



THORNHILL GROUP, INC.

Professional Hydrogeologists • Water Resources Specialists

July 21, 2023

Mr. John Lutz
RHF, LLC
3005 West Farm Road 979
Calvert, Texas 77837

Re: Aquifer Evaluation Report –
Drilling/Production Permit Applications for Five (5) New Simsboro Wells to be
Completed on the Red Hill Farms Property, Robertson County, Texas

Dear Mr. Lutz:

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 RHF, LLC herein referenced as RHF, completing five (5) new wells completed into the Simsboro Aquifer underlying the Red Hill Farms Property in Robertson County, Texas and producing an annual allocation of 8,130 acre-feet per year.

The subject Lutz property encompasses approximately 927 contiguous acres of land generally located about 2.6 miles north of the center of downtown Hearne, Texas. Red Hill Farms property extends from State Highway 6 (SH 6) at its eastern boundary. The western boundary of the subject property is about 1.3 miles east of Farm Road 1644 (FM 1644). The southern boundary of the property is as close as 0.75 mile from Farm Road 485 (FM 485) and the northern property line is within 1.25 miles of County Road 106 (CR 106). Red Hill Farms property is about 5.5 miles south-southeast of the City of Calvert. The Little Brazos River runs essentially north-south through the center portion of the subject farm.

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. 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;
- ❖ 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 Locations and Permit Pumping Rates

Figure 1 illustrates the locations for the proposed Simsboro wells on the Red Hill Farms property. 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	Longitude*	Latitude*	Est. Land Surface Elevation
No. 1	96°37'18.21"W	30°54'40.84"N	330
No. 2	96°38'22.95"W	30°53'55.10"N	273
No. 3	96°38'46.50"W	30°53'38.11"N	274
No. 4	96°38'23.23"W	30°54'19.03"N	315
No. 5	96°37'43.58"W	30°54'33.43"N	345

*Coordinate system is NAD83 State Plane Texas Central (feet)

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

<u>Well Identification</u>	<u>Maximum Pumping Rate</u>	<u>Annual Permit Allocation</u>
No. 1	1,300 gpm	1,678 acre-feet
No. 2	1,700 gpm	2,194 acre-feet
No. 3	1,350 gpm	1,742 acre-feet
No. 4	1,150 gpm	1,484 acre-feet
No. 5	800 gpm	1,032 acre-feet
Total Annual Allocation		8,130 acre-feet

The radii attributed to the pumping rates for each of the wells lie within the Lutz property boundaries. The nearest known existing well completed into the Simsboro Aquifer is mapped by the BVGCD right on the Lutz property boundary and is more than 675 feet from the nearest proposed Simsboro well. The landowners will request in the permit application an internal waiver per BVGCD Rule 6.2 to allow for slight overlap between the radii of Well No. 2 and Well No. 3 (less than 400 feet) and between Well No. 2 and Well No. 4 (less than 600 feet). The proposed overlap of well radii will result in an additional 480 gpm of average combined pumping rate. As will be discussed later in this report, the slight overlap will have minimal effects on interference drawdown between the proposed Lutz wells and will not significantly change impacts on surrounding wells. With an approved waiver, 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 illustrates that the entire Red Hill Farms property is underlain by downdip portions of the Carrizo-Wilcox Aquifer, a Major Aquifer delineated by the TWDB. Figure 3 shows that essentially the western half of the Lutz property lies atop the Brazos River Alluvium Aquifer, a Minor Aquifer in Texas. There are no other Major or Minor aquifers beneath the subject property.

Figure 4 is a Surface Geology Map reiterating that essentially the western half of the Lutz Farm property lies atop Brazos River alluvial and terrace deposits. The BEG infers the subcrop of the Carrizo Sands near the subject property (BEG, 1985). Apparently, the Carrizo subcrops the Brazos River alluvial and terrace deposits across much of the property. However, it is possible that the Reklaw occurs in the south-southeastern parts of the property and the

Calvert Bluff subcrops the alluvium in the northern parts of the farm. Regardless, the Reklaw and Carrizo formations, to the extent they occur, are relatively thin and shallow. Essentially, the entire local section of the Wilcox Group including, from younger to older, the Calvert Bluff, Simsboro, and Hooper formations occur beneath the subject property.

