

Technical Memorandum

TO: Sean Stibich – Port of Victoria

FROM: James Beach, P.G. - Advanced Groundwater Solutions, LLC

SUBJECT: Port of Victoria Brackish Groundwater Production Well Field in Victoria County, Texas

DATE: August 26, 2026

EXECUTIVE SUMMARY

The Port of Victoria (POV) is requesting a total production volume of 28,000 acre-feet per year (AFY) from the Victoria County Groundwater Conservation District (VCGCD) in the deep-saline groundwater management zones. The requested production is from the Goliad saline groundwater zone. POV asks to produce 18,000 AFY from the slightly saline zone and 10,000 AFY from the moderately saline zone of the Lower Goliad Formation.

AGS reviewed the Central Gulf Coast Brackish Groundwater Flow Model (CGCBGWFM) (Yang and others, 2026) and local geophysical logs to develop two conceptual well fields that screen the appropriate deep-saline groundwater management zone. The first conceptual well field has 23 wells with an average production rate of 485 gallons per minute (gpm) in the slightly saline zone (Layer 8) to produce the requested 18,000 AFY. The second conceptual well field has 16 wells with an average production rate of 387 gpm in the moderately saline zone (Layer 9) to produce the requested 10,000 AFY.

The CGCBGWFM was used to simulate continuous pumping from the POV conceptual well fields for 30 years. The maximum simulated drawdown at the POV site in the freshwater zone (Layer 6) ranged from about 34 to 35 feet. The maximum simulated drawdown at the POV site in slightly saline zone (Layer 8) ranged from about 700 to 750 feet. The maximum simulated drawdown at the POV site in the moderately saline zone (Layer 9) ranged from about 600 to 650 feet. In each of the zones, the model predicts less drawdown at greater distances from the POV site.

Based on CGCBGWFM results, the additional water level decline in the Freshwater Zone (Layer 6) caused by the POV pumping of 28,000 AFY would be about 34 feet. When this water level decline (34 feet) is added to current water levels (35-40 feet bls), the depth to water is about 70-75 feet bls. Water levels in the Freshwater Zone (Layer 6) have historically fluctuated. The modeled water level, with POV's pumping, is very similar to historical water levels measured in the Freshwater Zone from about 1980 through 2000.

INTRODUCTION

The Port of Victoria (POV) is applying for a permit from the Victoria County Groundwater Conservation District (VCGCD) to authorize POV to produce 28,000 acre-feet per year (AFY) from the deep-saline groundwater management zones below POV's property. The POV site is located about 10 miles southeast of the City of Victoria in southern Victoria County (Figure 1).



Figure 1. Port of Victoria Site Location Map

The requested groundwater production is from the “Goliad Saline Groundwater Zone” defined by the VCGCD. This zone includes the Upper and Lower Goliad Formations. POV proposes producing 18,000 AFY of groundwater from the slightly saline Goliad Saline Groundwater Zone and 10,000 AFY from the moderately saline Goliad Saline Groundwater Zone. This technical memorandum provides a review of the relevant model (the Central Gulf Coast Brackish Groundwater Flow Model or CGCBGWF), geophysical logs from the area, two conceptual brackish production well fields, and

freshwater wells in the vicinity of the POV site. AGS also reviewed relevant regulatory and permitting considerations for deep-saline groundwater zone production within the VCGCD.

HYDROGEOLOGY

The Gulf Coast Aquifer System is present at the POV site and consists of a thick sequence of interbedded sand, silt, and clay that generally dips toward the coast, increasing in depth and thickness to the southeast. Regionally, the Gulf Coast Aquifer can be subdivided into four hydrostratigraphic subunits including, from shallowest (youngest) to deepest (oldest), the Chicot Aquifer, Evangline Aquifer, the Burkeville Confining Unit, and the underlying Jasper Aquifer.

The Chicot Aquifer comprises the relatively shallow Holocene alluvium and eolian deposits consisting of the Beaumont, Lissie, and Willis Formations (Shi and others, 2022), while the underlying Evangeline Aquifer is associated primarily with the Goliad Formation and sand-rich portions of the Lagarto Formation (Shi and others, 2022; Baker, 1979). The Burkeville Confining Unit generally corresponds to the more clay-rich middle Fleming Formation and hydraulically separates the Evangeline from the deeper Jasper Aquifer, which includes the lower Fleming and Oakville formations (Shi and others, 2022; Baker, 1979).

GEOPHYSICAL LOG REVIEW

AGS reviewed a total of 13 geophysical logs from oil and/or gas wells or test holes within or near the POV site. This information was considered during the development of the conceptual well field. As a result of this review, conceptual POV pumping was modeled in the slightly saline zone (Layer 8) and the moderately saline zone (Layer 9) of the Lower Goliad formation.

CENTRAL GULF COAST BRACKISH GROUNDWATER FLOW MODEL

The Central Gulf Coast Brackish Groundwater Flow Model is a three-dimensional MODFLOW 6 groundwater flow model that includes fifteen model layers representing the nine geologic formations that comprise the Gulf Coast Aquifer System in Victoria, Jackson, Calhoun, and Refugio counties (Yang and Others 2026).

Salinity classification and Total Dissolved Solids (TDS) concentration data from the INTERA brackish groundwater resources study and CGCBGWFM (Yang and Others 2026) were reviewed to identify the salinity classification of each CGCBGWFM layer at and in the vicinity of the POV site. At the POV site, model Layers 1 through 6 generally represent freshwater zones, with TDS concentrations less than 1,000 milligrams per liter (mg/l). Model Layers 7 through 8 generally represent slightly saline zones, with estimated TDS concentrations between 1,000 and 3,000 mg/l, and model Layers 9 through 11 generally represent moderately saline zones, with estimated TDS concentrations

between 3,000 and 10,000 mg/l. Model Layers 12 through 15 generally represent very saline zones with estimated TDS concentrations greater than 10,000 mg/l.

Figures 2 through 5 show the modeled distribution of TDS based on each CGCBGWFM layer at the POV site from the deepest freshwater layer (Layer 6) in the Upper Goliad Formation to the uppermost moderately saline layer (Layer 9) in the Lower Goliad Formation.

