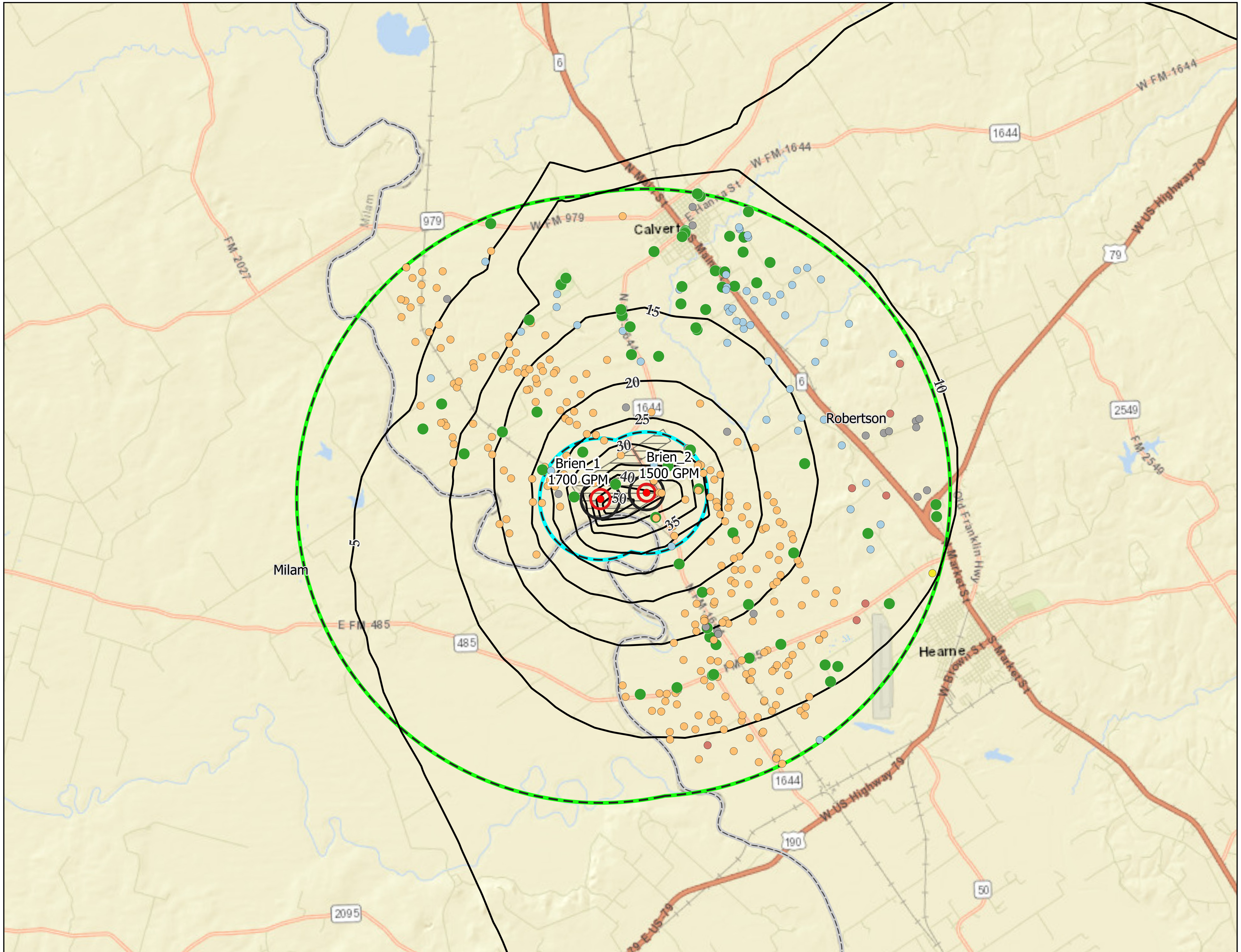

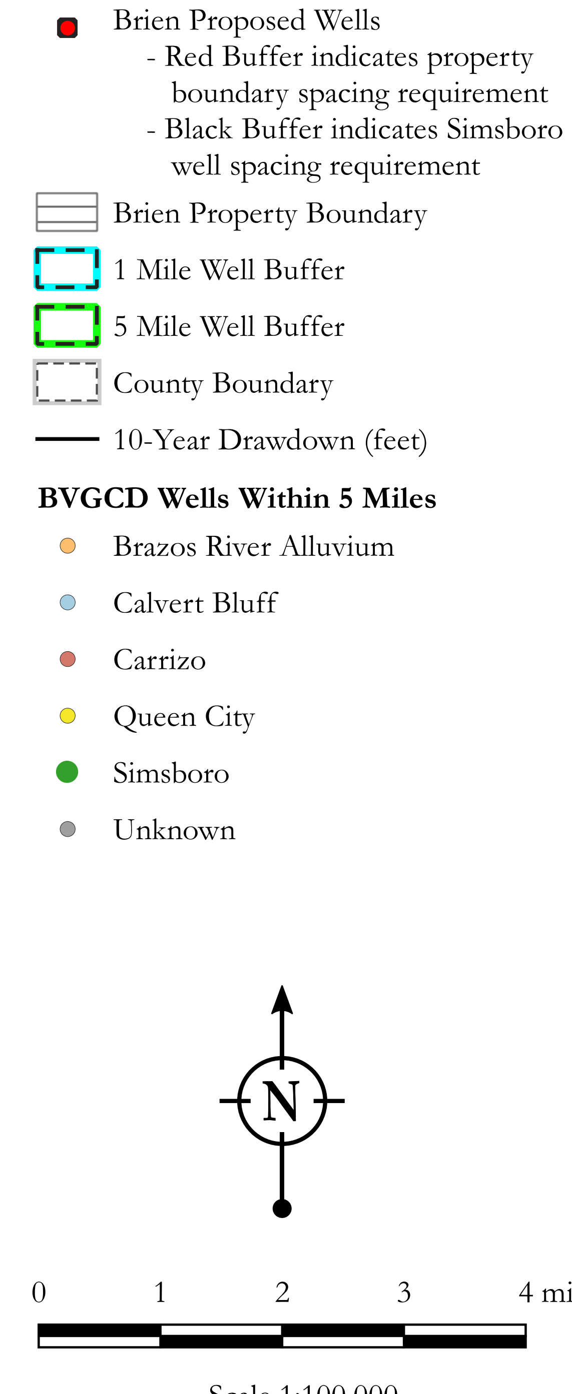

Figure 5:
10-Year QCSP GAM