THORNHILL GROUP, INC.

Professional Hydrogeologists • Water Resources Specialists

July 26, 2023

Mr. Jake Burnside, Manager
Burnside Investments, Inc.
15670 Union Bend
Hearne, Texas 77859

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

Dear Mr. Burnside:

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 Burnside Investments, Inc., herein also referenced as Burnside, completing five (5) new wells into the Simsboro Aquifer underlying the Burnside properties in Robertson County, Texas and producing an annual allocation of 9,189 acre-feet per year.

The subject Burnside Investment properties encompasses approximately 1,155 acres of land located about six (6) miles south-southwest from the downtown area of the City of Hearne. The property is approximately 2.3 miles south of State Highway 190/State Highway 79 (SH 190/SH 79) and the southeastern boundary of the property is adjacent to the intersection of Farm Road 50 (FM 50) and Muse Road. Muse Road crosses the northern one-third of the subject property in an east-west direction. The western boundary of the Burnside property is the Brazos River. Figure 1 provides the location of the subject property.

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 Burnside 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	Latitude*	Longitude*	Est. Land Surface Elevation
No. 1	30°48’08.78”N	96°37’00.89”W	262 feet AMSL
No. 2	30°47’49.16”N	96°37’36.52”W	265 feet AMSL
No. 3	30°47’28.54”N	96°38’04.10”W	264 feet AMSL
No. 4	30°47’13.23”N	96°38’35.64”W	253 feet AMSL
No. 5	30°48’26.00”N	96°36’27.34”W	268 feet AMSL

*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:

Well Identification	Maximum Pumping Rate	Annual Permit Allocation
No. 1	1,800 gpm	2,323 acre-feet
No. 2	1,800 gpm	2,323 acre-feet
No. 3	1,300 gpm	1,678 acre-feet
No. 4	1,400 gpm	1,807 acre-feet
No. 5	820 gpm	1,058 acre-feet
Total Annual Allocation		**9,189 acre-feet**

The radii attributed to the pumping rates for each of the proposed Simsboro wells lie within the Burnside property boundaries. The nearest known existing well completed into the Simsboro Aquifer as mapped by the BVGCD is 2.75 miles due north of the nearest proposed Burnside Simsboro well. The proposed well locations comply with the BVGCD rules regarding spacing between wells and allocation of acreage per well.

Hydrogeologic Conditions and Aquifer Characteristics

Geologic Setting

Figure 2 illustrates that the entire Burnside Property is underlain by downdip portions of the Carrizo-Wilcox Aquifer, a Major Aquifer delineated by the TWDB. Figure 3 shows that the full extent of the subject Burnside property lies atop the Brazos River Alluvium Aquifer, a Minor Aquifer in Texas. The Queen City subcrops the Brazos River Alluvium across the Burnside Investments property. The are no other Major or Minor aquifers beneath the subject property.

Figure 4 is a Surface Geology Map illustrating that the entire extent of the subject Burnside land lies atop the Brazos River Alluvium deposits. The surface geology maps shows that the Queen City Formation (unconformably) underlies the alluvial and terrace deposits across the subject property. Therefore, complete local thicknesses of the Reklaw, Carrizo, Calvert Bluff, Simsboro, and Hooper formations are present at depth beneath the Burnside property.

Due to the inherent nature of the floodplain and farming operations the topography across the Burnside Property is relatively flat with land surface elevations ranging generally from 250 to 270 feet above mean sea level (MSL). Geologic units dip generally from the north-northwest to the south-southeast. Locally, the dip along the base of the Wilcox Group is between 90 and 100 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 Burnside property are summarized in the table below:

Layer	Elevation	Depth	Thickness
Land Surface	250 to 270 feet AMSL	Not Applicable	Not Applicable
Base of Alluvium	200 to 215 feet AMSL	35 to 70 feet BGL	35 to 70 feet
Queen City	140 to 160 feet AMSL	90 to 130 feet BGL	20 to 95 feet
Base of Reklaw	30 to 80 feet AMSL	170 to 240 feet BGL	40 to 150 feet
Base of Carrizo	180 to 250 feet BMSL	430 to 520 feet BGL	190 to 350 feet
Base of Calvert Bluff	1,030 to 1,050 feet BMSL	1,280 to 1,320 feet BGL	760 to 890 feet
Base of Simsboro	1,420 to 1,590 feet BMSL	1,670 to 1,860 feet BGL	350 to 580 feet
Base of Hooper	2,200 to 2,260 feet BMSL	2,450 to 2,530 feet BGL	590 to 860 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 1,300 and 1,400 feet BGL based on GAM datasets and BEG mapping (BEG, 1985). Net sand thickness maps indicate productive sands with thicknesses of between 350 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 the proposed Simsboro wells on the Burnside land will be between 1,700 and 1,900 feet deep. Figure 5 illustrates locations for registered and permitted Simsboro wells within five (5) miles of the proposed Burnside wells. Per the BVGCD database, there are 10 Simsboro wells within five (5) miles of the proposed Burnside Simsboro wells. All of the wells are toward the north, northeast, and east. The nearest existing registered or permitted Simsboro well is 2.75 miles from the nearest proposed wells and all other existing Simsboro wells are more than three (3) miles away. Attachment 4 provides available well records for selected nearby Simsboro wells. Figure 6, Figure 6a, Figure 6b, and Figure 6c all illustrate that there are no existing registered or permitted Simsboro wells within one (1) mile of any of the proposed Burnside Simsboro wells, per the BVGCD database. The lack of nearby Simsboro wells is due to the rural population, depth of the Simsboro, and the availability of water from overlying aquifers such as the Queen City and the Carrizo.