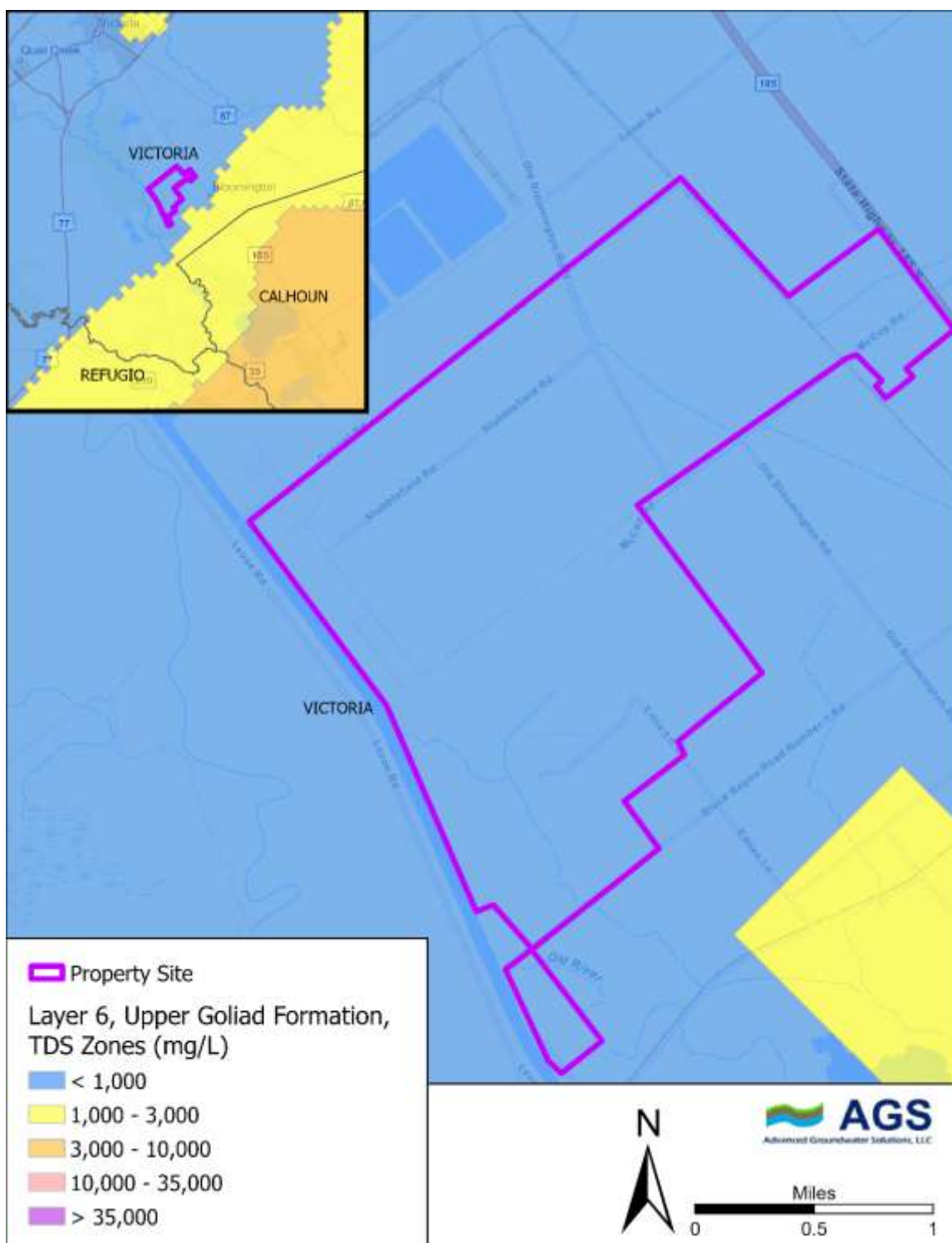


Figure 2. TDS Estimates in the Freshwater Zone in the Vicinity of the Port of Victoria Site based on CGCBGFM Layer 6 (Upper Goliad)

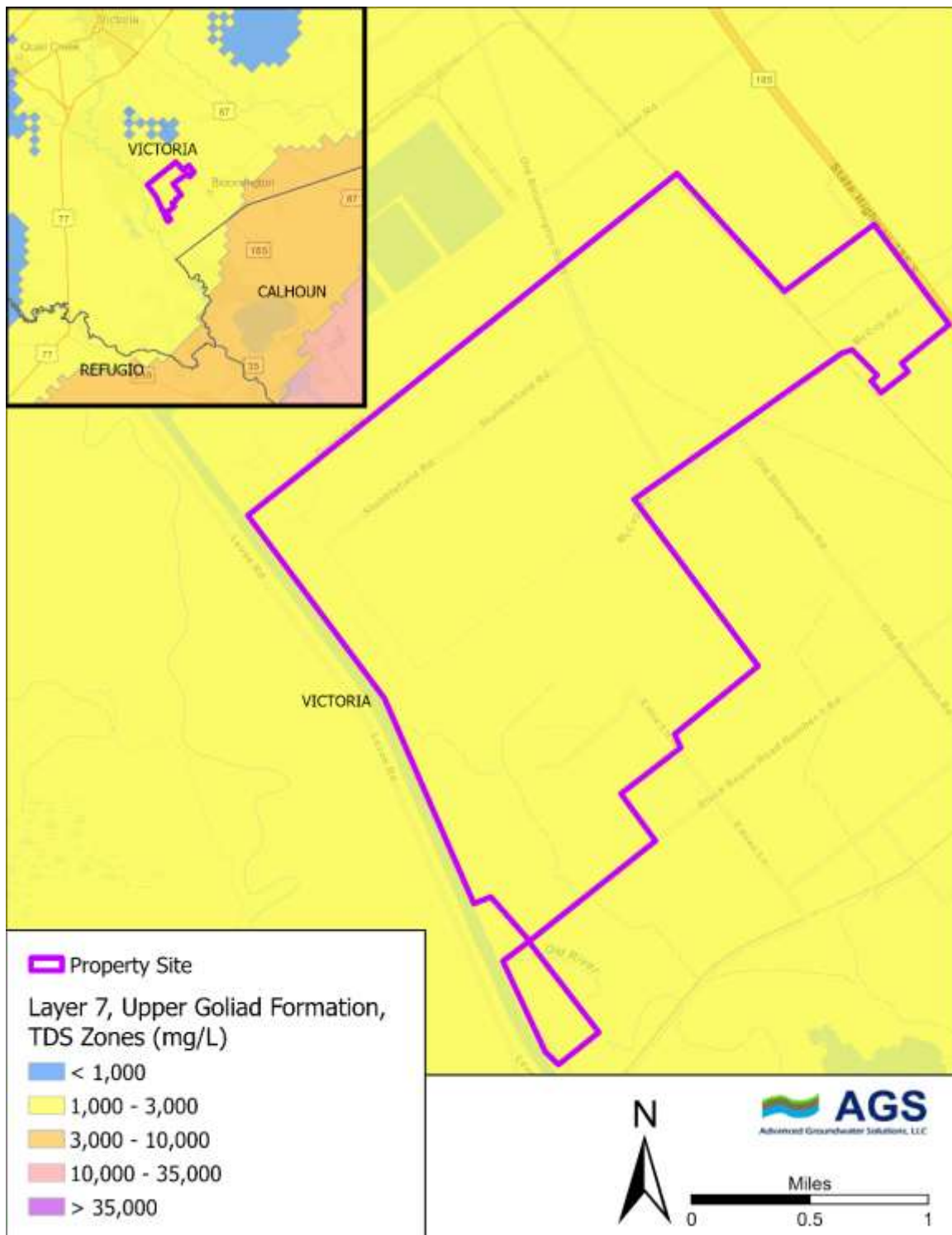


Figure 3. TDS Estimates in the Slightly Saline Zone in the Vicinity of the Port of Victoria Site based on CGCBGFM Layer 7 (Upper Goliad)