Drawdown Contours

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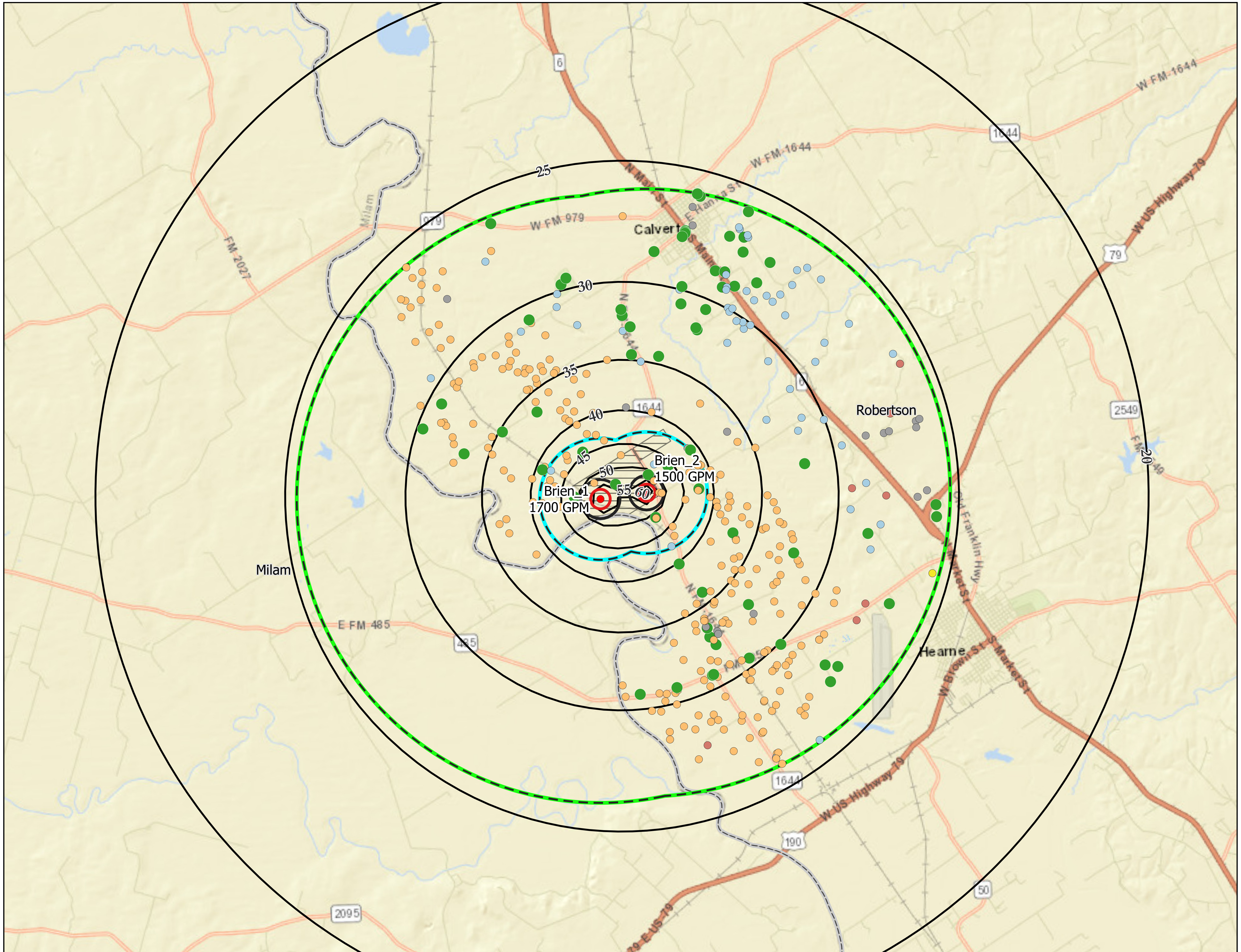

