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Advanced Groundwater Solutions, LLC
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Technical Memorandum

TO: Mr. Alan Day, General Manager
Brazos Valley Groundwater Conservation District

FROM: Christopher Drabek, P.G., and James Beach, P.G.

SUBJECT: Review of Trey Skiles Simsboro Aquifer Evaluation Report

DATE: March 6, 2023

Introduction

On behalf of the Brazos Valley Groundwater Conservation District (BVGCD, District), Advanced Groundwater Solutions, LLC (AGS) has reviewed the Aquifer Evaluation Report (AER) prepared by Thornhill Group, Inc. (TGI) in support of a permit application from Mr. Trey Skiles for a proposed new well completed in the Simsboro Aquifer with a withdrawal amount of 2,100 acre-feet per year (ac-ft/yr) and an increase in permitted production from the Simsboro Aquifer for existing well BVDO-0108 from 1,400 ac-ft/yr to 2,700 ac-ft/yr. Pumping from both wells will be aggregated for a total production of 4,800 ac-ft/yr from the Simsboro Aquifer. The first submitted AER is dated February 8, 2023. After preliminary review, AGS and BVGCD provided comments to TGI and requested some modifications to the report on February 20, 2023. A revised report was submitted to BVGCD on February 24, 2023. The AER was submitted to address BVGCD Rule 8.4(b)(7)(B) for wells capable of producing 800 or more acre-feet per year and discusses the potential impacts of groundwater production from the Simsboro Aquifer of the proposed new well and requested increase in permitted production from well BVDO-0108 in the west part of Robertson County.

The AER identifies Trey Skiles Well 1 with a maximum pumping rate of 1,600 gallons per minute (gpm) and an annual permit allocation of 2,100 acre-feet and BVDO-0108 with a maximum pumping rate of 2,000 gpm and an annual permit allocation of 2,700 acre-feet. The combined maximum pumping rate of both wells is 3,600 gpm with a total annual permit allocation of 4,800 acre-feet. The proposed locations of the wells are shown on Figure 1 below with the wells located north-northeast of the intersection of Highway 79 and FM 1644.

AGS has evaluated the hydrogeological conditions, mapping of BVGCD permitted and registered Simsboro wells within one mile of the proposed and existing Trey Skiles wells and the water level drawdown estimates developed using the Texas Water Development Board (TWDB) Groundwater Availability Model (GAM) and analytical tools presented in the submitted aquifer evaluation reports. Discussion of the AER in this memorandum refers to the revised version of the report dated February 24, 2023.

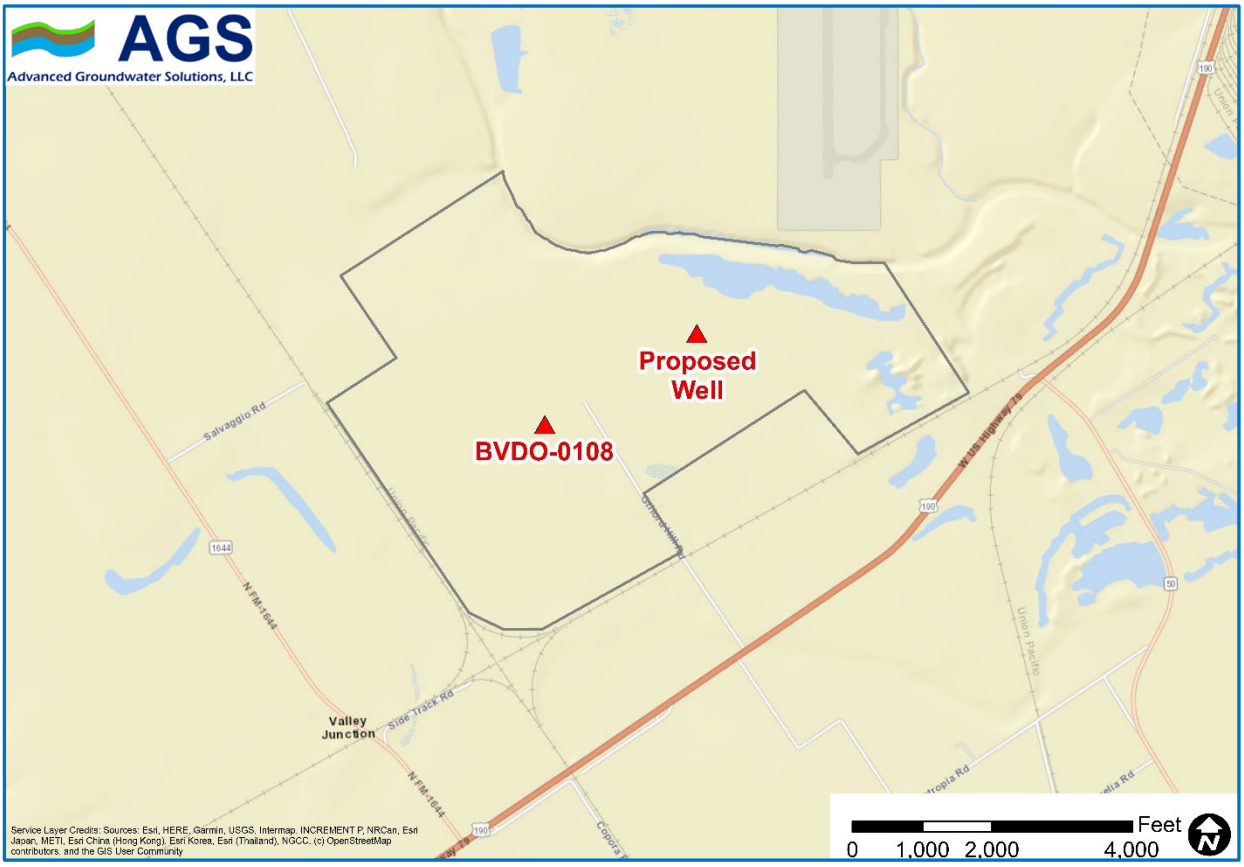


Figure 1. Well Location Map

Hydrogeologic Conditions

Rule 8.4(b)(7)(B)(1)

AGS has evaluated the hydrogeological conditions presented in the AER and generally agrees with the information presented in this section.

The AER identifies the top of the Simsboro Aquifer in the range of about -776 to -876 feet relative to sea level (rsl) or about 1,050 to 1,150 feet below land surface and the base of the Simsboro Aquifer in the range of about -1,146 to -1,376 feet rsl or about 1,420 to 1,650 feet below land surface at the Trey Skiles property. TGI estimated the sand thickness of the Simsboro Aquifer to be in the range of 370 to 500+ feet. Review of local electric logs and the BVDO-0108 lithology log (State of Texas Well Report Tracking Number 311188) indicates that the TGI top and bottom of the Simsboro Aquifer estimates in the vicinity of the Trey Skiles property are reasonable. The proposed well screen interval was not discussed in the AER.