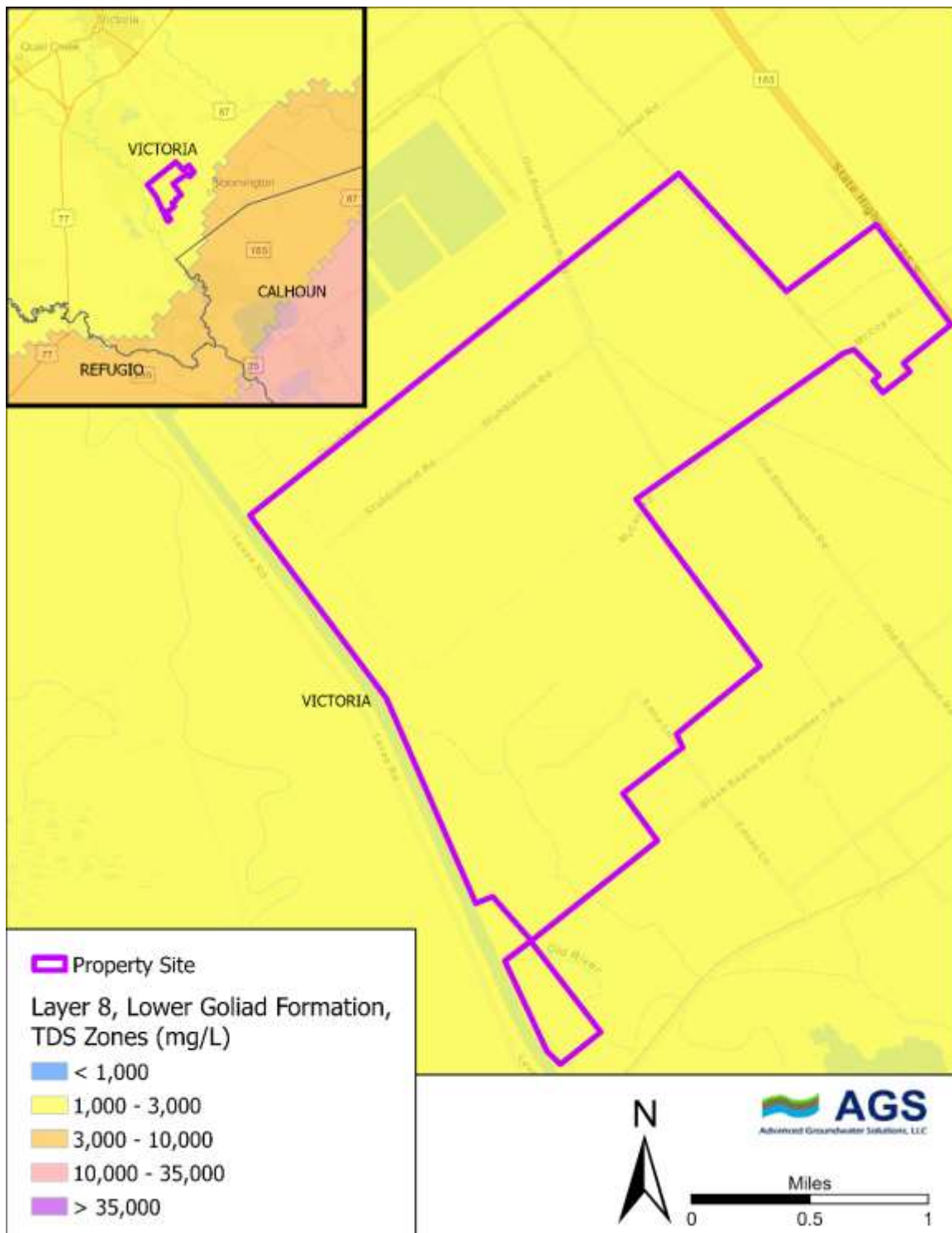


Figure 4. TDS Estimates in the Slightly Saline Zone in the Vicinity of the Port of Victoria Site based on CGCBGFM Layer 8 (Lower Goliad)

