THORNHILL GROUP, INC.

Professional Hydrogeologists • Water Resources Specialists

July 6, 2023

Sandra C. Ryan Trust
13839 Zane Wallace Road
Hearne, Texas 77859

Bernadette C. Priestly Trust
13839 Zane Wallace Road
Hearne, Texas 77859

Re: Aquifer Evaluation Report –
Drilling and Production Permit Application for Four (4) New Simsboro Wells to be Completed on the Corpora Mumford Farm, Robertson County, Texas

Dear Ms. Ryan and Ms. Sloat:

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 the Sandra C. Ryan Trust and Bernadette C. Priestly Trust, herein referenced as Corpora, producing 1,940 acre-feet of water per year from four (4) proposed new production wells to be completed in the Simsboro aquifer on the property identified as Corpora Mumford Farm located in southwestern Robertson County (identified as "Property G" on Figure 1). 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 in the District, including permit applications and field-testing associated with several local landowners and nearby tracts. 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;

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- Evaluating potential interference drawdown from other pumpage in the area and predicting long-term water levels in the proposed well-field area;
- 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 50-acre Mumford tract owned by Corpora. Proposed well identifications, coordinates, and estimated land-surface elevations in feet above mean sea level (MSL) as estimated from Google Earth are as follows:

Well Identification	Latitude*	Longitude*	Est. Land Surface Elevation
14	30° 44’ 38.58” N	96° 32’ 35.30 W	245.41
15	30° 45’ 00.58” N	96° 31’ 53.10 W	245.08
16	30° 44’ 45.69” N	96° 32’ 21.40 W	246.06
17	30° 44’ 54.00” N	96° 32’ 05.50 W	245.08

*Coordinate system is NAD83

The proposed wells are located between Farm Road 50 and United States Highway 190/State Highway 6 (HW6) just north of Mumford-Benchley Road. The wells are located between 9.7 and 9.9 miles south-southeast from the center of the City of Hearne and are between 3.0 and 4.2 miles essentially due west from the nearest City of Bryan water well.

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
14	375 gpm	485 acre-feet
15	375 gpm	485 acre-feet
16	375 gpm	485 acre-feet
17	375 gpm	485 acre-feet
Total	**1,500 gpm**	**1,940 acre-feet**

The proposed well sites are spaced between 1,270 and 1,620 feet apart, and the nearest property lines are more than 375 feet from proposed well locations. Therefore, the proposed well locations comply with the BVGCD rules regarding spacing between wells and allocation of acreage per well.

Hydrogeologic Conditions and Aquifer Characteristics

Surface Geologic Setting

Figure 2 shows that the entire Corpora Mumford Farm tract is located atop the Brazos River Alluvium aquifer, a Minor Aquifer in Texas. The Sparta aquifer occurs immediately below the Brazos River Alluvium and is possibly present beneath much of the subject property. The Queen City and Carrizo aquifers also occur beneath the Mumford Farm property.

Figure 3 is a Surface Geology Map illustrating that the entire Corpora Mumford Farm tract lies atop Brazos River alluvial sediments, which were deposited in the ancient and present-day floodplains of the Brazos River. As noted above the Sparta subcrops beneath the Brazos River Alluvium across the Corpora Mumford Farm. The Weches Sand underlies the Sparta and separates the Sparta from the underlying Queen City. The Reklaw Formation separates the Queen City Formation from the formations that comprise the Carrizo-Wilcox Aquifer. 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 shallower to deeper (i.e., younger to older), the Carrizo Sand, the Calvert Bluff Formation, the Simboro Sand, and the Hooper Formation.

The Corpora Mumford Farm lies within the ancient (and likely current) floodplain of the Brazos River; therefore, land surface topography is relatively flat and ranges in elevation between 245 and 255 feet above mean sea level (MSL). Geologic units dip generally from

northwest to southeast and dip angles generally increase downdip and with depth in the geologic section. From slightly southwest of Hearne to the Robertson-Brazos county boundary near the Brazos River, the dip of the base of the Wilcox Group is approximately 116 feet per mile based on BEG mapping (see Attachment 3). There are no faults mapped at land surface across the subject property. Based on available structure geology maps and GAM datasets estimates of the elevations of thicknesses of the hydrostratigraphic layers beneath the Corpora Mumford Farm are summarized in the table below:

Layer	Elevation	Depth	Thickness
Land Surface	250 ft AMSL	Not Applicable	Not Applicable
Base of Alluvium	180 to 220 feet AMSL	30 to 70 feet	30 to 70 feet
Base of Sparta	160 feet AMSL	95 feet	55 feet
Base of Weches	120 feet AMSL	135 feet	35 feet
Base of Queen City	170 feet BMSL	425 feet	290 feet
Base of Reklaw	265 feet BMSL	520 feet	95 feet
Base of Carrizo	535 feet BMSL	790 feet	270 feet
Base of Calvert Bluff	1,450 feet BMSL	1,700 feet	875 feet
Base of Simsboro	1,930 feet BMSL	2,180 feet	520 feet
Base of Hooper	2,750 feet BMSL	3,000 feet	1,015 feet

Figure 3 and Figure 4 show locations for registered and permitted BVGCD wells within five (5) miles of the subject proposed wells reportedly completed to produce from the Simsboro aquifer. Due to the size of the subject property this Hydrogeological Assessment contemplates only the Simsboro aquifer being tapped by proposed Corpora Mumford Farm wells. There are 16 wells completed into the Simsboro aquifer within five (5) miles of the subject wells.

