APPENDIX 10: CRITICAL PRESSURE CALCULATION
CTV II

1. Critical Pressure Calculation

At the project area, the underground source of drinking water (USDW) is Undifferentiated Non-Marine formation at around 2,400 feet true vertical depth (feet TVD) based on the lowermost USDW, and the average total dissolved solids (TDS) concentration is 8,500 parts per million (ppm). The top of the Injection Zone is 9,500 feet TVD, and TDS concentration is approximately 15,000 ppm.

Figure 1 is a schematic representing the local stratigraphy of the project area, highlighting the west side of the Stockton Arch fault and proposed Injection Zone.

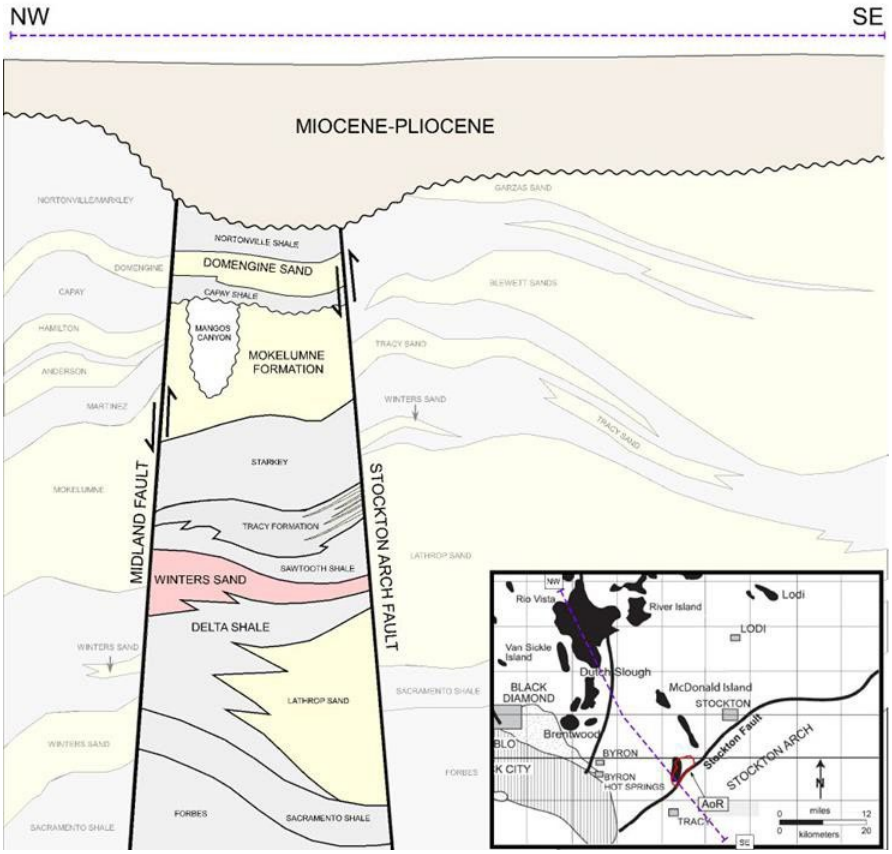

Figure 1. Schematic northwest to southeast cross section in the Sacramento basin, intersecting the project AoR.

The injection wells will inject carbon dioxide (CO_2) into the Cretaceous-aged Winters Formation, located in the Stockton Arch footwall. The footwall injection depth is approximately 9,500 feet TVD. The Winters Injection Zone has a known reservoir capacity demonstrated by historical gas production. Cumulative production is 292 full field billion cubic feet (bcf) of gas and 3.4 full field million stock tank barrels (MMSTB) water, lowering reservoir pressure from 5,040 pounds per square inch (psi) to 1,200 psi. In the area of review (AoR) scenario, CO_2 was injected into the depleted Winters Formation Union Island gas reservoir until the reservoir pressure reached 90% of the discovery pressure of 5,040 psi. No place has pressure above discovery occurring. The final reservoir pressure post injection is shown in **Figure 2a.** Pressure increase at the end of injection is shown in **Figure 2b.** Pressure difference distribution between the end of injection and the discovery shows in **Figure 4**. Because of the flow barrier between North and South, the pressure build up is different for both sides.