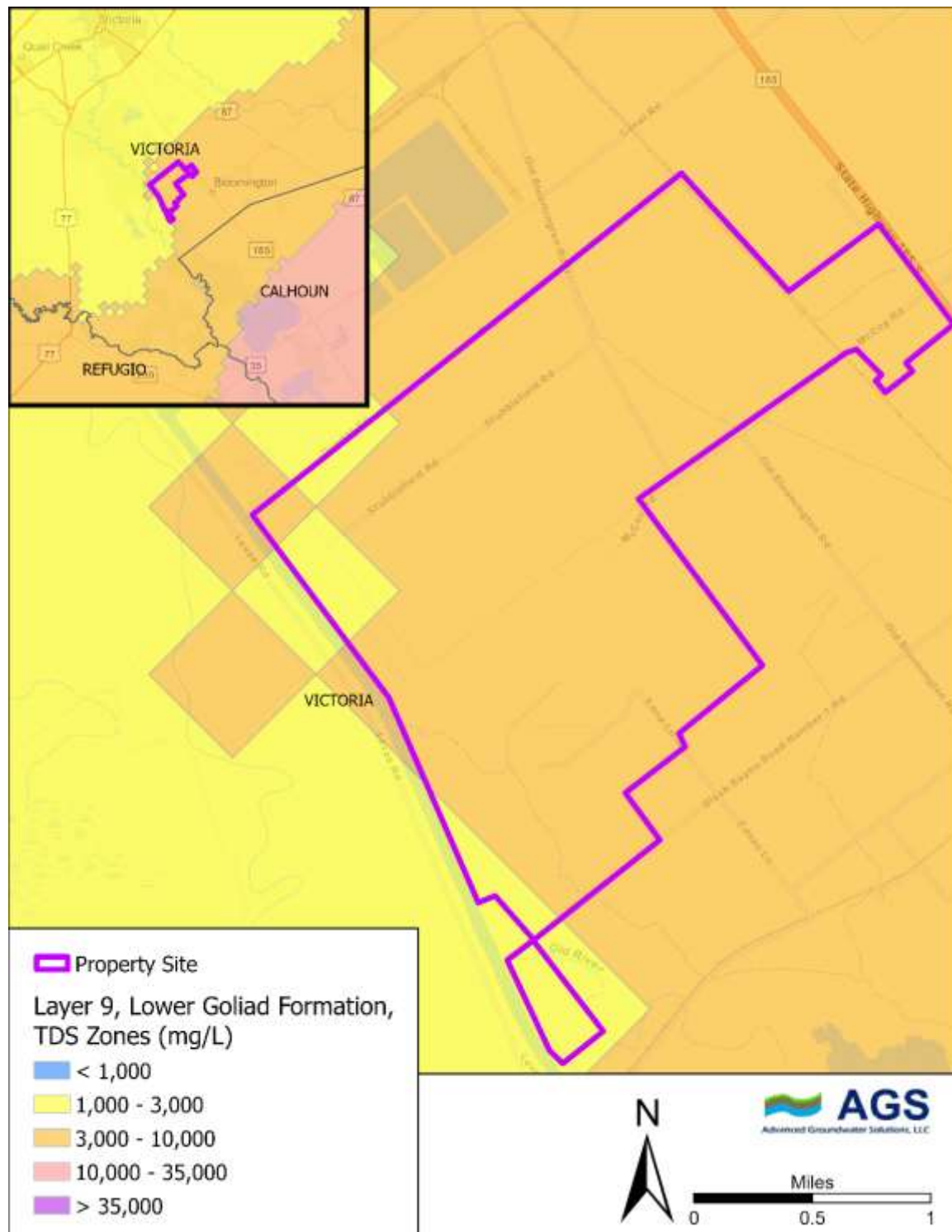


Figure 5. TDS Estimates in the Moderately Saline Zone in the Vicinity of the Port of Victoria Site based on CGCBGFM Layer 9 (Lower Goliad)

To support POV's application to produce 18,000 AFY of slightly saline groundwater and 10,000 AFY of moderately saline groundwater from the Goliad Saline Groundwater Zone, AGS averaged model layer elevations across the POV site to estimate the depths of potential well production zones:

- The average top of Layer 1 at the POV site is 51 feet; this value was used as the estimated average land surface elevation at and in the vicinity of the POV site.
- The average base of freshwater (Upper Goliad, Layer 6) at the POV site occurs at a depth of about 1,222 feet (elevation: -1,171 feet, relative to sea level (rsl)).
- The upper slightly saline zone (Upper Goliad, Layer 7) at the POV site occurs in the average depth interval of about 1,222 to 1,423 feet (elevation: -1,171 to -1,372 feet, rsl).
- The lower slightly saline zone (Lower Goliad, Layer 8) at the POV site occurs in the average depth interval of about 1,423 to 1,619 feet (elevation: -1,372 to -1,568 feet, rsl).
- The upper moderately saline zone (Lower Goliad, Layer 9) at the POV site occurs in the average depth interval of about 1,619 to 1,815 feet (elevation: -1,568 to -1,784 feet, rsl).

CONCEPTUAL WELL FIELDS

The CGCBGWFM and area geophysical logs were used to develop two conceptual well fields that screen brackish sands in the slightly saline and moderately saline zones within the Goliad Saline Groundwater Zone. Figure 6 shows both wellfields, with the proposed well locations screened in the slightly saline and moderately saline zones. Well locations on the POV site were chosen to reduce interference drawdown, with reasonable spacing, while avoiding planned infrastructure.

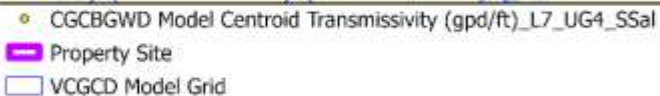
AGS anticipates that wells completed in the slightly saline zone could screen brackish sands in depth intervals between approximately 1,400 and 1,600 feet. AGS anticipates that wells completed in the moderately saline zone could screen brackish sands in depth intervals between approximately 1,600 and 1,800 feet. AGS anticipates that test holes and/or wells will include geophysical logging and that water sampling will be conducted to gain site-specific data as the well fields are developed.

Based on model transmissivity and estimated sand thickness from geophysical logs, AGS estimates that a properly constructed and developed well completed in the slightly saline zone could produce about 500 gallons per minute (gpm) and that a properly constructed and developed well completed in the moderately saline zone could produce about 400 gpm. However, actual production will vary based on local aquifer conditions.

The conceptual well field in the slightly saline zone (Layer 8) has 23 wells with an average production rate of 485 gallons per minute (gpm) to produce 18,000 AFY. The conceptual well field in the moderately saline zone (Layer 9) has 16 wells with an average production rate of 388 gpm to produce 10,000 AFY. These average production rates are included in this submittal for purposes of modeling; each well's actual production capacity is expected to vary based on local conditions. Figures 7 through 9 show the transmissivity estimates in CGCBGWFM Layers 7, 8, and 9 at the POV site.