Due to the inherent nature of the floodplain and farming operations the topography across the western half of the Red Hill Farms property is relatively flat with land surface elevations ranging from 268 to 287 feet above mean sea level (MSL). Most of the western part of the property is around 275 feet above MSL. Immediately east of the Little Brazos River, a prominent rise in topography occurs with the elevation reaching as high as 361 feet AMSL. Most of the eastern half of the subject property is at an elevation of approximately 330 feet above MSL.

Geologic units dip generally from the north-northwest to the south-southeast and dip angles typically increase with depth in the geologic section. Locally, the dip along the base of the Wilcox Group is between 80 and 90 feet per mile (see Attachment 3). There are no faults mapped locally at land surface across the subject property. Based on available structural geology maps and GAM datasets estimates of the elevations and thicknesses of hydrostratigraphic layers beneath the Lutz property are summarized in the table below:

Layer	Elevation	Depth	Thickness
Land Surface	270 to 360 feet AMSL	Not Applicable	Not Applicable
Base of Alluvium	200 to 210 feet AMSL	60 to 70 feet BGL	60 to 70 feet
Base of Reklaw	165 to 195 feet AMSL	105 to 165 feet BGL	45 to 150 feet
Base of Carrizo	130 to 140 feet AMSL	140 to 230 feet BGL	30 to 65 feet
Base of Calvert Bluff	600 to 685 feet BMSL	870 to 1,045 feet BGL	745 to 820 feet
Base of Simsboro	1070 to 1165 feet BMSL	1,340 to 1,525 feet BGL	460 to 480 feet
Base of Hooper	1,555 to 1,660 feet BMSL	1,825 to 2,020 feet BGL	490 to 495 feet

[Aquifer Conditions and Hydraulic Parameters](#)

This report focuses on proposed permitted production from the Simsboro Aquifer. The top of the Simsboro Formation is estimated to be at depths of between 875 and 1,050 feet BGL based on GAM datasets and BEG mapping (BEG, 1985). Net sand thickness maps indicate productive sands of between 400 and 450 feet, with sands potentially as thick as 500 feet. As most of the Simsboro Formation is comprised of sand, it is likely that Simsboro wells on the Red Hill Farms property will be between 1,350 and 1,550 feet deep. Figure 5 illustrates locations for registered and permitted Simsboro wells within five (5) miles of the proposed Lutz wells. Attachment 4 provides available well records for selected nearby Simsboro wells. Figure 6 shows locations for registered and permitted Simsboro wells within one (1) mile of the proposed Lutz wells locations. Figure 6a and Figure 6b provide the locations for Simsboro

wells within one (1) mile of the proposed well locations on maps with a scale of 1"=1,000 feet per BVGCD Rules. One historic use Simsboro well now owned by Upwell/Brazos Valley Farms is located adjacent to the Lutz property line and there are three (3) additional Simsboro wells reportedly located within one (1) mile of the proposed Lutz wells.

TGI extracted hydraulic data for the subject property and nearby areas from the currently-used 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 of estimated parameters extracted from the GAM datasets to those derived by TGI for the local Carrizo and Simsboro aquifers across the Astin Farms property:

<u>Parameter</u>	GAM	
	<u>Estimates Range</u>	<u>TGI Estimates*</u>
Sand Thickness	460 to 480 feet	400 to 450 feet
Hydraulic Conductivity	96 to 134 gpd/ft ²	125 to 175 gpd/ft ²
Transmissivity	44,120 to 64,200 gpd/ft	50,000 to 78,750 gpd/ft
Storage Coefficient	1.21 x 10 ⁻⁴ to 1.29 x 10 ⁻⁴	10 ⁻⁴