Simsboro Aquifer Wells Within 1-mile of the Proposed Wells

Rule 8.4(b)(7)(B)(2)

AGS has confirmed that the two BVGCD wells that were identified in Table 2 of the AER are the only permitted or registered Simsboro wells within one mile of the existing and proposed Trey Skiles wells. Table 2 of the Aquifer Evaluation Report includes data on each registered or permitted well screening the Simsboro Aquifer located within one mile of the proposed and existing wells and generally includes most of the required information for the wells. Ideally, the top and bottom of the screen interval would be shown in the Screen Depth column, if available.

A map showing the location of the proposed and existing Trey Skiles wells and the BVGCD registered or permitted wells within one mile of the Skiles wells is included as Figure 2 in the AER. The two BVGCD permitted or registered wells identified within one mile of the proposed and existing Trey Skiles wells are in agreement with the wells shown on the BVGCD Groundwater Management Application Public Web Map (https://brazosvalleygcd.halff.com/default.aspx).

Interference Drawdown Estimates

Rule 8.4(b)(7)(B)(3)

BVGCD Rule 8.4(b)(7)(B)(3) requires an estimate of water level drawdown caused by the well(s) pumping at the permitted rate for 1 year and 10 years at a distance of five miles from the well(s) using Version 3.02 of the Central Portion of the Sparta, Queen City and Carrizo-Wilcox Aquifers GAM (INTERA Incorporated and others, 2020). An estimate of the drawdown at locations of existing registered and permitted wells in the BVGCD database that are located within one mile and screen the same aquifer as the well(s) is required to be developed using an analytical tool.

Appropriate analytical models are generally used to provide estimates of pumping effects at or near the well(s) over shorter time horizons. Regional numerical models like the TWDB GAMs are generally used to account for regional variability in the aquifer such as changes in transmissivity and faulting as well as recharge, leakage between aquifers, stream-aquifer interaction, other pumping, and other factors impacting water levels. Appropriate numerical models can provide more reliable estimates of pumping effects on a more regional scale and over longer time horizons.

Groundwater Availability Model Simulation

TGI GAM Simulations

TGI used the TWDB Central Portion of the Sparta, Queen City and Carrizo-Wilcox Aquifer GAM to estimate drawdown that results from continuously pumping the proposed and existing Trey Skiles wells at a combined rate of 4,800 ac-ft/yr for 1 year and 10 years. A copy of the TGI 1-year and 10-year GAM simulated interference drawdown illustrations from the AER (TGI Figures 6 and 7) are attached to this memorandum. Table 1 from the AER shows GAM simulated 1-year and 10-year drawdown estimates at BVGCD permitted and registered Simsboro wells within a five-mile radius of the proposed wells.

The TGI report did not discuss the GAM simulation methodology, but it is our general understanding that TGI used the TWDB approved 2021 Groundwater Management Area (GMA) 12 Desired Future Conditions (DFC) run (GMA 12 "S-19") to evaluate water level (head) changes at various stress periods within the DFC run to estimate pumping effects. GMA 12 "S-19" includes additional regional pumping, which gradually increases through time. GMA 12 "S-19" was approved in 2021 and does not include all of the pumping from the Simsboro Aquifer that has been permitted by BVGCD in the area in the past year. Based on our understanding of the TGI methodology, it does not provide an isolated estimate of the water-level drawdown that can be caused by pumping the requested 4,800 ac-ft/yr from the Trey Skiles wells as required by BVGCD Rule 8.4(b)(7)(B)(3) due to the additional pumping in the GMA 12 "S-19" run.

To isolate the total impact of the proposed pumping, AGS completed two GAM simulations. The first simulation (the baseline run) is the unmodified GMA 12 "S-19" DFC run and the second simulation (the modified run) is identical to the baseline except that the requested 4,800 ac-ft/yr of pumping was included in the MODFLOW WEL file. The simulated water levels from each simulation were compared by subtracting the simulated water levels of the baseline run from the modified run. This comparison isolates the pumping effects of the requested pumping.

AGS GAM Simulations

The AGS methodology described above and used in the GAM simulations focuses on the pumping effects of the proposed pumping and does not include the impacts from other Simsboro pumping in BVGCD or regional impacts from pumping in areas surrounding BVGCD.

AGS simulated the requested annual permit allocation by assigning the proposed Trey Skiles well 2,100 ac-ft/yr of pumping at Node 162516 and BVDO-0108 2,700 ac-ft/yr of pumping at Node 162515. The AGS GAM simulation results after 1 and 10 years of pumping 4,800 ac-ft/yr show drawdown estimates that are generally about 5 feet or more greater than what is shown in the TGI simulation results. The AGS drawdown contours show that the estimated drawdown is spread over a larger geographical area than what is shown in the TGI report.

Figure 2 shows the AGS estimated effects that result from simulation of the requested 4,800 ac-ft of pumping from the Simsboro Aquifer after one year. AGS GAM simulated one year drawdown is estimated to range from about 22 to over 30 feet within one mile from the simulated Skiles wells and about 6 to 13 feet at a distance of five miles from the Skiles wells, depending on the direction from the proposed wells.