Brien Proposed Wells
- Red Buffer indicates property boundary spacing requirement
- Black Buffer indicates Simsboro well spacing requirement

Brien Property Boundary

1 Mile Well Buffer

5 Mile Well Buffer

County Boundary

1-Year Drawdown (feet)

BVGCD Wells Within 5 Miles

- Brazos River Alluvium
- Calvert Bluff
- Carrizo
- Queen City
- Simsboro
- Unknown

N

0 1 2 3 4 mi

Scale 1:100,000

Figure 6: 1-Year Analytical Drawdown Contours

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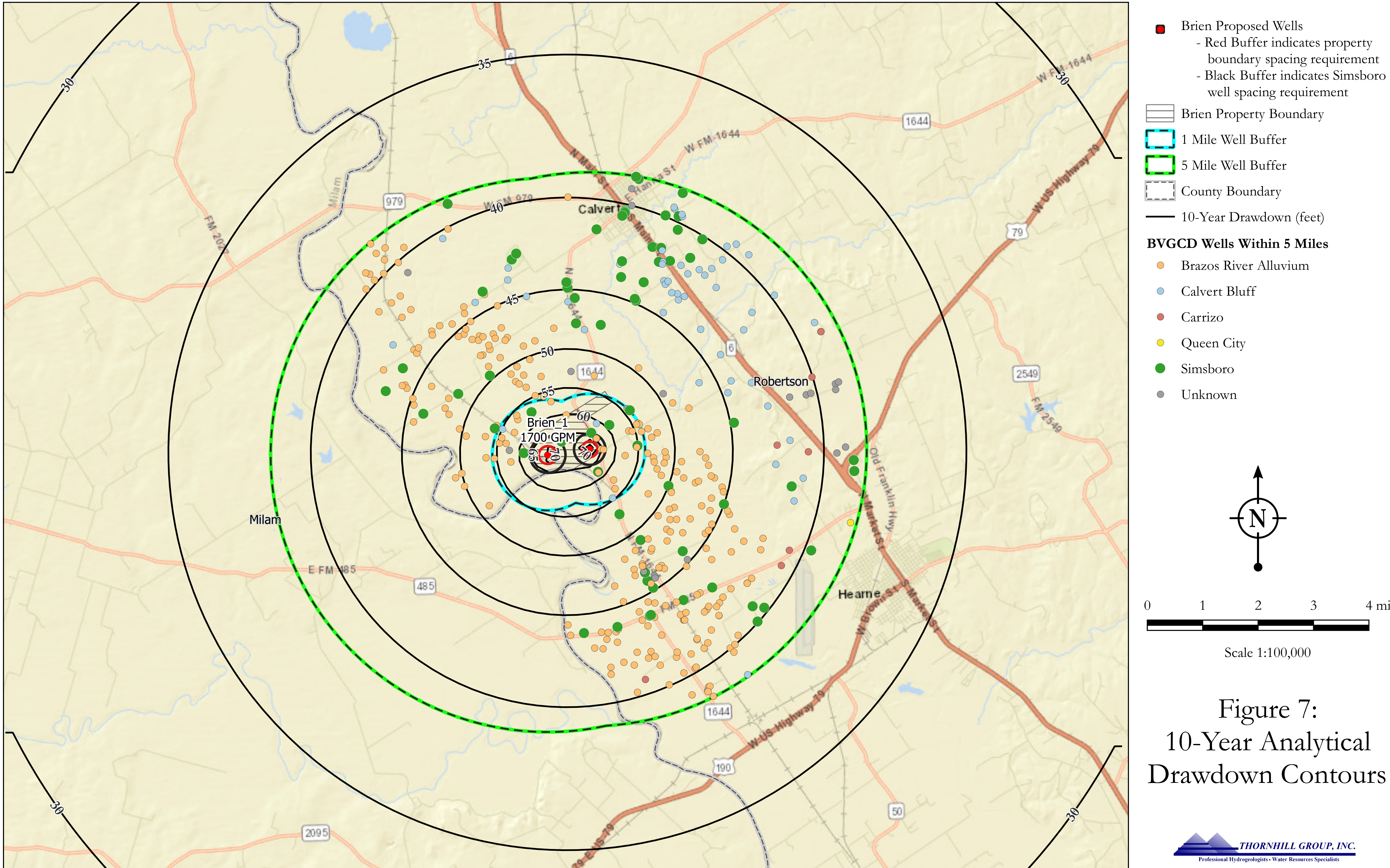