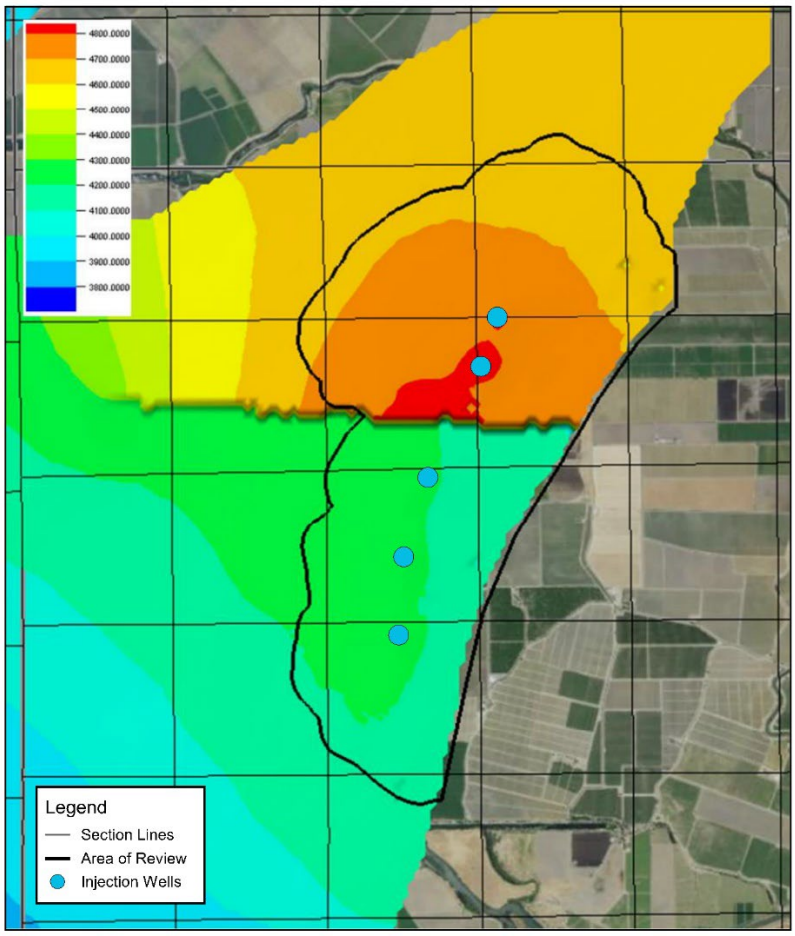

Figure 2a. CTV II storage project reservoir pressure at end of injection.

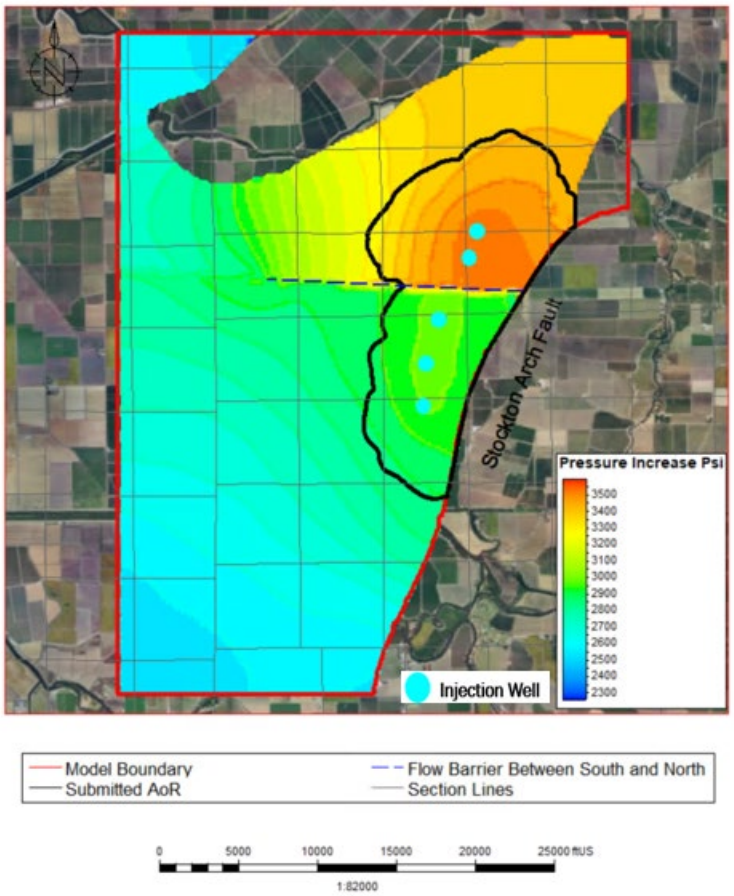

Figure 2b. CTV II storage project reservoir pressure increase at end of injection.

