4.0 Drawdown Predictions from Proposed Wells - Rule 8.4(B)(b)(B)(3)

Rule 8.4(B)(b)(B)(3) requires estimation of drawdown due to the proposed well. The rule requires both a regional assessment using the Central Carrizo Wilcox GAM and a local analysis of drawdown using an analytic tool approved by the District. In discussions with John Seifert (District consulting hydrogeologist), he agreed that we should report the drawdown from all four new wells pumped contemporaneously. The analyses requested are documented in the following two subsections.

4.1 Regional Drawdown Predicted Using the GAM

Rule 8.4(B)(b)(B)(3) requires that the applicant predict water level drawdown caused by the proposed wells pumping at the requested rate for one year and 10 years over an area defined by a radius of five miles surrounding the proposed new wells. The applicant must develop a drawdown map with a 10-foot contour interval. The model used for the regional drawdown impacts must be the most recent TWDB approved Carrizo-Wilcox GAM. The most recent version of the Central Carrizo-Wilcox GAM is a 2020 revision (Young and others, 2020) to the 2018 GAM (Young and others, 2018), found at the following link on the TWDB website (https://www.twdb.texas.gov/groundwater/models/gam/czwx_c/PE_Report_GMA12_final_october_2020_merge.pdf). This version of the model (v.3.02, 2020) was reviewed and approved by the Board staff and replaces version 3.01 (2018).

In the GAM simulation, we have added all four proposed wells producing at their average annual production rates (see **Table 1**). The amount of production added is 14,204 AFY. The simulation is run for 10 years, and results are post-processed for one and 10 years after pumping begins. **Figure 12** plots the additional drawdown incurred by the four proposed City of Bryan wells at one year after pumping commencement. After one year of pumping, drawdown extends past the five-mile boundary at drawdowns of approximately 40 to 45 feet. The rapid propagation of the drawdown cone is due to the deep confined conditions of the Simsboro in the vicinity of the Bryan wellfield. Within one mile of the proposed wells, the average drawdown contour is between 60 and 80 feet of drawdown.