Figure 6. Conceptual Well Field at the Port of Victoria Site



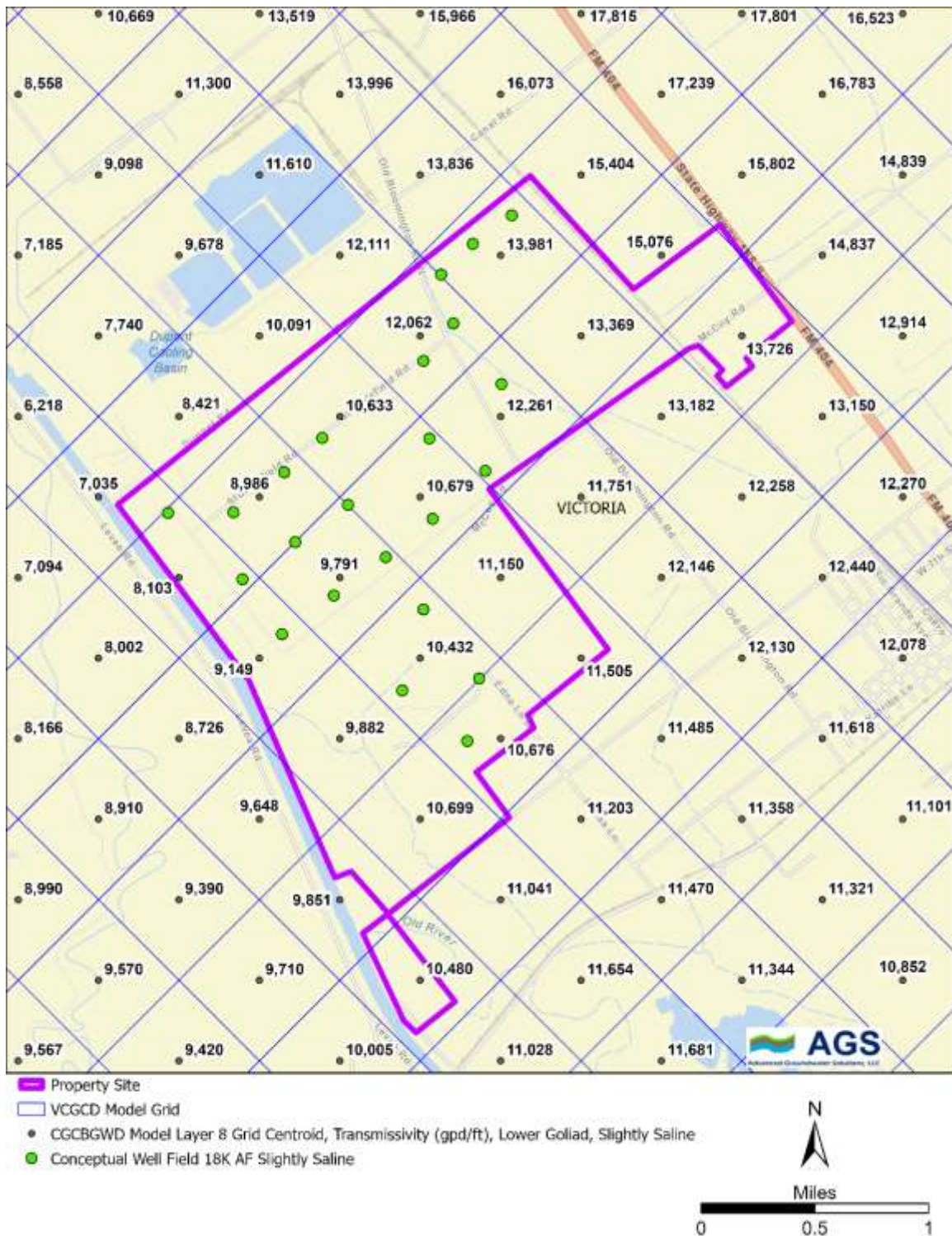


Figure 8. Transmissivity Values in the Vicinity of the Port of Victoria Site based on CGCBGFM Layer 8 (Lower Goliad)



Figure 9. Transmissivity Values in the Vicinity of the Port of Victoria Site based on CGCBGFM Layer 9 (Lower Goliad)

WELL FIELD MODEL SCENARIOS

The CGCBGWFM was used to evaluate impacts associated with the proposed pumping of 28,000 AFY within the slightly and moderately saline zones, with 18,000 AFY produced from the slightly saline zone and 10,000 AFY produced from the moderately saline zone. AGS evaluated the conceptual well field scenarios—23 wells each pumping 485 gpm from the slightly saline zone (Layer 8) and 16 wells each pumping 387 gpm from the moderately saline zone (Layer 9)—for a simulated continuous pumping period of 30 years.

Drawdown was estimated as the difference between the initial static groundwater levels and the simulated groundwater levels at the end of the 30-year pumping period. Table 1 summarizes the average and maximum 30-year drawdown from the conceptual well fields. The average 30-year drawdown across the POV site is approximately 730 feet in the slightly saline zone and 632 feet in the moderately saline zone, while the corresponding maximum drawdowns are approximately 811 feet and 664 feet, respectively. In the Freshwater zone (Layer 6), the average and maximum drawdown at the POV site are 34 and 35 feet, respectively.

Table 1. Average and maximum 30-year simulated drawdown across the POV site.

Drawdown	Model Layer	30-Year Drawdown (feet)
Average	Layer 6 (Freshwater)	34
Maximum		35
Average	Layer 8 (Slightly Saline)	730
Maximum		811
Average	Layer 9 (Moderately Saline)	632
Maximum		664

Figures 10 through 12 show the simulated 30-year drawdown contours at the POV site for the freshwater zone (Layer 6), the slightly saline zone (Layer 8), and the moderately saline zone (Layer 9), respectively. The simulated drawdown contours indicate up to 750 feet of drawdown, over 30 years, in the slightly saline zone (Layer 8) and 650 feet in the moderately saline zone (Layer 9). In contrast, the simulated drawdown contours in the freshwater zone (Layer 6) were relatively small, with a maximum drawdown of about 35 feet experienced after 30 years of continuous pumping.