Figure 7:
10-Year Analytical Drawdown Contours

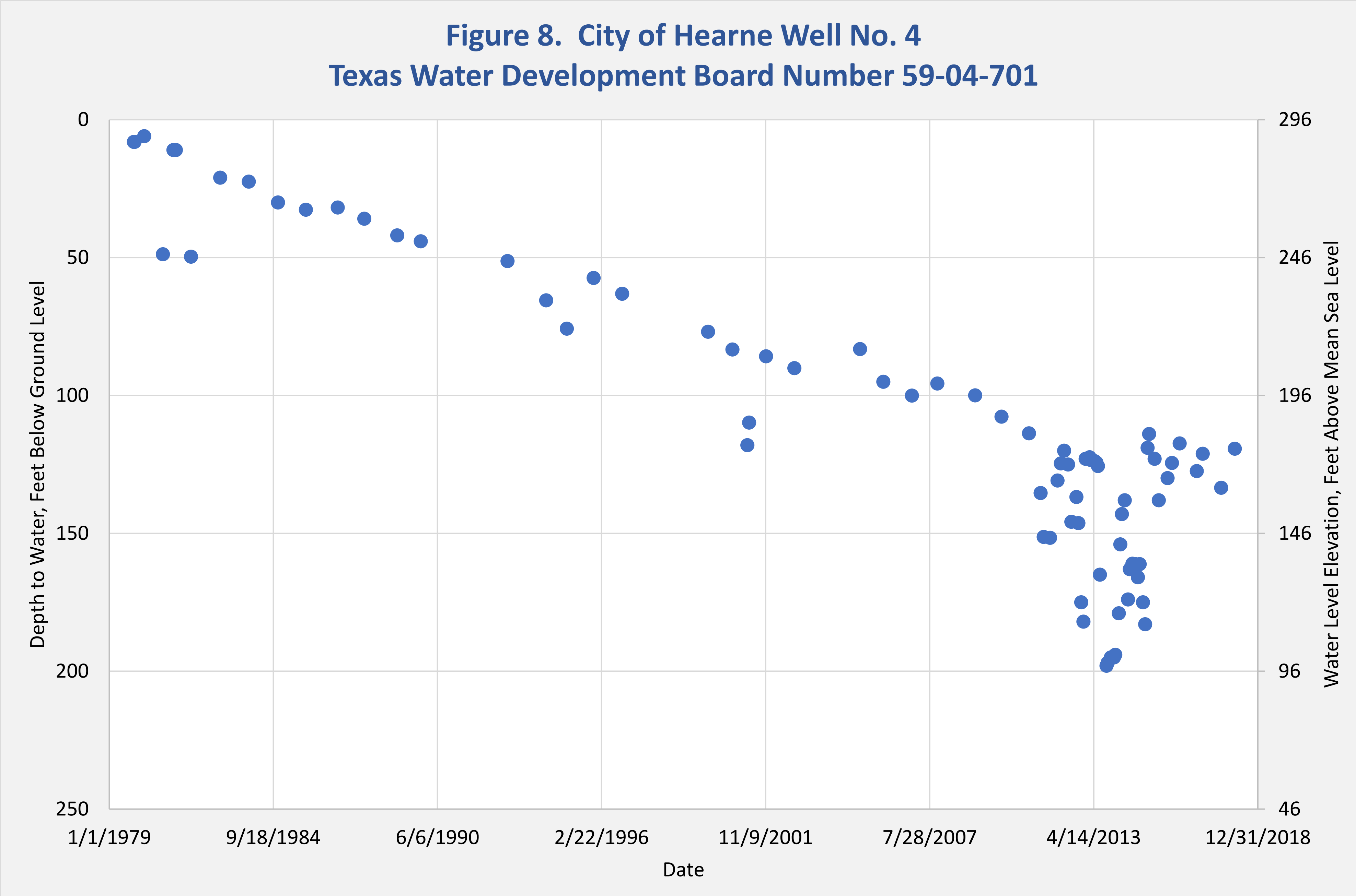
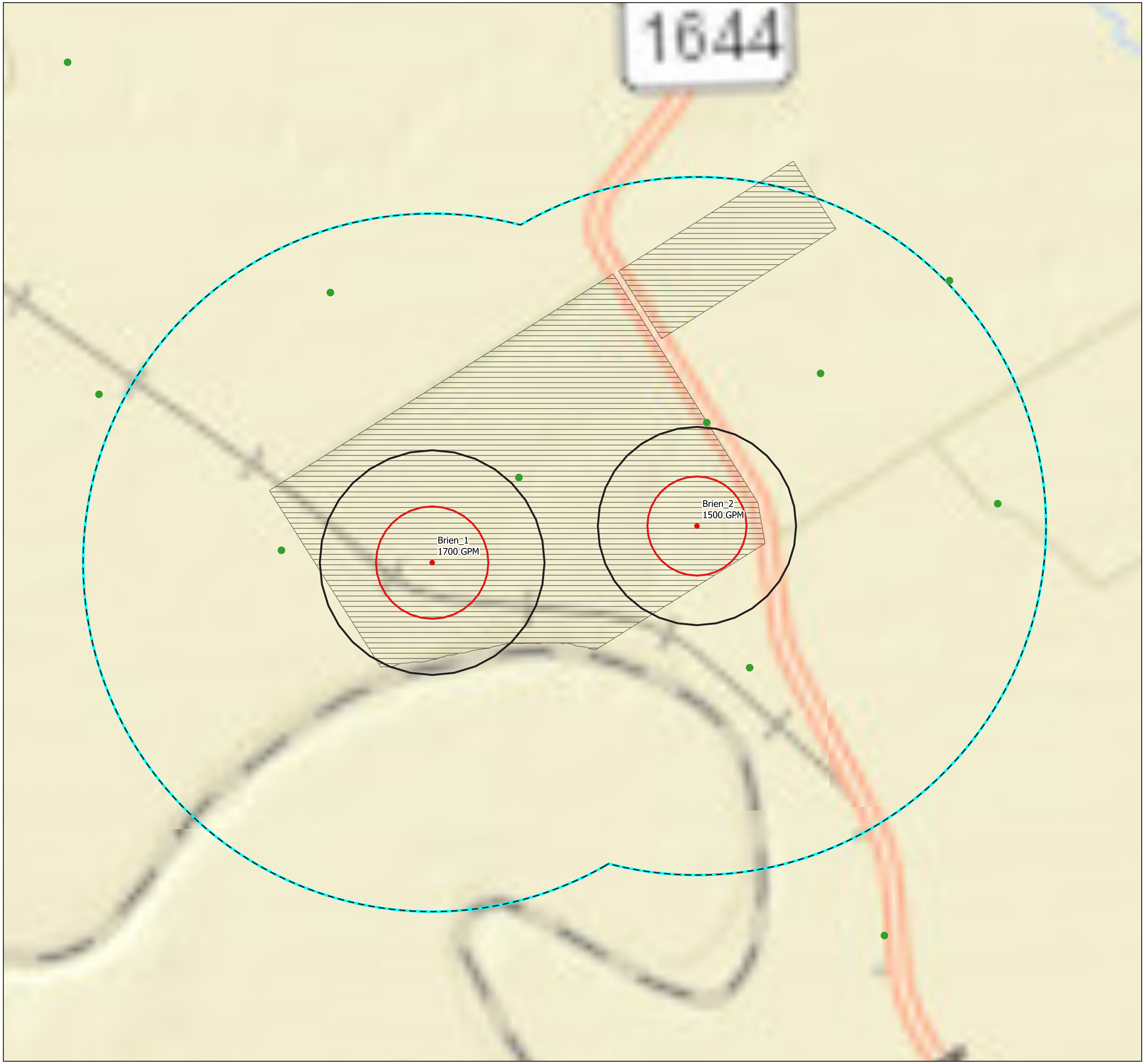