The threshold pressure front is defined as the minimum pressure within the injection zone necessary to cause fluid flow from the injection zone into the formation matrix of the USDW through a hypothetical conduit, which is referenced in the U.S. Environmental Protection Agency (EPA) AoR and Corrective Action Guidance. Specifically, the following equation was used:

$$P_{i,f} = P_u + \rho_i g \cdot (z_u - z_i)$$

where $P_{i,f}$ = Injection zone Pressure, megapascals (MPa)
P_u = Base of USDW zone pressure, MPa
ρ_i = Injection Zone brine density, kilograms per cubic meter (kg/m^3)
Z_i = Injection Zone depth, meters above mean sea level (m msl)
Z_u = Base of USDW zone depth, m msl
g = Acceleration due to gravity, 9.81 m/s^2

An average TDS concentration of 15,000 ppm with density of 1,008.2 kg/m^3 was used for the Injection Zone based on water analysis, and an average TDS concentration of 8,500 ppm was assumed for the USDW based on salinity calculations in the project area. Injection zone and USDW depths in the project area are around 9500 feet TVD (2895.6 meters TVD) and 2400 feet

TVD (731.5 m TVD), respectively. This results in a USDW pressure of 1,039.2 psi (7.17 MPa) assuming the water table is at the land surface. Using the aforementioned data, the equation for the injection-zone pressure that defines the pressure front (critical pressure) is solved as follows:

$$P_{i,f} = 7.17\,MPa + \left[\left(1008.2\,\frac{kg}{m^3} * 9.81\frac{m}{s^2}\right) * (-731.5\,m - -2895.6\,m) * 1^{-6}\,\frac{MPa}{Pa}\right]$$

$$P_{i,f} = 28.6\,MPa\,(i.e.\,4143.5\,psi)$$

Figure 3 shows calculated pressure front based on USDW and Injection Zone input across the project area.

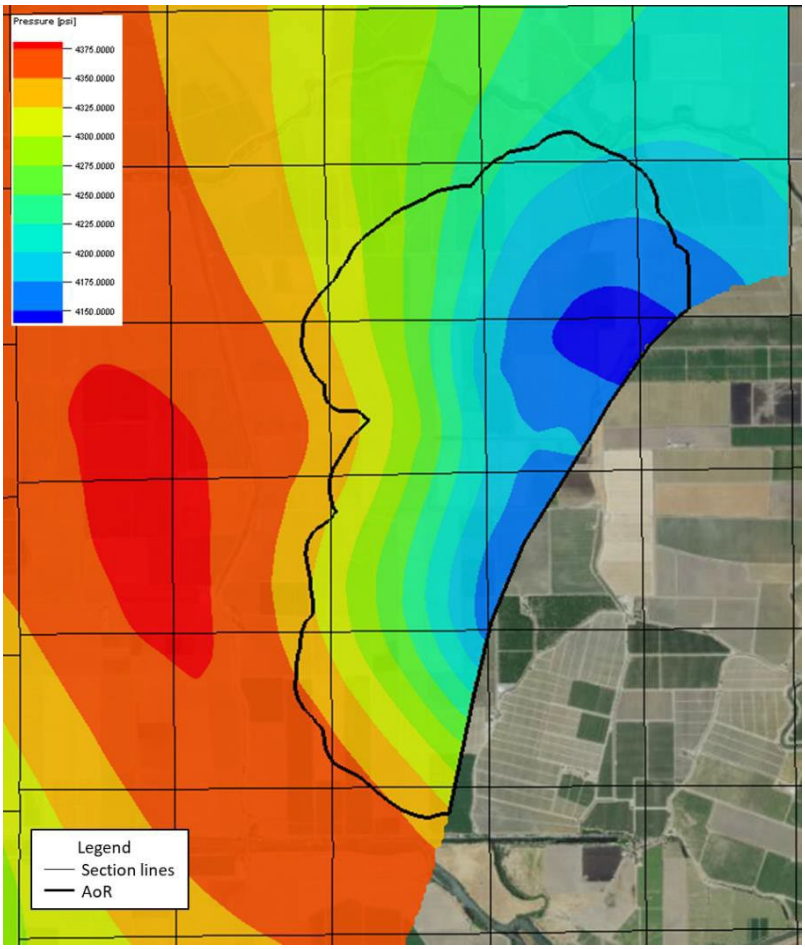

Figure 3. Threshold pressure front map in psi using the Base USDW and Winters Formation Surface.