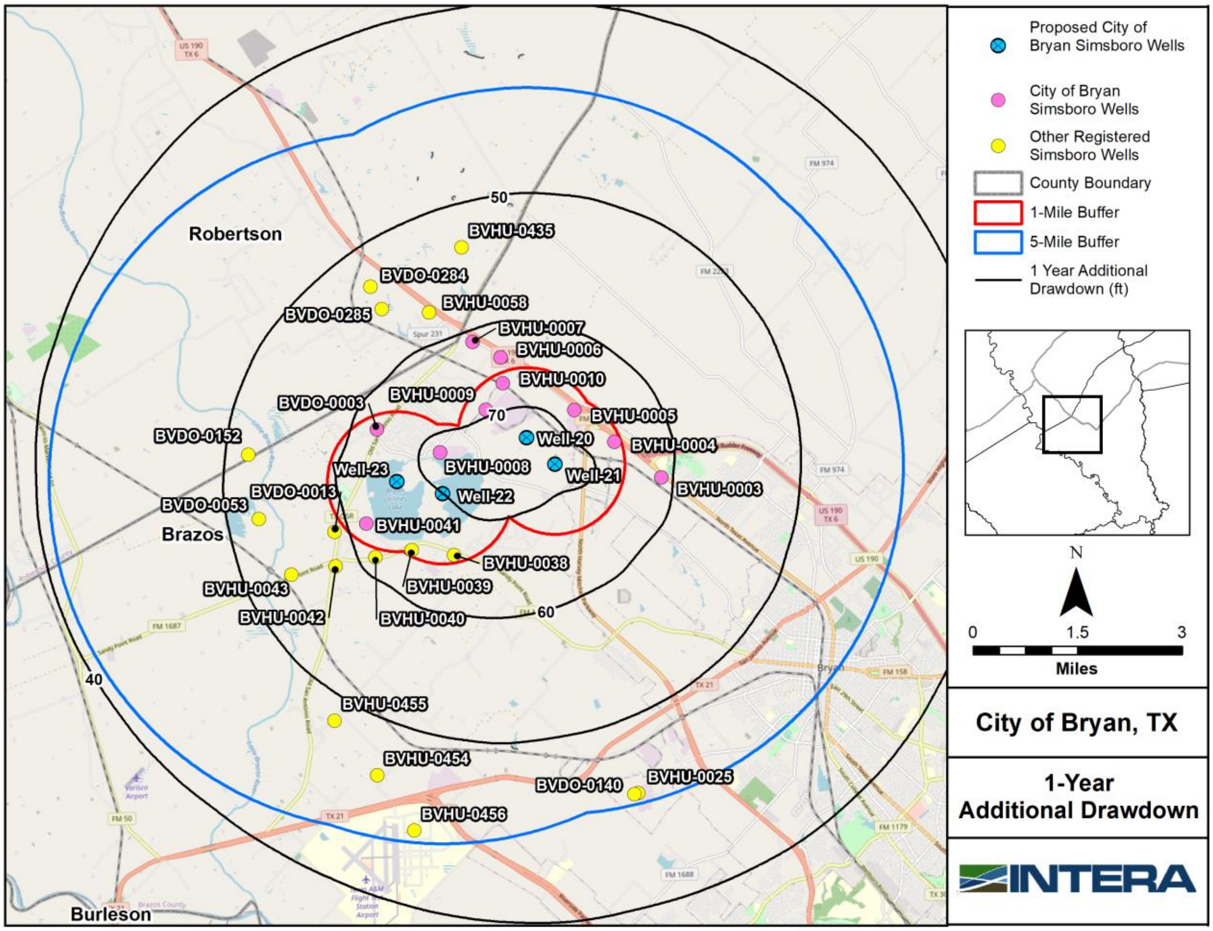

Figure 12. Drawdown after one year of pumping using the TWDB GAM.

Figure 13 plots the additional drawdown incurred by the four proposed City of Bryan wells ten years after pumping commencement. After ten years, the drawdown cone continues to extend regionally with drawdown near the five-mile boundary of approximately 55 to almost 65 feet. Within one mile of the proposed wells, the average drawdown contour is between 75 and 85 feet of drawdown. Proposed Bryan Well #22 has the highest flow rate and one can see a closed contour of 90 feet of drawdown centered on Bryan Well #15 (BVHU-0008). In reality, the closed contour would be around new Bryan Well #22; however, because the GAM grid centroid which contains the pumping from Well #22 is close to Bryan Well #15, the plotted contour closes around Well #15. To illustrate this grid resolution effect, **Figure 14** reproduces **Figure 13** with the addition of the GAM grid. One can see that Wells 15 and 22 share the same grid block and the centroid of the cell is close to Well #15, which causes the displacement of the closed contour from Well #22 to Well #15.