Figure 8. City of Hearne Well No. 4
Texas Water Development Board Number 59-04-701
0
50
100
150
200
250
296
246
196
146
96
46
Depth to Water, Feet Below Ground Level
Water Level Elevation, Feet Above Mean Sea Level
1/1/1979
9/18/1984
6/6/1990
2/22/1996
11/9/2001
7/28/2007
4/14/2013
12/31/2018
Date



Brien Proposed Wells
Brien Property Boundary
1 Mile Well Buffer
BVGCD Registered Simsboro Wells
Simsboro

N

0 1,000 2,000 ft

Scale 1:12,000

Figure 9:
BVGCD Wells
Within 1 Mile

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ATTACHMENT 2 –
TABLES

Table 1. Simulated Drawdowns at Registered and Permitted Simsboro Wells Within a 5-Mile Radius

Registration or Permit Number	Latitude	Longitude	Well Depth	Aquifer	1 Year Analytical Drawdown, ft.	10 Year Analytical Drawdown, ft.	1 Year GAM Drawdown, ft.	10 Year GAM Drawdown, ft.
BVR-3106	30.962635	-96.662779	656	Simsboro	7.45	13.36	29.35	42.32
BVR-1773	30.962757	-96.659386	720	Simsboro	7.27	13.22	29.04	42.01
BVR-1811	30.979607	-96.726402	380	Simsboro	0.98	3.18	25.94	38.90
BVR-0060	30.902652	-96.624694	1193	Simsboro	4.70	12.23	28.66	41.63
BVR-1304	30.946609	-96.681066	560	Simsboro	12.07	17.75	34.75	47.73
BVDO-0134	30.916389	-96.694167	778	Simsboro	38.58	44.16	55.14	68.13
BVR-1018	30.918418	-96.685023	0	Simsboro	32.51	38.55	52.35	65.34
BVR-2975	30.952630	-96.670163	654	Simsboro	9.75	15.57	32.18	45.16
BVR-0900	30.974725	-96.660279	590	Simsboro	5.73	11.57	26.79	39.75
BVR-0846	30.958966	-96.674405	590	Simsboro	8.82	14.48	30.83	43.80
BVR-0023	30.953885	-96.688707	510	Simsboro	10.48	15.85	33.00	45.98
BVR-3043	30.956639	-96.690810	482	Simsboro	10.10	15.40	32.08	45.06
BVOP-0047	30.963442	-96.653281	660	Simsboro	6.42	12.44	27.82	40.79
BVR-0991	30.963396	-96.653204	640	Simsboro	6.42	12.44	28.35	41.32
BVHU-1025	30.931095	-96.747055	580	Simsboro	2.70	5.68	30.08	43.06
BVR-1283	30.936926	-96.741631	460	Simsboro	3.08	6.06	30.93	43.91
BVR-1894	30.958068	-96.691089	515	Simsboro	9.73	15.02	31.22	44.20
BVDO-0092	30.924837	-96.735858	530	Simsboro	7.44	11.29	32.79	45.77
BVR-2659	30.974381	-96.656316	470	Simsboro	5.76	11.64	26.56	39.52
BVR-1321	30.980449	-96.654839	550	Simsboro	4.93	10.76	26.07	39.03
BVR-3087	30.970848	-96.656708	600	Simsboro	5.93	11.82	27.07	40.03
BVR-3047	30.956323	-96.716640	485	Simsboro	6.94	10.86	30.82	43.80
BVR-3044	30.953124	-96.670470	660	Simsboro	9.75	15.57	32.18	45.16
BVR-3086	30.968145	-96.649334	627	Simsboro	5.60	11.65	27.00	39.97
BVR-0434	30.913686	-96.705731	400	Simsboro	27.25	32.36	48.30	61.29
BVR-1506	30.870019	-96.669033	1250	Simsboro	4.81	12.02	30.44	43.41