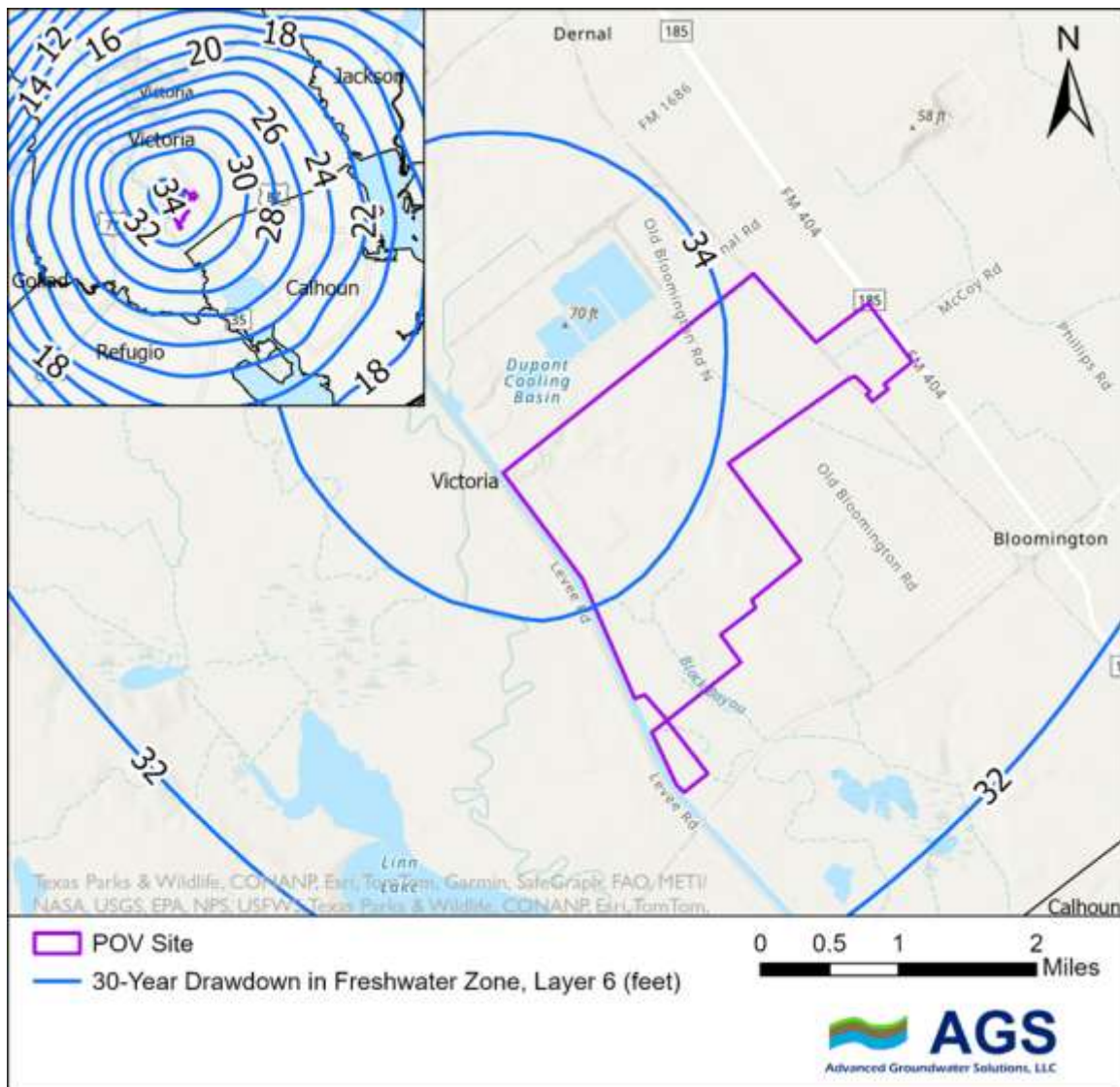


Figure 10. Simulated 30-year Drawdown in the Freshwater Zone (Layer 6).

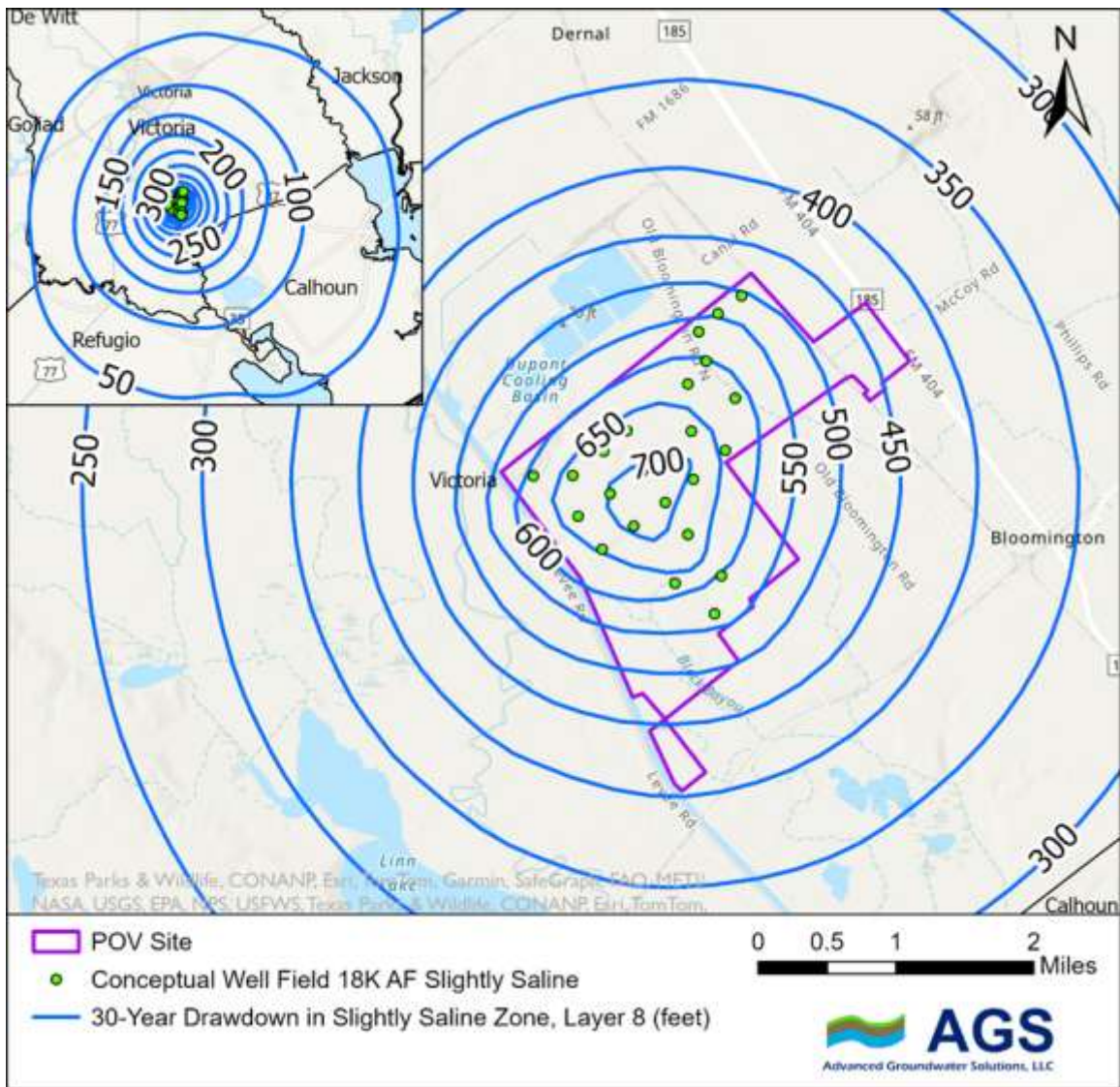


Figure 11. Simulated 30-year Drawdown in the Slightly Saline Zone (Layer 8).