Simsboro Aquifer Conditions and Hydraulic Parameters

Due to the relatively small size of the Corpora Mumford Farm property, the conditions in the Simsboro aquifer will likely not vary considerably from well to well. Based on GAM datasets and geologic maps and cross sections from the University of Texas Bureau of Economic Geology (BEG), the elevation of the top of the Simsboro Sand ranges from 1,410 to 1,460 feet below MSL across the Corpora Mumford Farm property (see Attachment 3). The closest portion of the Simsboro outcrop is more than 15 miles to the northwest. Based on the geologic dip and land surface elevation, the depth to the top of the Simsboro should be approximately 1,700 feet BGL across the Corpora Mumford Farm property. Attachment 4 provides selected well records for City of Bryan water wells located within five (5) miles of the subject property. The net sand thickness of the Simsboro ranges from 400 to 500 feet across the subject property based on BEG maps (see Attachment 3).

TGI extracted hydraulic data for the subject property and nearby areas from the newly released version of the groundwater availability model (GAM) for the Central Portion of the Sparta, Queen City, and Carrizo-Wilcox Aquifers (Young, et al., 2018). The following table provides a summary comparison of average estimated parameters extracted from the GAM datasets to those derived by TGI for the local Simsboro aquifer at the proposed well sites:

Parameter	Updated GAM Estimates Range	TGI Estimates
Sand Thickness	500 to 525 feet	400 to 500 feet
Hydraulic Conductivity	290 to 300 gpd/ft^2	200 to 250 gpd/ft^2
Transmissivity	145,000 to 157,500 gpd/ft	80,000 to 125,000 gpd/ft
Storage Coefficient	3 x 10^{-4}	10^{-4}

Figure 6 provides a hydrograph illustrating water-level measurements collected for nearby TWDB/BVGCD Simsboro monitoring well (State Well No. 59-21-209) which is located near the Lake Bryan and is about 5 miles southeast from the nearest proposed Corpora Mumford Farm well (see Figure 5). The water level in 1976 was about 126feet below land surface and has declined by about 235 feet over almost 50 years. The current water-level elevation at 59-21-209 is approximately 6.89 feet above MSL, and the corresponding depth to water is about 361.11 feet BGL. Water-level data presented by Advanced Groundwater Solutions (AGS) indicate the proposed wells are within a cone of depressurization formed by drawdown primarily due to pumping in the City of Bryan and City of College Station well fields. Based on current pumping conditions in the aquifer, water levels will probably rise between 275 and 325 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.

Projected Effects of Proposed Pumping

The total proposed maximum combined pumping rate from the four (4) proposed wells is 1,500 gpm. The annual allocation of 1,936 acre-feet will result in an average combined pumping rate of 1,200 gpm. Therefore, the independent impacts due to pumping will be relatively minor.

The immediate impacts from production will be drawdown at the pumping wells. 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.

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 for continuous pumping periods of one (1) year and 10 years. Figure 7 and Figure 8 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.

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 the GAM runs predicted less than 1 foot of drawdown after one (1) year, and a total of between 1 and 2 feet after 10 years. The GAM simulated approximately 2 feet of drawdown at the nearest City of Bryan well.

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.

Figure 9 and Figure 10 provide the Theis-modeled drawdown contours for pumping periods of one (1) year and 10 years, respectively. Table 1 modeled drawdown at specific registered and permitted Simsboro well sites after one (1) year and 10 years of continuous pumping, respectively. Assuming properly completed and highly efficient production wells, the Theis model predicted drawdown in the proposed pumping wells of between 15 and 17 feet after one (1) year of continuous pumping, with an additional 1 to 2 feet of drawdown at each well with continuous pumping for 10 years. The Theis calculation resulted in one-year interference drawdown of about 10 feet at the nearest City of Bryan well. The analytical model predicted drawdown after 10 years of continuous pumping is 11 feet at the Bryan well. Predicted drawdown at Simsboro wells between one (1) and five (5) miles from the proposed wells will be less than 14 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;
- 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 again assist you in our specialty. If you have any questions, please call.

Sincerely,
THORNHILL GROUP, INC.

Michael R. Thornhill, P.G.
President

The seal appearing on this document was authorized by Michael R. Thornhill, P.G. on July 5, 2023.

Attachments