BVR-3049	30.957417	-96.667598	620	Simsboro	8.62	14.50	30.32	43.29
BVR-1574	30.947231	-96.688573	530	Simsboro	12.56	17.97	35.13	48.11
BVOP-0010	30.976071	-96.672705	683	Simsboro	6.61	12.25	27.33	40.30
BVOP-0011	30.975810	-96.672639	738	Simsboro	6.61	12.25	27.33	40.30
BVOP-0012	30.975019	-96.673443	661	Simsboro	6.61	12.25	27.46	40.43
BVR-0380	30.867554	-96.636420	1100	Simsboro	2.41	10.20	27.08	40.04
BVDO-0055	30.920306	-96.679457	840	Simsboro	29.48	35.72	46.46	59.45
BVDO-0090	30.934265	-96.715276	656	Simsboro	12.73	17.37	35.78	48.76
BVDO-0091	30.929765	-96.725049	565	Simsboro	10.76	15.14	35.36	48.34
BVR-0985	30.923989	-96.673093	735	Simsboro	21.17	27.54	40.97	53.95
BVR-0294	30.984500	-96.668067	340	Simsboro	5.46	11.10	25.61	38.57
BVR-3048	30.966589	-96.664572	667	Simsboro	7.05	12.88	28.72	41.69
BVOP-0051	30.964499	-96.707475	440	Simsboro	7.86	12.47	29.94	42.92
BVR-1699	30.966006	-96.706046	420	Simsboro	8.30	13.13	29.25	42.22
BVDO-0254	30.886626	-96.658433	0	Simsboro	7.85	15.59	32.85	45.83
BVDO-0255	30.903856	-96.662094	0	Simsboro	15.58	23.06	36.96	49.95
BVDO-0256	30.919825	-96.641585	0	Simsboro	8.27	15.68	31.74	44.72
BVHU-1058	30.896850	-96.677267	930	Simsboro	18.96	25.59	40.16	53.15
BVHU-1058A	30.866028	-96.689233	1095	Simsboro	5.32	11.74	30.87	43.85
BVHU-1058B	30.867349	-96.678991	1090	Simsboro	5.12	12.00	30.56	43.54
BVHU-1058C	30.870200	-96.668713	1100	Simsboro	5.19	12.39	30.44	43.41
BVHU-1058D	30.873824	-96.658706	1131	Simsboro	4.79	12.35	30.28	43.25
BVHU-1058E	30.876867	-96.649833	1175	Simsboro	4.21	11.96	29.88	42.85
BVHU-1058F	30.877300	-96.667783	1065	Simsboro	6.27	13.55	31.88	44.86
BVHU-1058G	30.898588	-96.645434	964	Simsboro	7.62	15.22	32.30	45.28
BVHU-1058H	30.889917	-96.671117	979	Simsboro	12.01	19.02	35.93	48.92
BVHU-1058J	30.914647	-96.671122	875	Simsboro	24.75	31.56	41.30	54.28
BVHU-1058K	30.924333	-96.702966	720	Simsboro	21.89	27.16	44.22	57.21
BVHU-1058L	30.920417	-96.714283	691	Simsboro	16.64	21.44	41.75	54.73
BVR-0240	30.881350	-96.670083	1065	Simsboro	8.25	15.40	33.16	46.14
BVR-3042	30.963100	-96.673970	450	Simsboro	8.13	13.83	30.07	43.05
BVR-3190	30.906118	-96.605514	1225	Simsboro	2.86	10.36	25.82	38.78
BVHU-0013	30.885707	-96.619420	1441	Simsboro	2.82	10.58	26.64	39.60
BVR-1845	30.871595	-96.637759	1100	Simsboro	2.78	10.56	27.92	40.89
BVR-1396	30.966266	-96.661967	660	Simsboro	6.92	12.78	28.72	41.69
BVR-0344	30.985106	-96.668827	340	Simsboro	5.46	11.10	25.61	38.57
BVR-1479	30.871121	-96.634251	1080	Simsboro	2.62	10.41	27.45	40.42
BVR-3187	30.909000	-96.605579	1270	Simsboro	2.91	10.37	25.85	38.81