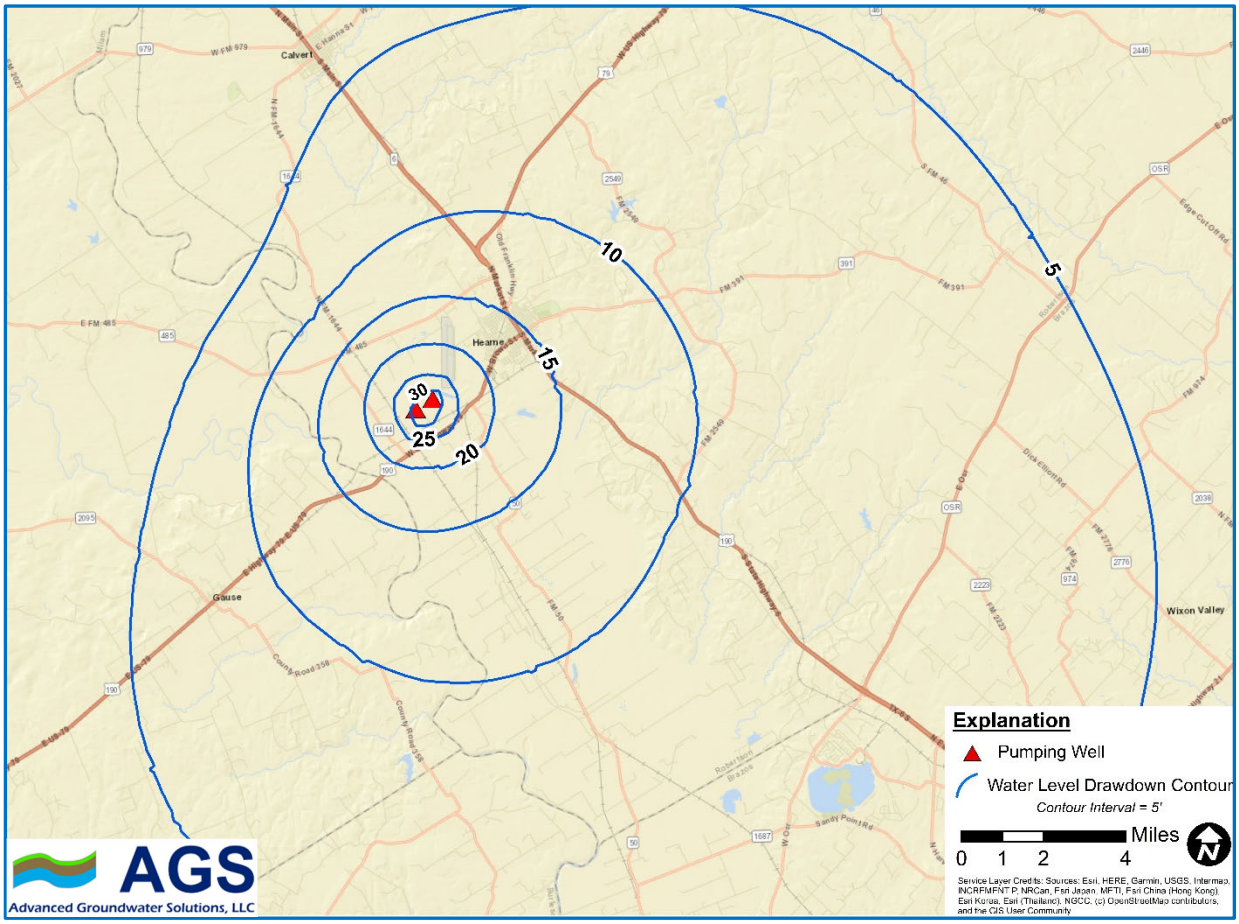


Figure 2. GAM Simulated Drawdown Effects in Simsboro Aquifer After Proposed Skiles Pumping of 4,800 ac-ft/yr for 1-Year

Figure 3 shows the AGS estimated effects that result from simulation of the requested 4,800 ac-ft of pumping from the Simsboro Aquifer after 10 years. AGS GAM simulated 10-year drawdown is estimated to be about 24 to over 35 feet within one mile from the simulated Trey Skiles wells and about 8 to 14 feet at a distance of five miles from the proposed and existing Trey Skiles wells, depending on the direction from the proposed wells.

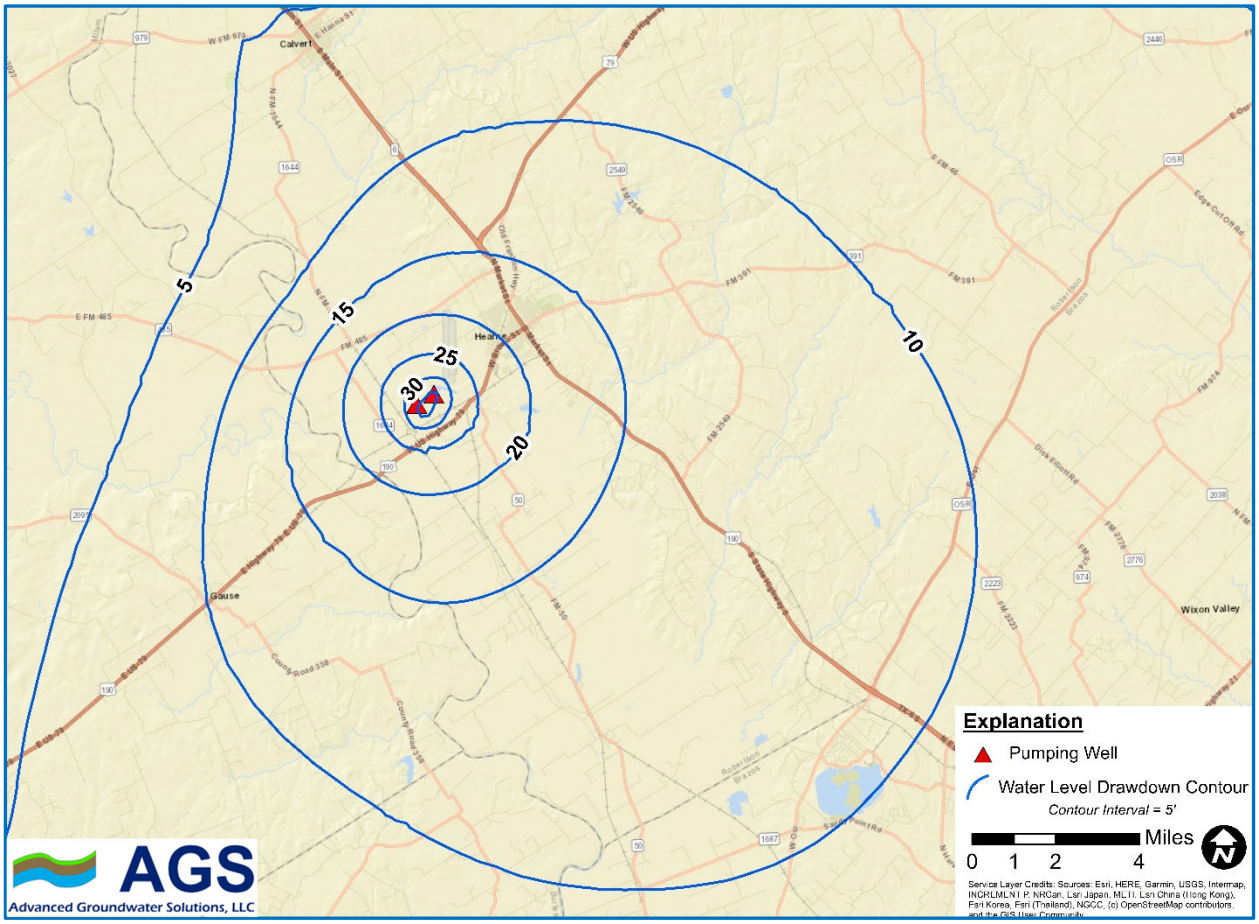


Figure 3. GAM Simulated Drawdown Effects in Simsboro Aquifer After Proposed Skiles Pumping of 4,800 ac-ft/yr for 10-Years

The AGS GAM estimated 5-foot drawdown contours to the northwest appear to be influenced by a fault included in the GAM, which is in the same general area as a fault that has been mapped recently by Groundwater Consultants, LLC and AGS using local geophysical logs and other hydrogeologic data.

AGS has reviewed this AER based on the hydrogeologic information available today, the information provided by the applicant, and the models and tools available at this time. New scientific or hydrogeologic information or updated models may change the findings of this review.