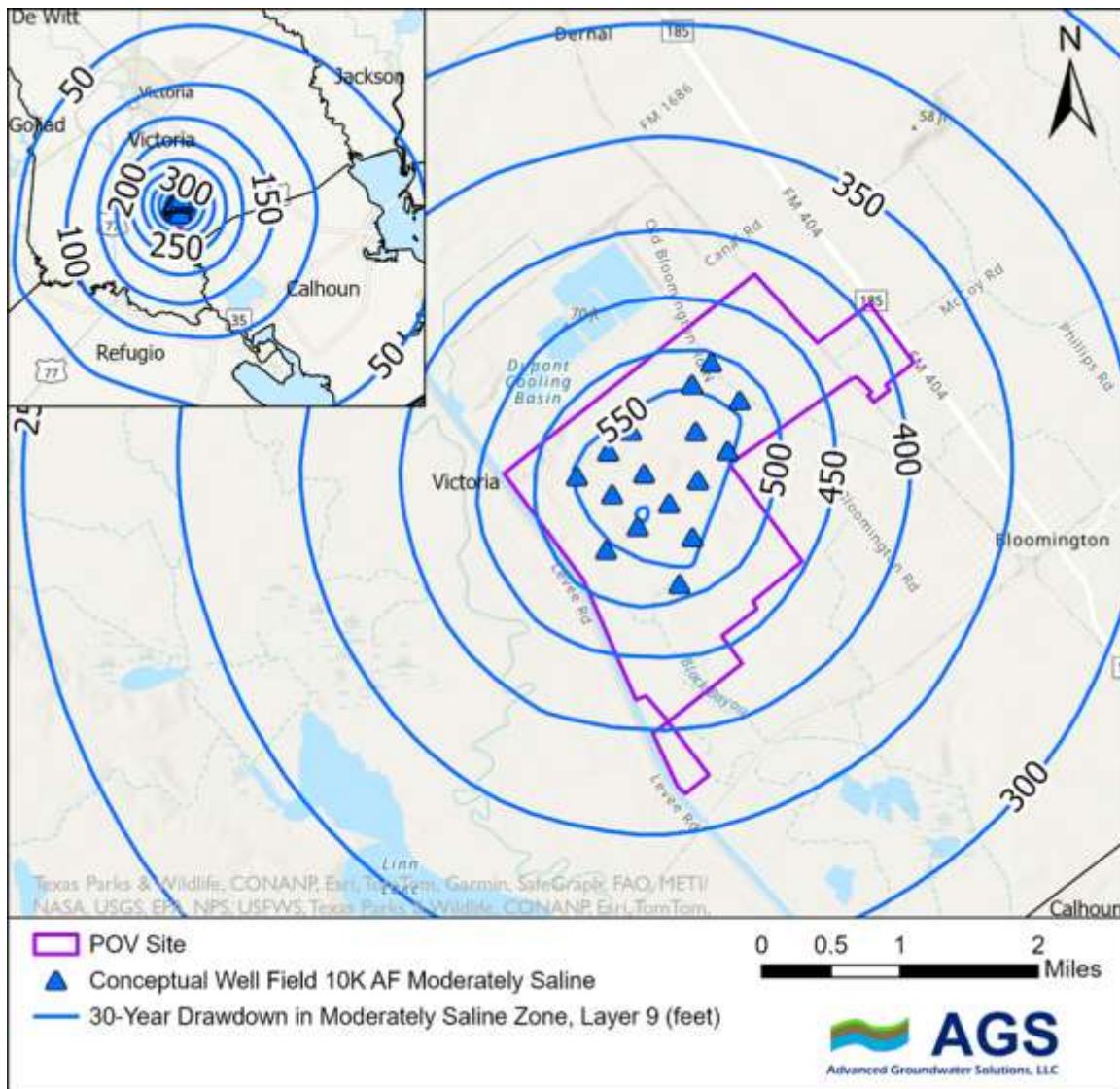


Figure 12. Simulated 30-year Drawdown in the Moderately Saline Zone (Layer 9).

HISTORIC WATER LEVELS NEAR THE SITE

Well and aquifer data from the TWDB Groundwater Database (GWDB) and VCGCD Water Well Database were assembled and reviewed. The VCGCD Well Database shows that the nearest registered water wells that have well depths greater than 800 feet are located between 1.5 to 2.0 miles northeast of the POV proposed well fields and have total depths ranging from 1,026 to 1,130 feet. Additionally, the TWDB GWDB shows the nearest wells with total well depths greater than 800 feet and are located between about 1.5 miles to the northwest and about 0.75 to 3 miles southeast. The wells in the TWDB GWDB have total well depths ranging from 820 to 1,130 feet. The locations of these wells are shown on Figure 13.

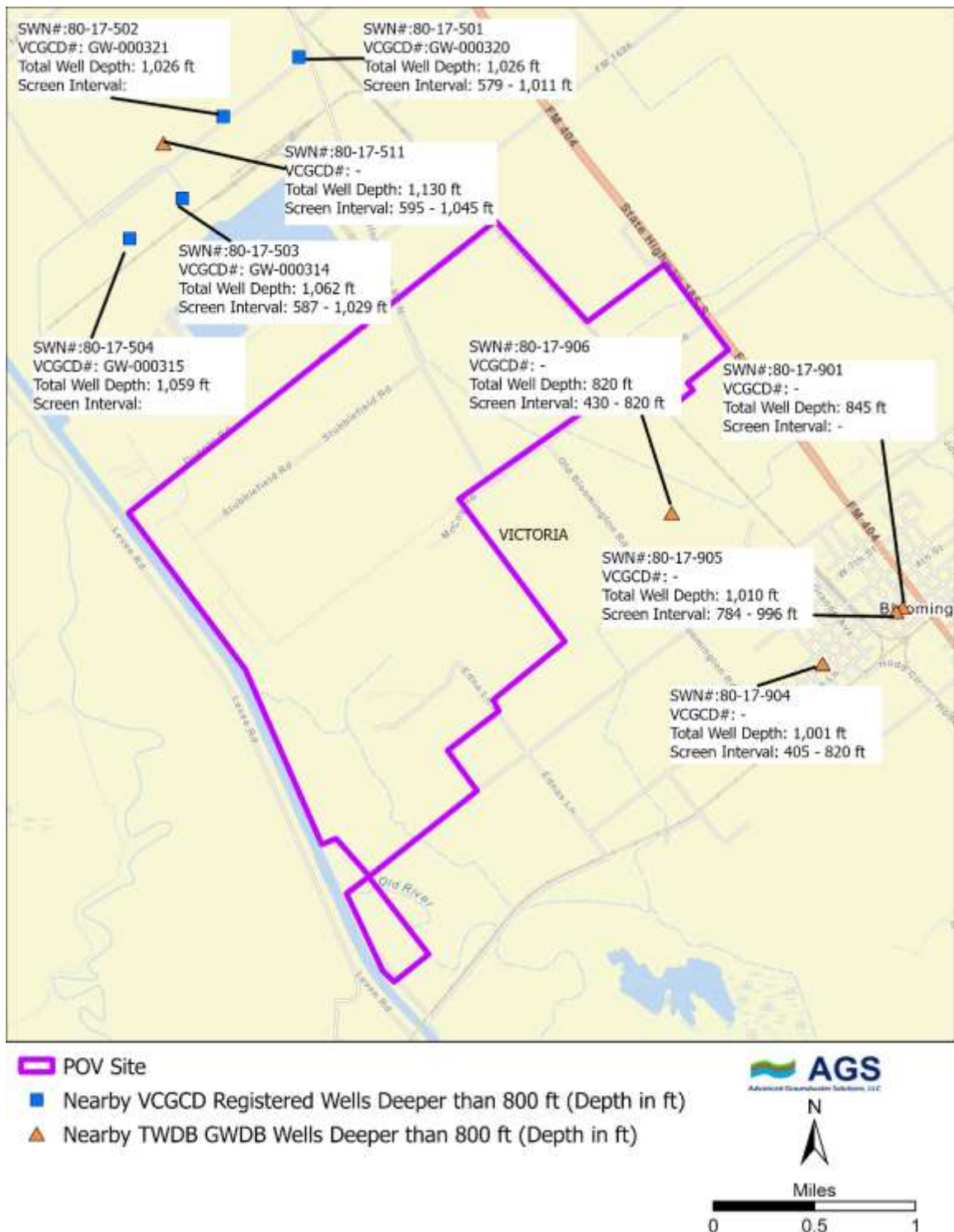


Figure 13. Locations of Wells near the Port of Victoria Site with Total Well Depths Greater than 800 feet.