ATTACHMENT 3 –
REFERENCE MATERIALS

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Ecb Calvert Bluff Formation
Esb Simsboro Formation
Eh Hooper Formation

Base map adapted from Army Map Service base maps. 10,000-meter Universal Transverse Mercator grid, zones 14 and 15. Cartography by John T. Ames under the supervision of Richard L. Dillon.

by W. B. Ayers, Jr., and Amy H. Lewis

SCALE
5 0 5 10 15 20 Mi
5 0 5 10 15 20 25 30 Km

PLATE 2. WILCOX STRUCTURE MAP

1985

Generalized structure map drawn on the base of the Wilcox Group (sea-level datum) shows regional dip to the southeast. The angle of dip increases from the northeast (1/2°) to the southwest (2°). Major structural elements are the Mexia Fault Zone, the Elkhart Graben, salt structures in Anderson and Freestone Counties, and the East Texas Basin (fig. 2).

QAa1984-2

SCALE 5 0 5 10 15 20 Mi; 5 0 5 10 15 20 25 30 Km

Base map adapted from Army Map Service base maps. 10,000-meter Universal Transverse Mercator grid, zones 14 and 15. Cartography by John T. Ames under the supervision of Richard L. Dillon.

by W. B. Ayers, Jr., and Amy H. Lewis

PLATE 3. WILCOX ISOPACH MAP AND LOCATIONS OF CROSS SECTIONS

1985

The Wilcox Group thickens from less than 1,000 ft (305 m) on the north to more than 3,500 ft (1,065 m) at the basinward margin of the study area. The local increase in thickness in central Lee County is attributed to syndepositional movement along the Mexia Fault Zone (fig. 2 and pl. 2).

QAe1984-3

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Base map adapted from Army Map Service base maps. 10,000-meter Universal Transverse Mercator grid, zones 14 and 15. Cartography by John T. Ames under the supervision of Richard L. Dillon.

by W. B. Ayers, Jr., and Amy H. Lewis

PLATE 5. SIMSBORO FORMATION, MAJOR-SAND ISOLITH MAP

1985

Dip-elongate major sand bodies (sands 40 ft [12 m] or thicker) in the shallow subsurface are straight; they bifurcate, displaying a deltaic geometry, in Fayette County and terminate in small delta lobes in Houston County. When projected updip, sand-body trends southwest of Leon County (Rockdale fluvial-deltaic system) intersect at a broad locus in Coryell County (fig. 3). Sand-body trends in Anderson and Houston Counties (secondary fluvial system with sources to the north and northeast) are directed into the axis of the East Texas Basin (fig. 2 and pl. 2).

QAe1984-5

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The Simsboro Formation becomes muddier basinward. Thick lignite seams are found in the lower Calvert Bluff Formation as well as basinward in muddy intervals of the Simsboro Formation (well log Q44). The lower tongue of the Simsboro Formation is of local extent and was not included in the Simsboro lithofacies map (pl. 5). See plate 3 for location.

Cartography by John T. Ames under the supervision of Richard L. Dillon.