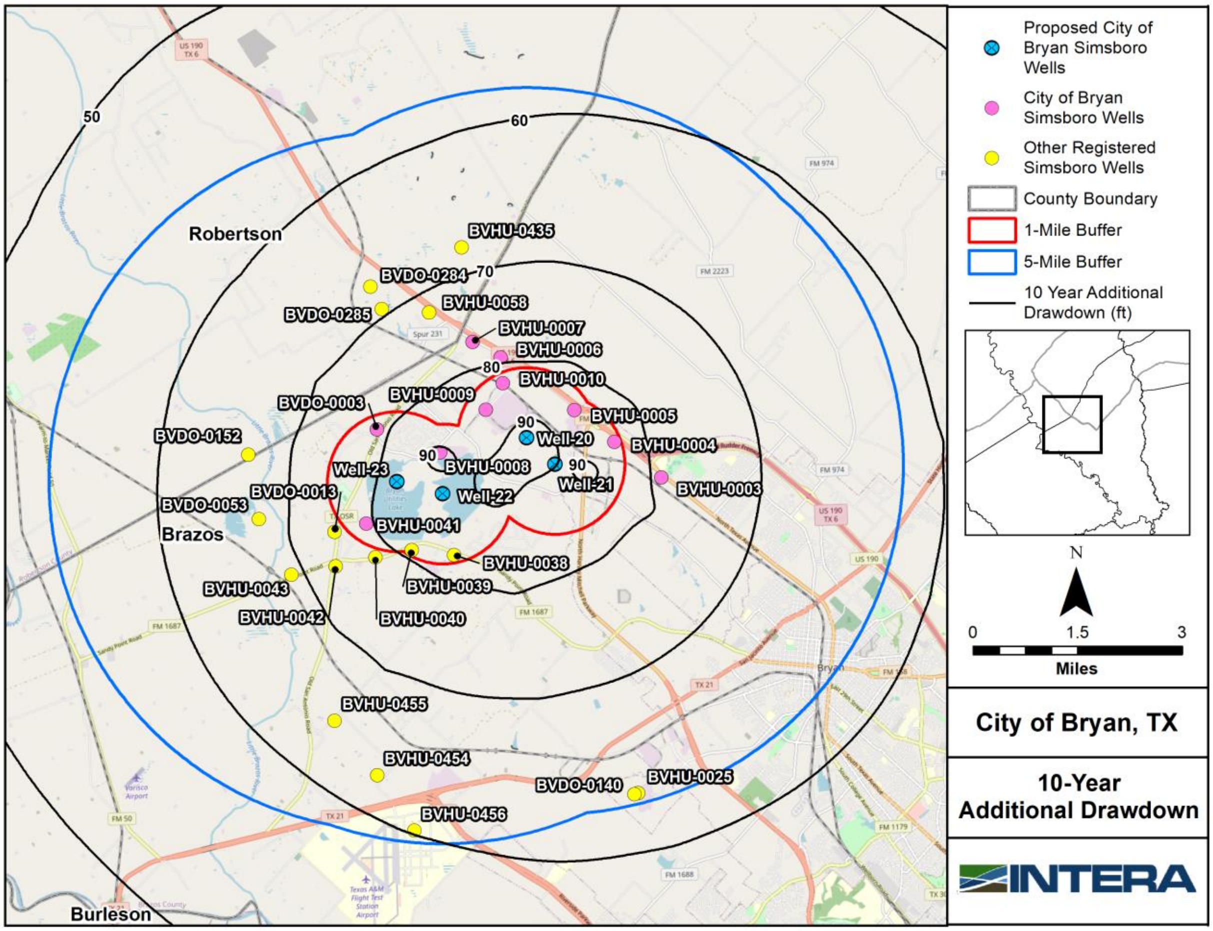

Figure 13. Drawdown after 10 years of pumping using the TWDB GAM.