Analytical Model Simulation

TGI used an analytical model based on the Theis non-equilibrium equation to estimate theoretical potentiometric head declines at and surrounding the proposed wells. A transmissivity value of 75,000 gallons per day per foot (gpd/ft) and storativity value of 0.0001 were used at each well location to simulate drawdown after 1 and 10 years of pumping. A copy of the TGI 1-year and 10-year analytical simulated interference drawdown illustrations from the AER (TGI Figures 8 and 9) are attached to this memorandum. Table 1 provided in the AER shows simulated 1-year

and 10-year drawdown estimates at BVGCD permitted and registered Simsboro wells within a five-mile radius of the proposed wells based on the analytical modeling. Discussions with TGI personnel indicate that the estimated analytical drawdown values at the proposed Trey Skiles well and existing well BVDO-0108 locations shown in Table 1 were derived from averaging the estimated drawdown at the well over a grid cell within the analytical tool.

AGS estimated the drawdown at the pumping wells using the Theis analytical model and calculating the drawdown at one foot from the well. Using this approach, AGS simulated an additional 22 feet of drawdown at the proposed well location (1-year drawdown: 52 feet (TGI) versus 74 feet (AGS); 10-year drawdown: 62 feet (TGI) versus 84 feet (AGS)) and an additional 24 feet of drawdown at the existing BVDO-0108 location (1-year drawdown: 59 feet (TGI) versus 83 feet (AGS); 10-year drawdown: 70 feet (TGI) versus 94 feet (AGS)). AGS was able to verify the TGI analytical estimated drawdown at all other locations shown in Table 1 of the TGI report.

With this approach, there is an increased density of contours near the proposed Trey Skiles well and existing well BVDO-0108 and we think these are more appropriate estimates of "near well" drawdown. However, there are many factors that will determine the actual drawdown near the well during pumping, and therefore, these differences are assumed to be minor for the purposes of the AER. Figures 4 and 5 show the estimated AGS analytical modeling drawdown contours that result from pumping 4,800 ac-ft/yr for 1-year and 10-years, respectively. Simulated drawdown contours at distance are similar for both methodologies.

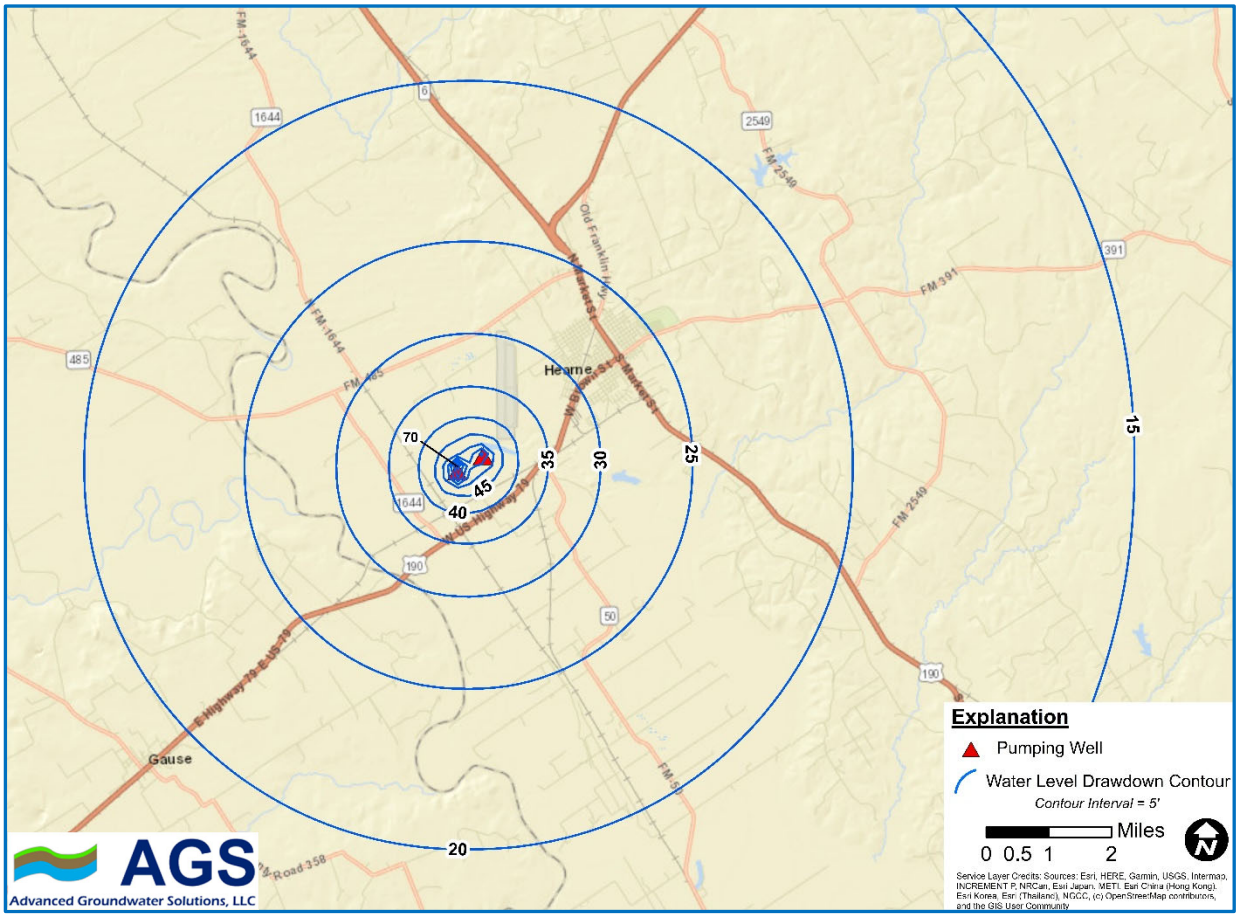


Figure 4. Analytical Simulated Drawdown Effects After Proposed Skiles Pumping of 4,800 ac-ft/yr for 1-Year