by W. B. Ayers, Jr., and Amy H. Lewis

PLATE 8. CROSS SECTION C-C′
1985

QAe1984-8

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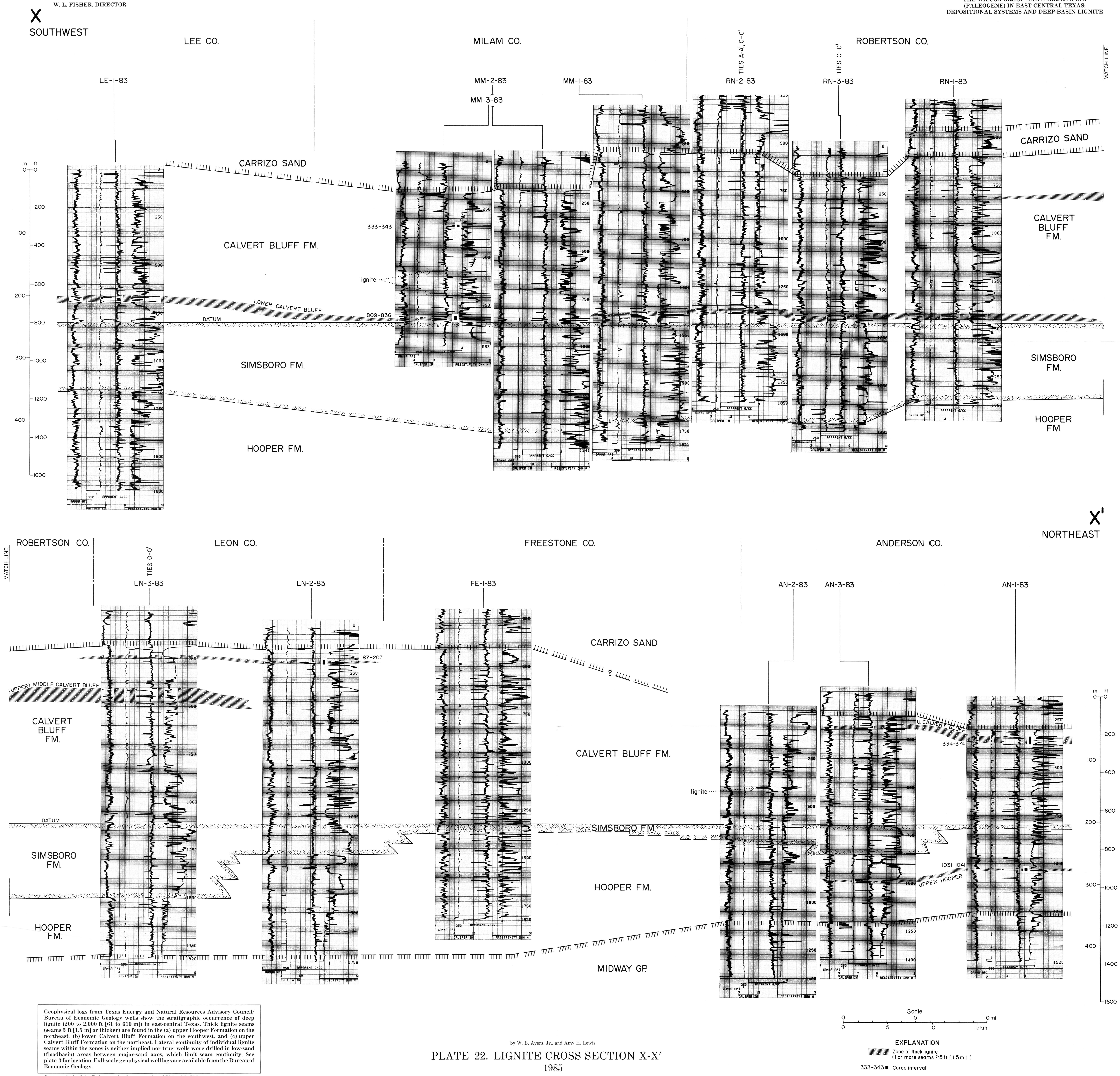
PLATE 22
THE WILCOX GROUP AND CARRIZO SAND (PALEOGENE) IN EAST-CENTRAL TEXAS: DEPOSITIONAL SYSTEMS AND DEEP-BASIN LIGNITE



Geophysical logs from Texas Energy and Natural Resources Advisory Council/ Bureau of Economic Geology wells show the stratigraphic occurrence of deep lignite (200 to 2,000 ft [61 to 610 m]) in east-central Texas. Thick lignite seams (seams 5 ft [1.5 m] or thicker) are found in the (a) upper Hooper Formation on the northeast, (b) lower Calvert Bluff Formation on the southwest, and (c) upper Calvert Bluff Formation on the northeast. Lateral continuity of individual lignite seams within the zones is neither implied nor true; wells were drilled in low-sand (floodbasin) areas between major-sand axes, which limit seam continuity. See plate 3 for location. Full-scale geophysical well logs are available from the Bureau of Economic Geology.

Cartography by John T. Ames under the supervision of Richard L. Dillon.

by W. B. Ayers, Jr., and Amy H. Lewis

PLATE 22. LIGNITE CROSS SECTION X-X'

1985

Ecb Calvert Bluff Formation
Esb Simsboro Formation
Eh Hooper Formation

Base map adapted from Army Map Service base maps. 10,000-meter Universal Transverse Mercator grid, zones 14 and 15. Cartography by John T. Ames under the supervision of Richard L. Dillon.

by W. B. Ayers, Jr., and Amy H. Lewis

SCALE
5 0 5 10 15 20 Mi
5 0 5 10 15 20 25 30 Km

PLATE 28. SIMSBORO OVERBURDEN MAP

1985

The depth to the top of the Simsboro (Simsboro overburden) provides an estimate of the depth required to test the entire lignite-bearing Calvert Bluff Formation.

QAe1984-28

ATTACHMENT 4 –
SELECTED REFERENCES

SELECTED REFERENCES

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