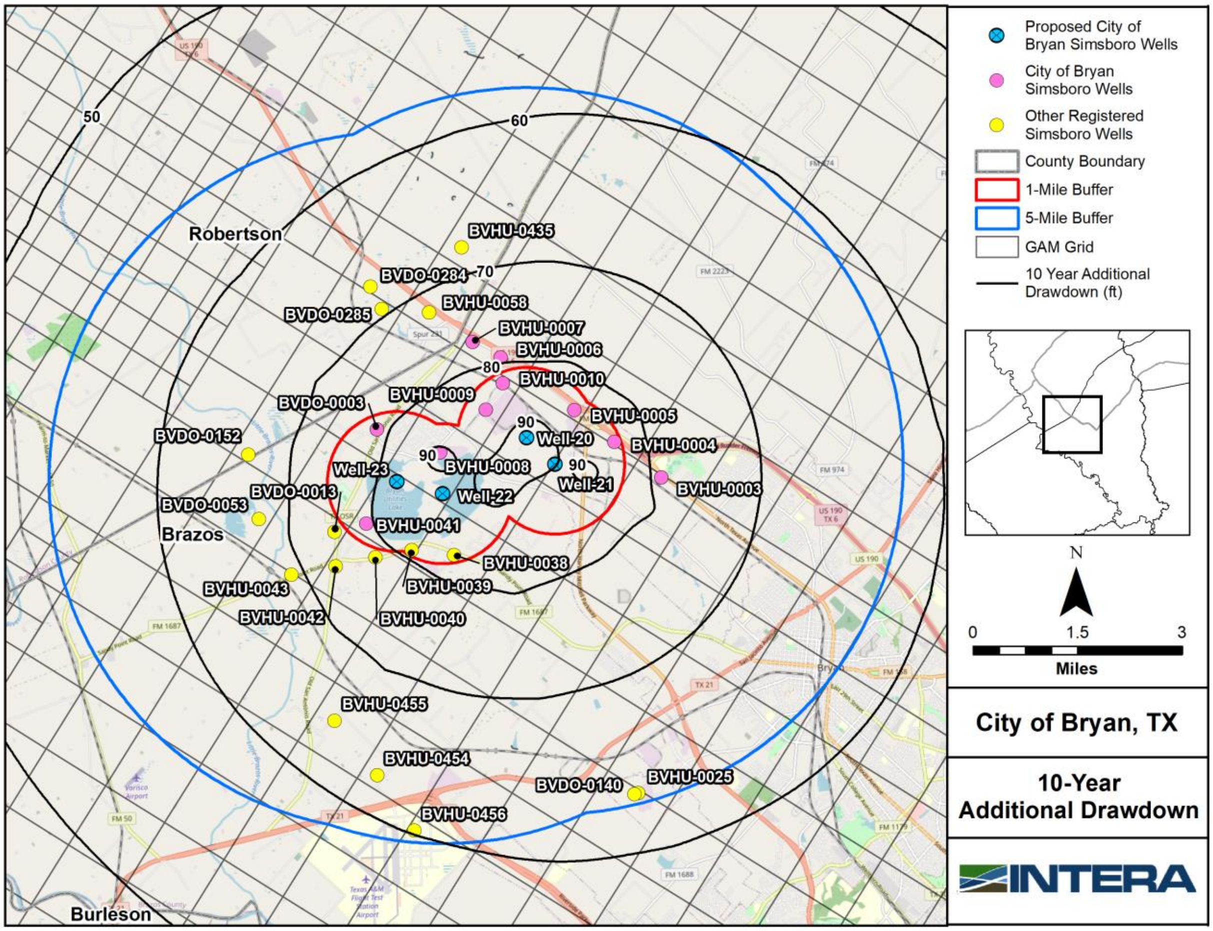

Figure 14. Drawdown after ten years of pumping using the TWDB GAM with the Horizontal GAM Grid Shown.

While these predicted drawdowns are significant in the vicinity of the proposed wells, the top of the Simsboro Aquifer in this area is 2,300 to 2,500 ft bgs and available head above top of the Simsboro in the wellfield area is approximately 2,000 feet. The aquifer remains with significant available drawdown and confined aquifer conditions.

4.2 Drawdown Predictions Using Analytic Techniques

The local analysis is meant to predict drawdown for all existing registered or permitted wells completed in the same aquifer within a one-mile radius of the proposed well(s). Estimates are made after one and 10 years of continuous pumping at the average annual pumping rate requested for permitting.

Because of the local-scale nature of well field hydraulics, drawdown estimation problems are typically solved using analytical models as opposed to finite-volume models such as the industry standard MODFLOW. Since 1935, analytical models have made significant advances, and the analytical element model TTim (Bakker, 2013: included in **Appendix C**) is among the most robust and versatile groundwater hydraulics analytical models available. TTim can simulate multi-layered aquifer systems and properly calculate discharge from wells screened across multiple aquifers, which are important features for well field assessments. Because it is an analytical model, no gridding scheme is needed; the wells can be located at specific coordinates. TTim is a freely available code and has a large international user group. INTERA has routinely used TTim on local scale well hydraulic analyses for the last decade and with numerous groundwater conservation districts. An advantage of TTim over solutions such as Theis is that it enables the user to include aquifers and aquitards above and below the aquifer in which the pumping occurs. This is more comparable to the GAM, except the analytic-element method accurately predicts drawdown at all scales, including at the wellbore. Due to the typically idealized assumptions of analytic equations, these methods are not good for regional impacts. In discussions with James Beach (District consulting hydrogeologist), he agreed TTim was a good tool to use for the calculations.