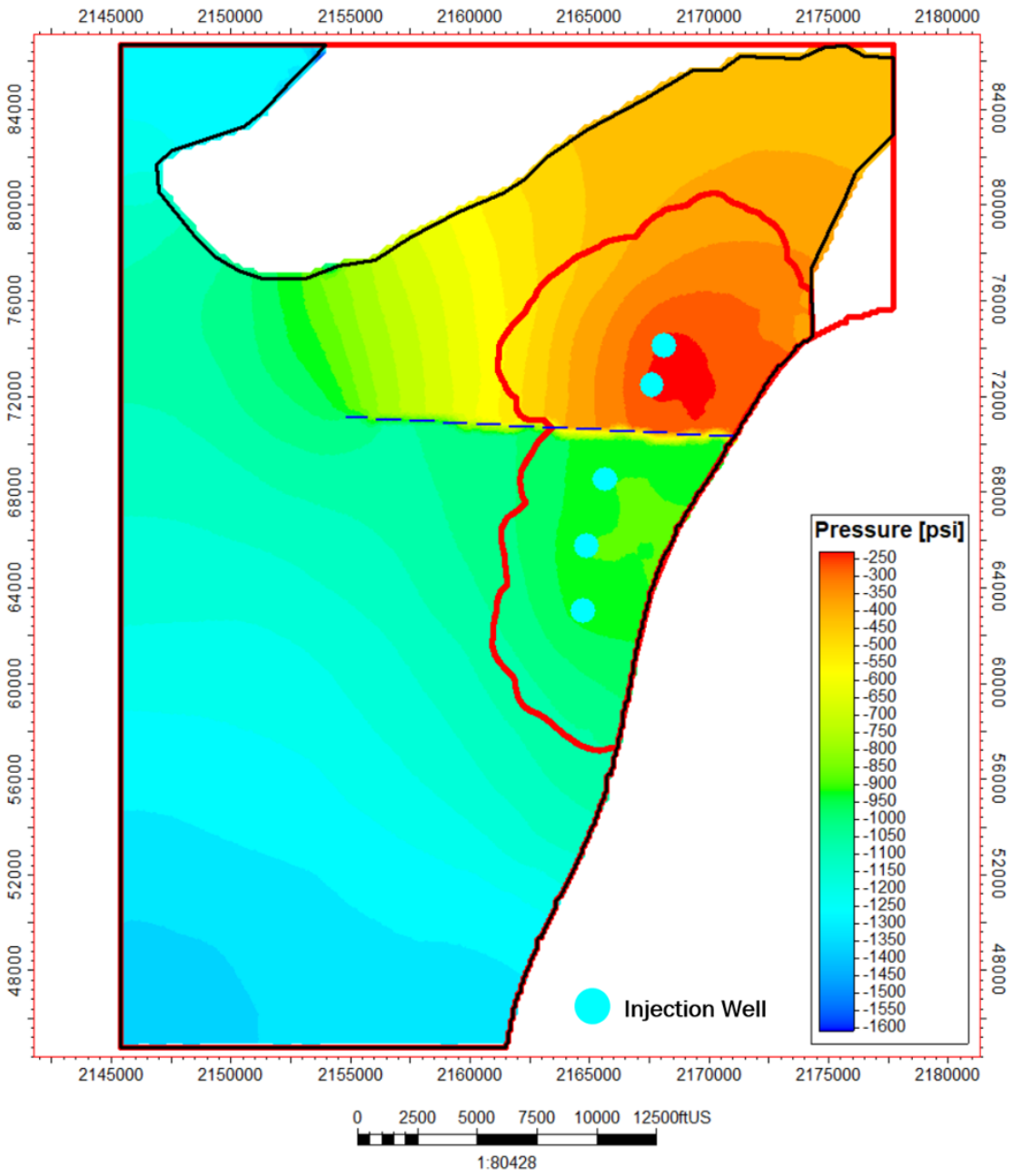

Figure 4. **Pressure difference distribution between the end of injection and the discovery (pressure at end of injection subtract discovery pressure).** No place has pressure above discovery at end of injection.

2. Summary of AoR

The final pressure of the Winters formation Union Island gas reservoir will be at or below the initial reservoir pressure to ensure that CO_2 occupies the same pore space that was initially saturated with hydrocarbons and the pressure front is at equilibrium with initial conditions. As such, CTV defines the AoR as the areal extent of the CO_2 plume.