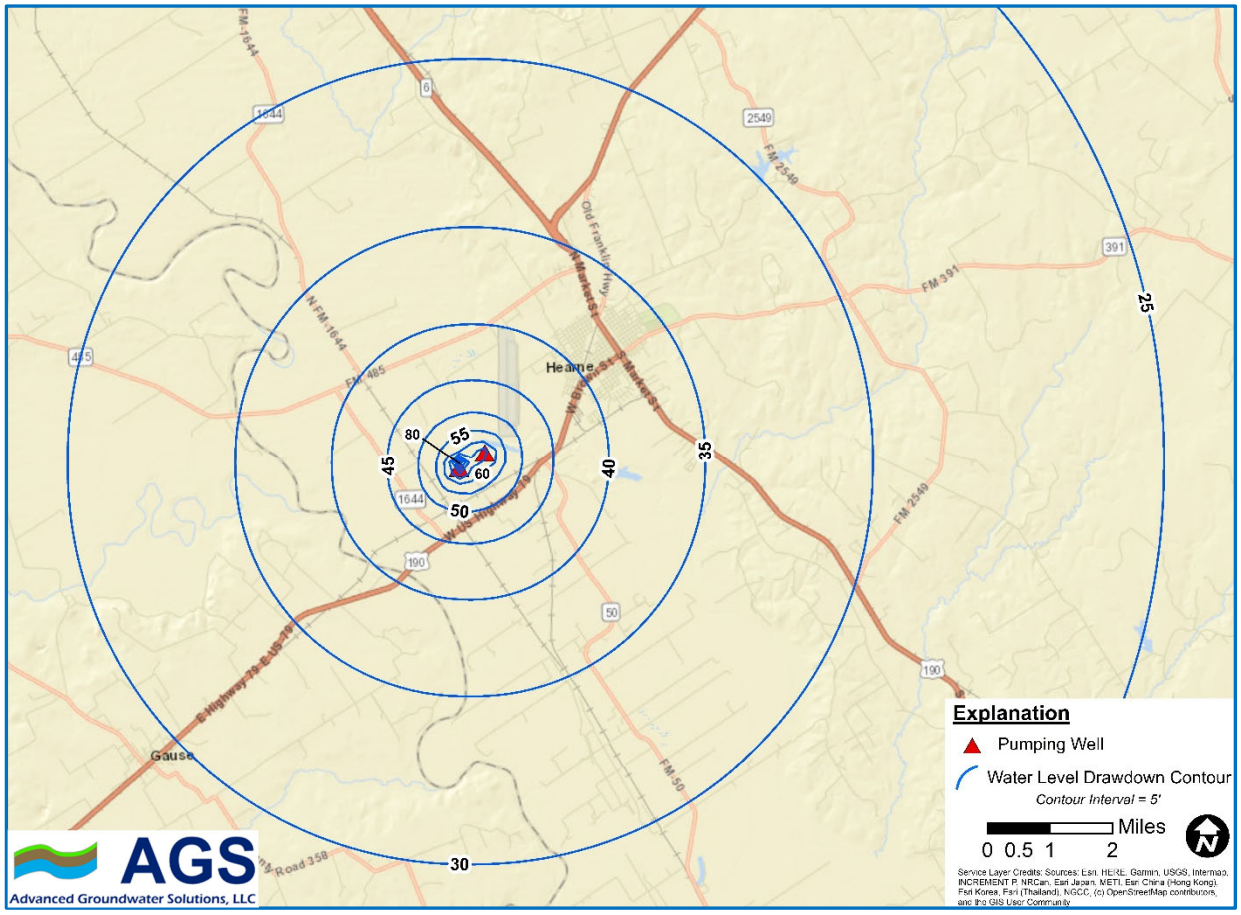


Figure 5. Analytical Simulated Drawdown Effects After Proposed Skiles Pumping of 4,800 ac-ft/yr for 10-Years

Estimated Long-term impacts at wells based on GMA 12 2021 DFC Run

As a way of evaluating potential long-term estimated water level decline at the proposed Trey Skiles well and existing well BVDO-0108, AGS plotted the simulated water level decline at each well location based on the 2021 GMA 12 DFC/Modeled Available Groundwater (MAG) projections for the Simsboro Aquifer as shown in Figure 6 below. The water level projections shown in Figure 6 are from the TWDB approved DFC/MAG run known as GMA 12 "S-19", but do not include the local impacts from the proposed Trey Skiles well and the requested well BVDO-0108 permitted production increase included in the AER, nor do they include all of the pumping from the Simsboro Aquifer that has been permitted in the area in the past year. The DFC run includes pumping estimates from the Groundwater Conservation Districts in GMA 12 as of about December 2021 that yield DFCs so that the TWDB can estimate the MAG. The detailed assumptions for the DFC simulation can be found in the GMA 12 Explanatory Report (Daniel B. Stephens & Associates and others, 2022) and documentation of the TWDB MAG run can be found in GAM Run 21-017 MAG: Modeled Available Groundwater for the Aquifers in Groundwater Management Area 12 (Shi and Harding, 2022).

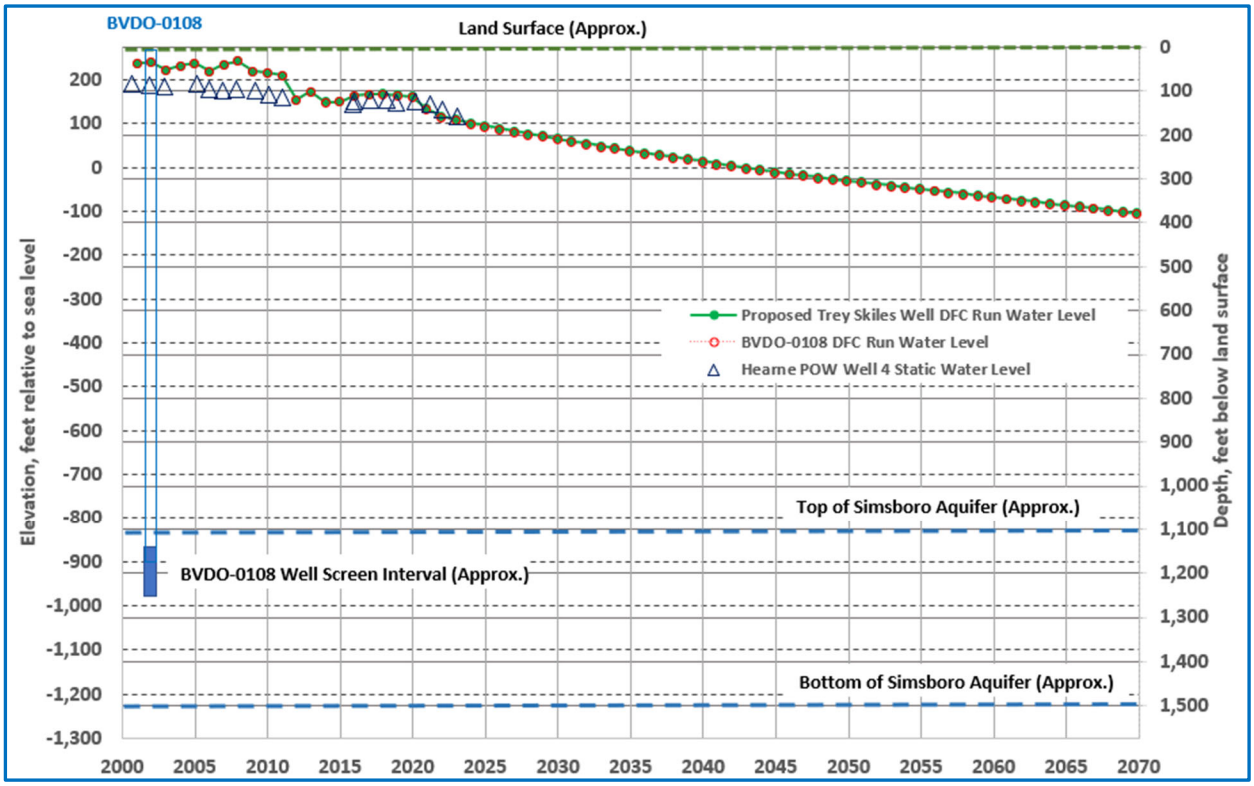


Figure 6. Projected GMA 12 2021 Planning Cycle DFC Water Level Decline at the Proposed Trey Skiles Well and Existing Well BVDO-0108

The graph illustrates the relationship between the land surface, estimated static water level through time, and the estimated top and bottom of the Simsboro Aquifer at the location of the proposed Trey Skiles well and BVDO-0108. Select historical static water level measurements are also shown on Figure 6 for the City of Hearne POW Well 4 (BVGCD Permit BVHU-0013), which is located about 2.1 miles to the north-northeast of the proposed Trey Skiles well and screen sands of the Simsboro Aquifer in the depth interval of about 1,221 to 1,426 feet below land surface or approximately -920 to -1,133 feet rsl).