Figure 7 provides a hydrograph illustrating water-level measurements collected for nearby TWDB/BVGCD Simsboro monitoring well (BVGCD No. BVHU-0013, TWDB No. 59-04-701) which the City of Hearne Well No. 4 and is located within approximately 7,600 feet of the nearest proposed Lutz well (see Figure 5). Water levels in the well declined by between 110 and 140 feet from 1979 to 2021. AGS reported artesian head decline of 81 feet between 1999 and 2023 in TWDB Well No. 59-04-701 (AGS, May 11, 2023). The AGS map shows between 60 and 70 feet of artesian head decline in the Simboro beneath the Lutz property from 2000 to 2023. Based on the updated data provided by AGS, current depths to water on the subject property will likely range from 150 to 250 feet BGL. Therefore, water levels will probably rise between 600 and 900 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 immediate impacts from production will be artesian head decline (i.e., 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. Pumping from the Simsboro aquifers will cause some vertical leakage from overlying and underlying zones. While leakage can serve to dampen drawdown due to boundary effects and inflows, the leakage will likely not result in any identifiable water-level changes or water-quality variations in any of the overlying or underlying zones.

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 from the Simsboro Aquifer. Red Hill Farms has requested a permit allocation for the Simsboro Aquifer of 8,130 acre-feet per year. Figure 8 and Figure 9 provide maps showing modeled drawdown contours after one (1) year and 10 years of pumping at the maximum authorized rate, respectively. Table 1 and Table 2 provide modeled drawdown at specific registered and permitted Simsboro well sites after one (1) year and 10 years of continuous pumping, respectively. The GAM predicts that Simsboro artesian pressure will decline by as much as 50 feet immediately adjacent to the Lutz Farms property and from 27 to 36 feet one (1) mile from the proposed wells within the first year of pumping. Declines during the initial year are simulated to be less than 10 to 13 feet five (5) miles from the wells. After 10 years of pumping the proposed Simsboro wells drawdown (i.e., artesian head decline) will be as much as 55 feet adjacent to the subject property and range from 30 to 40 feet one (1) mile from the well locations. Simulated drawdown ranges from less than 10 to 18 feet five (5) miles from the wells. 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. Local wells will continue to maintain a few hundred feet of artesian head.

Drawdown Simulations Using Analytical Modeling

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 previous 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 producing aquifers, 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 fields.

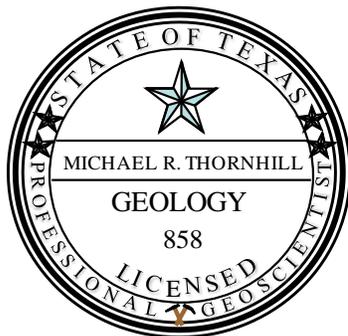
Figure 10 and Figure 11 provide drawdown contours from Theis calculations due to pumping the Simsboro wells proposed for Red Hill Farms after one (1) and 10 years, respectively. Table 1 and Table 2 provide drawdown values at specific well locations. The analytical model calculated artesian pressure declines of as much as 80 feet adjacent to the subject property after one (1) year of pumping. Drawdown at a distance of one (1) mile was modeled to be 57 to 68 feet after the first year of pumping. At five (5) miles away the drawdown calculation resulted in 37 to 41 feet after a year. After 10 years the calculated drawdown at the Red Hill Farms property line is as much as 90 feet and the drawdown at a distance of a mile was modeled to be 65 to 74 feet. The drawdown at five (5) miles was modeled to be between 44 and 47 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 for the Red Hill Farms property 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 local Simsboro Aquifer will stay completely full and groundwater in the formation will remain under considerable artesian pressure within the well-field areas 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.



The seal appearing on this document was authorized by Michael R. Thornhill, P.G. on July 21, 2023.

Attachments

Sincerely,
THORNHILL GROUP, INC.

A handwritten signature in black ink that reads "Michael R. Thornhill".

Michael R. Thornhill, P.G.
President