The inputs to TTim are the aquifer properties, the pumping rates, the radius of the pumping well, and the relative coordinates of the observation wells. We modeled the Simsboro, the underlying Hooper, and the overlying Calvert Bluff, Carrizo and Reklaw. The properties used were sampled and averaged from the GAM for a five-mile radius surrounding the proposed wells and are shown in **Table 5**. As previously discussed, the average Simsboro transmissivity is representative of pump tests in the vicinity. The well (screen) radius at the pumping wells is assumed to be five inches, which is consistent with other Bryan wells. The pumping rates used are the average annual rates being requested in this application (**Table 1**).

The drawdown at the nine existing wells within one mile of the proposed wells after one year and 10 years of pumping can be found in **Table 10**. Because the TTim solution does not have spatial averaging and can predict drawdown at a specific wellbore (assuming 100% well efficiency), the drawdowns at the proposed wells are greater than those predicted in the GAM; this is expected. The GAM provides a better long-term drawdown estimate at a regional scale and late time and TTim gives a better estimate of drawdown near the proposed wells and early time. Because Bryan Well #22 has the highest flow rate, it has the highest predicted drawdown (134 feet after 10 years). Most wells within one mile of the new wells are existing City of Bryan wells. Drawdowns at these wells range from 67 to 80 feet after 10 years. College Station Well #1 and Well #2 have 73 feet of drawdown after ten years.

Table 10 Estimated drawdown (ft) at existing Simsboro wells within one mile from, and at the proposed well locations.

Well Name	BVGCD Permit Number	One-Year Drawdown (ft)	Ten-Year Drawdown (ft)
City of Bryan - Well #11	BVHU-0004	-58.2	-67.1
City of Bryan - Well #12	BVHU-0005	-61.8	-70.8
City of Bryan - Well #15	BVHU-0008	-71.4	-80.4
City of Bryan - Well #16	BVHU-0009	-65.9	-74.9
City of Bryan - Well #17	BVHU-0010	-62.0	-71.0
City of Bryan - Well #18	BVDO-0003	-62.2	-71.1
City of Bryan - Well #19 (CS #4)	BVHU-0041	-62.2	-71.2
City of College Station - Well #1	BVHU-0038	-64.0	-73.0
City of College Station - Well #2	BVHU-0039	-63.6	-72.6
Well-20		-99.3	-108.3
Well-21		-99.6	-108.6
Well-22		-124.9	-133.8
Well-23		-104.1	-113.0

Chapter 36.0015(b) defines the purpose of a groundwater conservation district as to protect property rights, balance the conservation and development of groundwater to meet the needs of this state, and use the best available science in the conservation and development of groundwater. Through the joint-planning process, BVGCD has established a Desired Future Condition (DFC) for the Simsboro (Shi and Harding, 2022) of an average drawdown of 262 feet across the entire district (measured between the year 2000 and 2070). An average drawdown of 262 feet implies that there are drawdowns which will be observed within the Simsboro and within the District that far exceed 262 feet. The Modeled Available Groundwater (MAG) for the Simsboro in 2030 is 89,849 AFY and in 2070 is 147,245 AFY. The BVGCD 2020 Annual Report estimates the metered non-exempt Simsboro pumping in the District in 2020 was 53,164 AFY. Evaluated in isolation, the requested permits would not exceed the MAG or the DFC.

The District recognizes that the MAG is not a permitting cap but rather is a goal to manage groundwater for the long-term compliance with the DFC. The District has an expanding monitoring well network and collected Simsboro water levels from 58 wells in 2020. The District has Simsboro monitoring wells in the vicinity of the Bryan wellfield. Through the continued monitoring and the joint planning process, the District has collected, and will continue to collect, the data it requires to manage towards the compliance of the DFC based upon actual data (water levels and pumping) and regional predictive modeling.