Available drawdown in wells in the Simsboro Aquifer will decline over time based on the DFC simulation. Pumping water levels in wells in areas of concentrated pumping could be one hundred or more feet deeper than the estimated regional static water levels shown on Figure 6. Although not evaluated or discussed in detail herein, these levels of water level decline in wells and artesian head decline in the aquifer will have some impact on vertical leakage, intercepted discharge, reduction in confined and unconfined storage, and potential flow directions in the aquifer.

TGI's report makes note of the testing observed by BVGCD representatives on March 18, 2009. For clarification, BVGCD representatives (LBG-Guyton Associates John Seifert) observed short term pumping (15-20 minutes) of the irrigation wells with flow meter readings of about 3,000 gpm on March 18, 2009.

Conclusions

The submitted AER generally addresses the requirements defined by BVGCD Rule 8.4(b)(7)(B) for wells capable of producing 800 or more acre-feet per year.

The GAM simulations performed by TGI did not completely isolate the effects of pumping the total requested permitted amount of 4,800 ac-ft/yr from the proposed Trey Skiles well and existing well BVDO-0108. AGS performed GAM simulations that isolated the proposed Trey Skiles well and existing BVDO-0108 effects of pumping 4,800 ac-ft/yr. The AGS evaluation focused on the requested Trey Skiles permitted pumping of 4,800 ac-ft/yr from the Simsboro Aquifer and does not include what could be the overall effects of all the pumping that could occur in the area. AGS concluded that the TGI GAM simulations underestimated the amount of potential drawdown by about 5 or more feet and underestimated the areal extent of the drawdown.

The TGI analytical modeling simulations underestimate the pumping effects of the requested permitted pumping (4,800 ac-ft/yr) by about 22 to 24 feet very near the proposed Trey Skiles well and existing well BVDO-0108 but provide reasonable estimates of drawdown at distance.

AGS considers these differences to be worth mentioning but not overly consequential for the purposes of this report. AGS recommends that future AER simulations be completed using methods that isolate the pumping effects of the proposed permitted pumping.

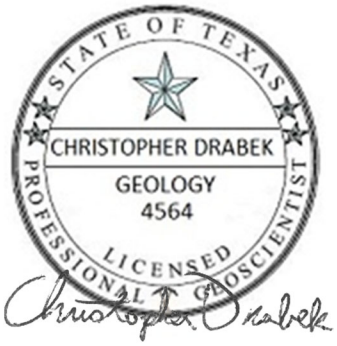
References

Daniel B. Stephens & Associates, INTERA Incorporated, and Ground Water Consultants, LLC, 2022, Desired Future Condition Explanatory Report for Groundwater Management Area 12, 859 p.

INTERA Incorporated, D.B. Stephens & Associates, and Ground Water Consultants, LLC, 2020, GMA 12 Update to the Groundwater Availability Model for the Central Portion of the Sparta, Queen City, Carrizo-Wilcox Aquifers: Update to Improve Representation of the Transmissive Properties of the Simsboro Aquifer in the Vicinity of the Vista Ridge Well Field, 30 p.

Shi, J. and Harding, J., 2022, GAM RUN 21-017 MAG: Modeled Available Groundwater for the Aquifers in Groundwater Management Area 12, 36 p.

Geoscientist's Seal:



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by Christopher Drabek, P.G. 4564 on 3/6/2023.
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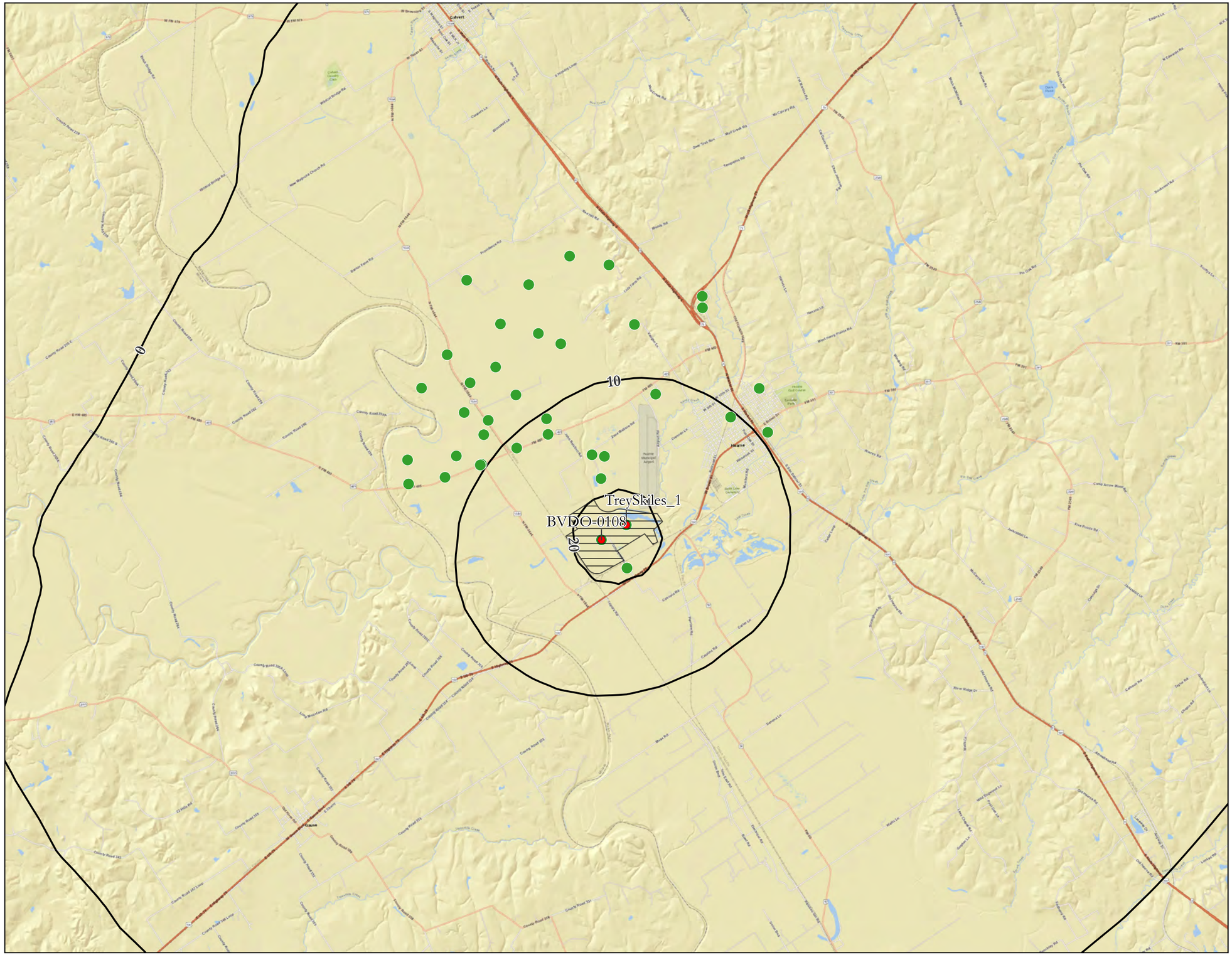