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). Note that the units for hydraulic parameters are: gallons per day per square foot (gpd/ft^2) for hydraulic conductivity; gallons per day per foot (gpd/ft) for transmissivity; and, dimensionless for storativity (or storage coefficient). The following table provides a summary of estimated parameters

extracted from the GAM datasets to those derived by TGI for the local Simsboro aquifer across the Burnside property:

Parameter	GAM Estimates Range	TGI Estimates*
Aquifer/Sand Thickness	470 to 580 feet	350 to 500 feet
Hydraulic Conductivity	225 to 250 gpd/ft^2	175 to 225 gpd/ft^2
Transmissivity	105,000 to 140,000 gpd/ft	61,250 to 112,500 gpd/ft
Storage Coefficient	1.28 to 1.46 x 10^{-4}	10^{-4} (5 x 10^{-4})

The asterisk indicates that TGI utilized a storage coefficient representative of a slightly leaky artesian aquifer for the 10-year analytical model calculations.

Figure 7 provides two hydrographs illustrating water-level measurements collected for Texas Water Development Board (TWDB) and/or BVGCD Simsboro monitoring wells: the first chart illustrates data for TWDB Well No. 59-11-703 which is a City of Gause well located in Milam County and is 5.4 miles due west of the center of the Burnside property; and, the second well is TWDB Well No. 59-04-701 (BVHU-0013) which is the City of Hearne Well #4, also known as the POW well, which is 6.2 miles north-northeast from the center of the subject Burnside property. Water levels declined from 1979 to 1999 by approximately 70 feet in the Hearne POW Well. Additionally, Advanced Groundwater Solutions (AGS) reported that water-levels declined between 1999 and 2023 by 85 feet in the Gause Well and by 81 feet in Hearne's POW well (see AGS, May 11, 2023). AGS mapped water-level declines in the Simsboro of slightly more than 70 feet in vicinity of the Burnside Investments property from 1999 to 2023 (AGS, May 11, 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 1,050 and 1,250 feet above the top of the aquifer in the proposed 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. Burnside Investments, Inc. has requested a permit allocation for the Simsboro Aquifer of 9,189 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 proposed authorized annual 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 42 feet immediately adjacent to the Burnside property and from 27 to 35 feet one (1) mile from the proposed wells within the first year of pumping. Declines during the initial year are simulated to be 15 to 18 feet five (5) miles of the wells. After 10 years of pumping the proposed Simsboro aquifer drawdown (i.e., artesian head decline) will be as much as 48 feet adjacent to the subject property and range from 35 to 42 feet one (1) mile from the well locations. Simulated head declines range from 19 to 37 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. The local aquifer and any local wells completed in the Simsboro will continue to maintain hundreds of 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.

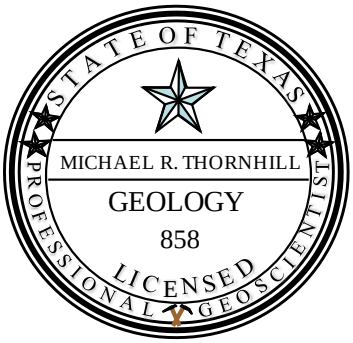
Figure 10 and Figure 11 provide drawdown contours from Theis calculations due to pumping the Simsboro wells proposed for the Burnside Property after one (1) and 10 years, respectively. Table 1 and Table 2 provide drawdown values at specific well locations. The analytical model calculated artesian pressure declines of as much as 65 feet in the Simsboro aquifer adjacent to the subject property after one (1) year of pumping. Drawdown at a distance of one (1) mile was modeled to be 50 to 60 feet after the first year of pumping. At five (5) miles away the drawdown calculation resulted in 35 to 38 feet of artesian-head decline after a year. After 10 years the calculated drawdown at the Burnside Property line is as much as 72 feet and the drawdown at a distance of a mile was modeled to be 57 to 65 feet. The drawdown at five (5) miles was modeled to be between 39 and 43 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 Burnside Investments 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.



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 26, 2023.

Attachments