TWDB water-level data for wells near the POV site screening the Goliad Sand (Evangeline Aquifer) provides information regarding the historical hydraulic pressure heads of the aquifer sands screened by deeper wells. Figure 14 shows historic static water level for select wells near the POV site. The lowest water levels measured in the freshwater zone in the area near POV's site occurred from about 1980 through 2000; at that time, water levels were about 70 feet below land surface (bls). Since that time, the measured water levels in the freshwater zone have increased to about 35-40 feet bls from about 2005 through 2024 (the most recent data available).

Based on modeled results from the CGCBGWFM, the maximum anticipated additional water level decline in the Freshwater Zone (Layer 6) caused by the POV pumping 28,000 AFY from the slightly and moderately saline layers would be between 34 and 35 feet after 30 years of pumping. When this modeled water level decline (approximately 34 feet) is added to current water levels (35-40 feet bls), the depth to water is about 70-75 feet bls. This estimated depth-to-freshwater water level is very similar to water levels experienced in the Freshwater Zone in this area during the years 1980 - 2000.

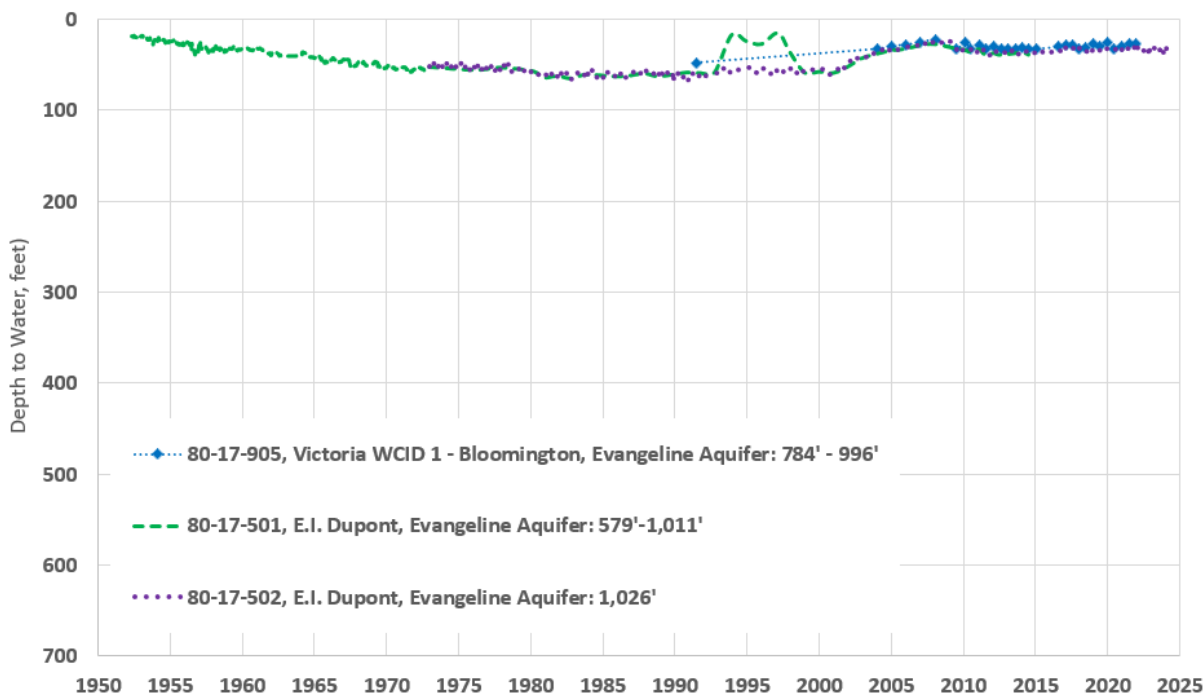


Figure 14. Static Water Level Hydrographs for three Wells near the Port of Victoria Site.

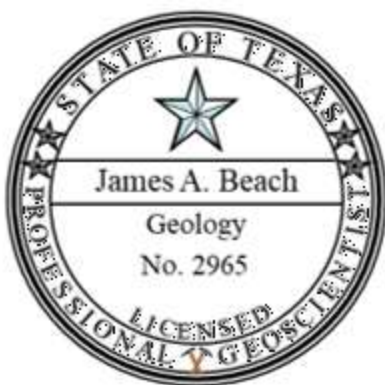
FINDINGS

- The POV is asking for a permit from the Victoria County Groundwater Conservation District (VCGCD) to produce 28,000 acre-feet per year (AFY) of brackish groundwater from the deep-saline special groundwater management zone within Victoria County called the “Goliad Saline Groundwater Zone.” POV proposes producing 18,000 AFY from the slightly saline zone and 10,000 AFY from the moderately saline zone.
- AGS reviewed the CGCBGWFM and local geophysical logs to develop two conceptual well fields that screen the slightly saline and moderate salinity zones within the Goliad Saline Groundwater Zone.
- To produce 28,000 AFY, POV proposes two wellfields: one wellfield with 23 wells, pumping at an average rate of 485 gpm from the slightly saline zone, and the other wellfield with 16 wells pumping at an average rate of 387 gpm from the moderately saline zone.
- Using the CGCBGWFM model to simulate continuous pumping from all conceptual wells for a 30-year period, the maximum simulated drawdown is 35 feet in the freshwater zone (Model Layer 6), 811 feet in the slightly saline zone (Model Layer 8), and 664 feet in the moderately saline zone (Model Layer 9) at the POV site.
- Historic water levels in the Evangeline Aquifer have been generally less than 70 feet below ground surface. The lowest water level to freshwater was from about 1980 through 2000; these water levels have increased to about 40 feet below ground surface during the period 2005 through 2024 (the most recent data available).
- Based on modeling results, the additional water level decline predicted in the Freshwater Zone (Layer 6) from POV pumping 28,000 AFY would be about 34-35 feet. When this modeled water level decline is added to current water levels (35-40 feet bls), the depth to water is about 70-75 feet bls. This estimated water level is the very similar to the water levels that have already been experienced in the Freshwater Zone in this area during the years 1980 - 2000.

REFERENCES

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GEOSCIENTIST'S SEAL



James Beach

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