Trey Skiles Proposed Well Location

BVGCD Registered Simsboro Well

1-Year Drawdown (feet)

Trey Skiles Property Boundary

N

0 1 2 3 4 mi

Scale 1:100,000

Figure 6: 1-Year QCSP GAM Drawdown Contours

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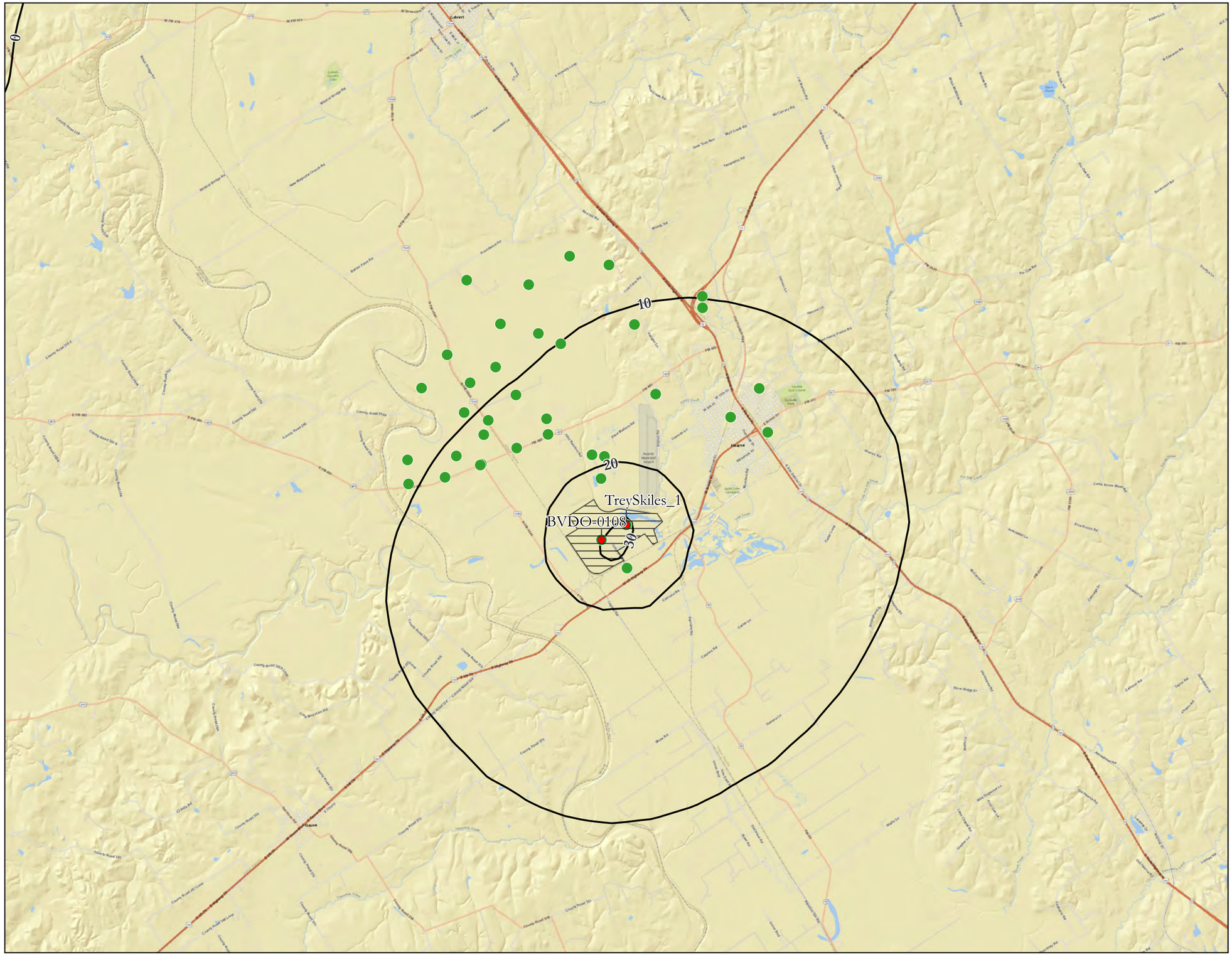

Trey Skiles Proposed Well Location

BVGCD Registered Simsboro Well

10-Year Drawdown (feet)

