

Deep Brackish Groundwater Development Rule Framework

- Volume Limitation by TDS Concentration
 - Slightly Saline Groundwater Total Dissolved Solids Concentration: 1,000 mg/L to 3,000 mg/L
 - Estimate of Available Slightly Saline Groundwater: 947,550 Acre-Feet (1% of volume)
 - Sustainable Annual Brackish Groundwater Production Level: 18,951 Acre-Feet per Year (based on 50 year period; 1/50th of Estimate of Available Slightly Saline Groundwater)
 - Moderately Saline Groundwater Total Dissolved Solids Concentration: 3,000 mg/L to 10,000 mg/L
 - Estimate of Available Slightly Saline Groundwater: 763,120 Acre-Feet (1% of volume)
 - Sustainable Annual Brackish Groundwater Production Level: 15,262 Acre-Feet per Year (based on 50 year period; 1/50th of Estimate of Available Moderately Saline Groundwater)
- Production Limitations Dependent on Formation, depth, and TDS concentration
 - Allocation Ratio(Average Acre-Feet per Year per Contiguous Acre Controlled)

Formation Groups	Formation Conditions (Depth of Top of Well Screen; Total Dissolved Solids concentration of groundwater)		
	Depth > 1300 ft	Depth > 1800 ft	Depth > 2,200 ft
	TDS > 1,500 mg/L	TDS > 2,500 mg/L	TDS > 5,000 mg/L
Upper Goliad Lower Goliad	10 AFY/acre	13 AFY/acre	16 AFY/acre
Oakville	6 AFY/acre	8 AFY/acre	10 AFY/acre
Upper Lagarto Middle Lagarto Lower Lagarto	4 AFY/acre	5 AFY/acre	6 AFY/acre

- Time Period for Permit
 - Total Volume Set for a Five-Year Period (AFY/acre * 5 years)
- Temporal Pumping Restrictions
 - No more than 7 percent of the permitted volume will be allowed to be pumped over any two-month period. (limit to three times average rate)
- Spacing and Well Construction Requirements
 - Horizontal Spacing of Wells
 - Rules 5.1 apply (spacing to property boundary, spacing to closest well)
 - no registered well with a portion of its well screen below a depth of 800 feet bgs will be closer than 0.5 miles of a production well
- Monitoring Requirements
 - Pump Test Requirements:

- Well owners will submit the results of a 36-hour aquifer pumping test to the District within two months after start of production. The aquifer pumping test will be performed prior to the start of production. The aquifer pumping test will consist of pumping the well at a constant rate, measuring water levels in the production and all observation well, and calculating hydraulic properties for the aquifer. The aquifer pumping test will be conducted in accordance to an aquifer pumping test workplan developed by the applicant and approved by the District. At a minimum, the aquifer pumping test work plan will provide the following:
 - a.) Plots showing the measured pumping rate and measured water levels
 - b.) Baseline water level for each observations well that will be used as the datum for determining drawdown for each observation well
 - c.) Documentation of the methodology and assumptions used to calculate aquifer hydraulic properties
 - d) Predictions of water levels and TDS concentrations in the pumping well and observation wells at 1, 5, 10, 20, and 30 years. Predication of contours for drawdown of 5 ft, 10 ft, 20 ft, 50ft, and 100 ft for formation containing the production well and for the formations that exist between the top of the well and the ground surface.
 - e) A geophysical log for the production well that includes a temperature, spontaneous potential, and shallow and deep resistivity surveys
 - f) A methodology for estimating drawdown in the pumped formation based on the measured pumping rates for the production well and the measured drawdown values for the production well and the sentry wells.
- Monitoring Well Requirements:
 - For each production well, a vertical sentry observation well will be installed. The vertical sentry well will be located within 300 feet of the production well. The vertical sentry well will have a continuous 50-foot well screen and will meet at least one of the following criteria: 1.) the groundwater will have a TDS concentration greater than 900 mg/L or 2.) no portion of the well screen will exist above a depth of 900 ft bgs
 - If the annual permitted volume exceeds 2,000 AF the well owner will install a horizontal sentry well in addition to the required vertical sentry wells. The horizontal sentry well will be at the property boundary where the greatest amount of drawdown is predicted to occur. The horizontal sentry well will have a 100-foot well screen that intersects major sand units located at elevations associated with the well screen for the closest production well associated with the well permit.
 - The well owner will grant the District permission to install a GPS measurement unit to measured changes in the elevation of land surface in order to monitor for land subsidence.
- Monitoring Data Collection Requirements and Protocols:

- The well owner will prepare a workplan for the collection and analysis of monitoring data. The workplan will list the equipment to be used for measuring water levels and pumping rates and will explain the file structure that will be used to store, manage, and report the data to the District. The workplan will protocols for manually checking the accuracy of the measuring equipment and a description of the planned data analysis.
 - The monitoring equipment will be designed to measure the water levels at a frequency of at least hour or better. At a minimum , the pumping will be measured by recording the daily total pumpage.
 - Monitoring Data Analysis and Reporting:
 - Well owners of permitted wells will submit monthly monitoring well reports. The reports will be due to the District within 30 days after the end of the month.
 - All well owners will provide monitoring data for the pumped well that consists of: 1.) Total volume of pumped groundwater in units of gallons. 2.) Hourly water level measurements. 3.) Measured water quality parameters listed in Table below every six months.

Water Quality Parameter	Analysis Method
Total Dissolved Solids	Method M2540C
Metals	ICPMS (0.45u filtered): SW6020A
Specific Conductance	M2510 B
Alkalinity	M2320 B
pH	M4500-H+ B
Anions	IC method - Water (E300)

- All well owners will provide hourly water level measurements for all vertical sentry wells and all horizontal sentry wells.
 - **Performance Criteria**
 - Modeled Impacts:
 - The drawdown impacts caused by the pumping of the production well will be less than 10 feet at any registered well in VCGCD that outside of the property owned or leased by the well owner. The methodology used to predict drawdown impacts will be checked using measured water levels in the vertical and horizontal sentry wells.
 - Measured Water Level
 - Measured drawdowns in the vertical sentry wells that is caused by the pumping from the production well will be less than 20 ft in the vertical sentry wells
 - Measured Land Surface Change

- At the location where the change the land surface elevation is being monitored, the measured land surface change that is attributed to the production pumping will be less than 1 foot.
 - Measured Change in Ambient Groundwater Salinity within Zone:
 - groundwater pumped by the production well will have a TDS concentration no less than 1,500 mg/L and not greater than 10,000 mg/L.
 - Measured Change of Ambient Groundwater Salinity outside Zone:
 - commingling of waters outside of the well will not cause degradation of groundwater in any of the pumped aquifers
- Performance Triggers and Responses
 - Trigger 2 at Vertical Sentry Well
 - if the monthly average of the daily drawdown in any vertical sentry well exceeds 15 feet ,
 - Response:
 - the well owner will notify the District within 5 calendar days. Within 30 days of notifying the District, the well owner will submit a correction action plan that will adjust pumping rates, pumping schedule, and total pumping to prevent drawdown from exceeding 20 feet in any vertical sentry well.
 - Trigger 2 at Vertical Sentry Well:
 - the m monthly average of the daily drawdown in any vertical sentry exceeds 20 feet two consecutive months.
 - Response:
 - the well owner will notify the District within 5 calendar days and will reduce pumping to the lesser of 1) 90% of the permitted average annual pumping rate ; 2) 90% of the average rate for the previous month;
 - Trigger 3 at Vertical Sentry Well:
 - If the monthly average of the daily drawdown in any vertical sentry well exceeds 20 feet for three consecutive months or exceeds 30 feet for the monthly average
 - Response:
 - the permit for the production well will be modified so that the production pumping rate will not exceed an average rate of 200 gallons per minute (gpm) over a 24 hour period
 - Trigger 4 at the Horizontal Sentry Well
 - If the monthly average of the daily drawdown at the horizontal well sentry well is greater than 150 feet
 - Response:
 - the well owner will notify the District within 5 calendar days. Within 30 days of notifying the District, the well owner will submit prediction of land subsidence that may occur as a result of the drawdown caused by permitted groundwater production

- The well owner will pay the district \$15,000 to assist the District efforts to measure and better land subsidence .
- Trigger 5 at the Horizontal Sentry Well or GPS Measurement Location
 - If the monthly average of the daily drawdown at the horizontal well sentry well is greater than 300 feet or the measured land subsidence that is attributed to the production pumping is greater than 1 foot
 - Response:
 - the permit for the production well will be modified so that the production pumping rate will not exceed an average rate of 200 gallons per minute (gpm) over a 24 hour period.