Trey Skiles Property Boundary

N

0 1 2 3 4 mi

Scale 1:100,000

Figure 7: 10-Year QCSP GAM Drawdown Contours

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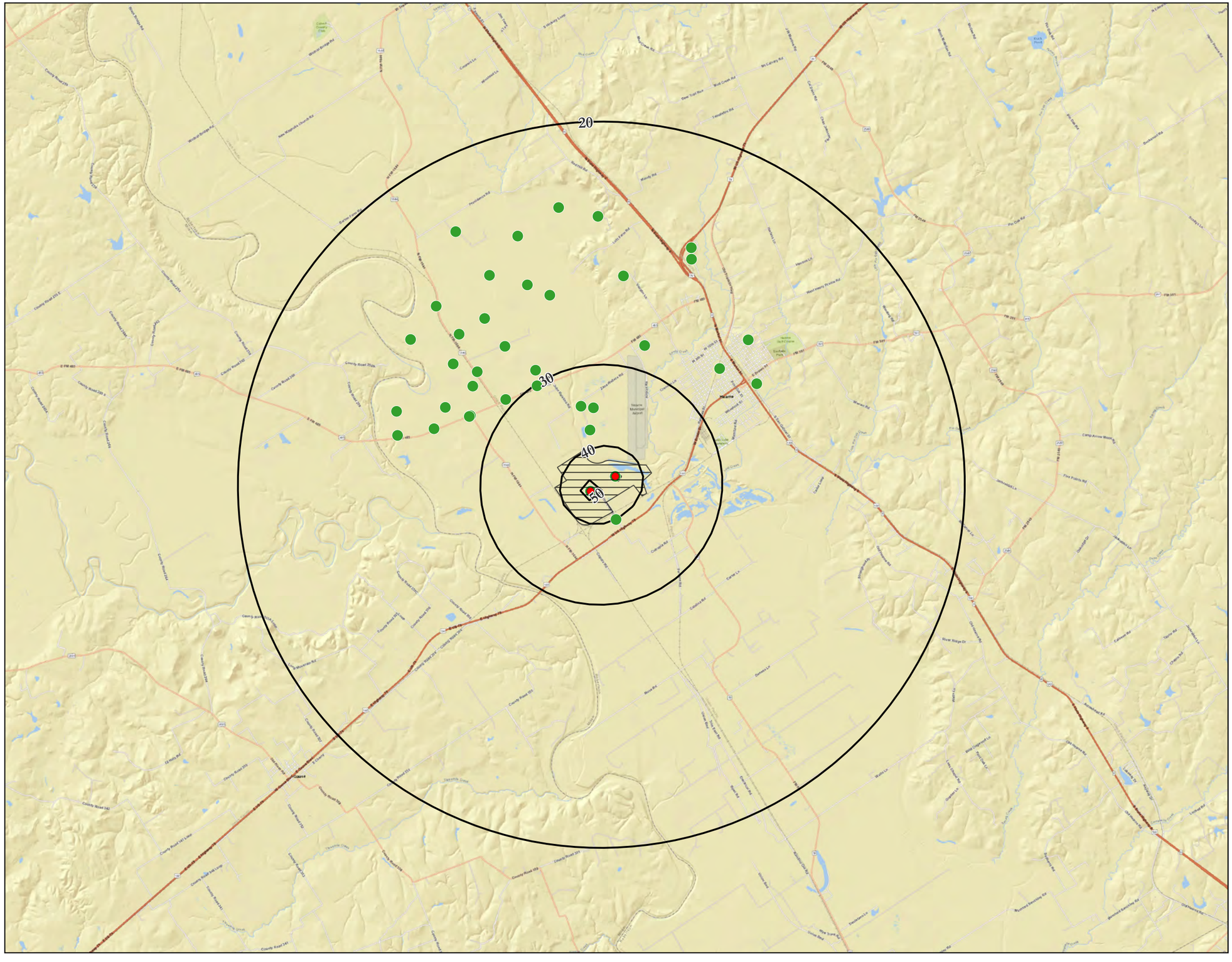

Trey Skiles Proposed Well Locations

BVGCD Registered Simsboro Well

1-Year Drawdown (feet)

Trey Skiles Property Boundary

N

0 1 2 3 4 mi

Scale 1:100,000

Figure 8: 1-Year Analytical Drawdown Contours

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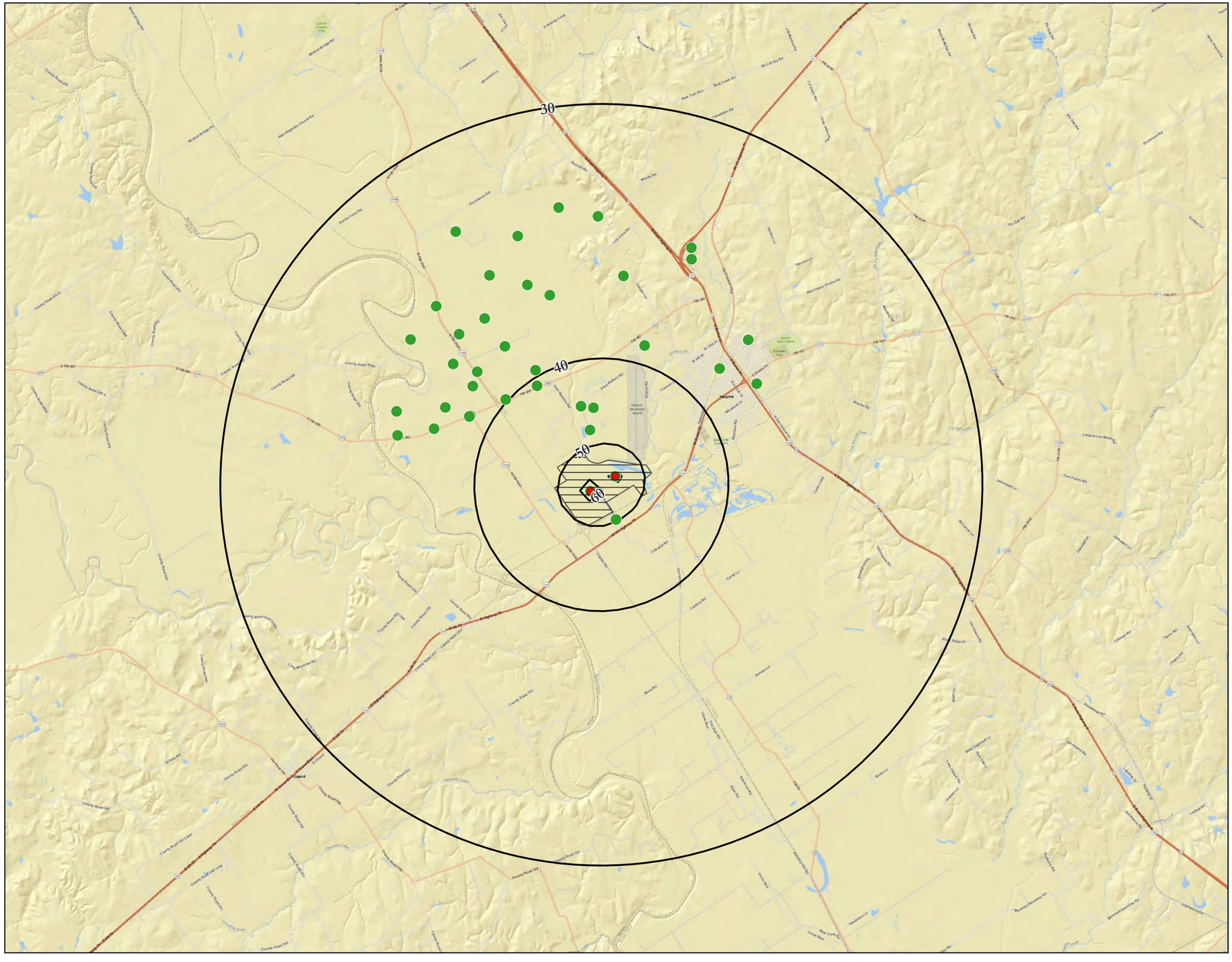

Trey Skiles Proposed Well Location

BVGCD Registered Simsboro Well

10-Year Drawdown (feet)

Trey Skiles Property Boundary

N

0 1 2 3 4 mi

Scale 1:100,000

Figure 9: 10-Year Analytical Drawdown Contours

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