Aquifer Water Quality

1. Due to a lack of initial understanding of the aquifer characteristics in the shallow unconfined aquifer, SWCA installed groundwater wells across the Project boundary targeting shallow groundwater. These wells and determined surface water sampling locations were monitored four times during 2022 to collect baseline data to inform the mass-balance and flow calculations presented in this report. Wells and surface water sites were monitored for field parameters (pH, specific conductivity, DO, and temperature), nitrate, total phosphorus, and *E. coli*. General conclusions resulting from the monitoring effort are listed below. In general, based on field data collected during 2022, the unconsolidated aquifer is far above the state pollution indicator threshold (0.05 mg/L) for total phosphorus in rivers/streams. Sampling results of total phosphorus and lithology observations suggest that some wells just south of the Project boundary and in the southwestern portion of the Project boundary may have elevated phosphorus due to phosphorus levels in the nearby soil that has potentially accumulated from anthropogenic sources in the Project boundary area.
2. Based on shallow water levels and general hydrology, a direct connection between the shallow, surficial aquifer and surface water features in the study area (drains, ditches, sloughs) is highly likely. Water quality in the shallow, surficial aquifer is anticipated to have a direct influence on surface water quality. As described in Section 3.2.2, the Howard Slough WMA receives most of the surface runoff from the Project boundary area and is considered among the higher quality impounded wetlands around GSL, based on data collected and assessed by UDWQ in 2014. Nitrogen and phosphorus are both considered important stressors to impounded wetlands (UDWQ 2014b). Increases in septic density would result in increased nutrient loads to the shallow aquifer, associated surface waters, and, ultimately, Howard Slough, thereby threatening to degrade the health of these important wetlands as waterfowl habitat.
3. Sampling results of nitrate concentrations showed elevated levels in the northern section of the focused study area. Wells with the highest nitrate concentrations are located downgradient of areas of concentrated septic systems (see Figure 11), which suggests that there is possible nitrate contamination from these areas that is traveling downgradient.
4. *E. coli* was not found in high concentrations in any of the groundwater wells and was only detected in high concentrations in surface water locations. This suggests that most *E. coli* contamination is traveling via surface water runoff and surface waterways.

Shallow Aquifer Characteristics

The known characteristics of the shallow aquifer within the focused study area are as follows:

1. The focused study area is characterized by very shallow groundwater, generally occurring less than 5 feet below ground surface.
2. Most potable production wells in the area draw from the deeper regional aquifer units that underlay the shallow aquifer: the Sunset and Delta aquifers. The shallow aquifer is not used for drinking water.
3. The shallow aquifer is poorly characterized by previous research, with large unknown flow components resulting from surface infiltration and potential upwelling from lower aquifers.
4. The shallow aquifer generally consists of poor-quality water characterized by high dissolved solids. All groundwater samples exhibited concentrations of TDS over 500 mg/L, with roughly 75% of

samples considered brackish (TDS between 1,000 and 10,000 mg/L), and 5% of samples considered saline (TDS greater than 10,000 mg/L).

5. No specific water quality target has been identified by Davis County for the purposes of this study; however, SWCA has selected the thresholds of 2.0 mg/L (1.5 times the current water quality), 5.0 mg/L (0.5 times the groundwater quality standard), and 10 mg/L (Utah groundwater quality standard) for assessment of nitrate loading from septic tanks.
6. Based on sampling conducted for this study in 2022, the shallow aquifer is currently impacted by nitrates. On average, across the focused study area, the nitrate concentration has been measured at about 1.32 mg/L, but elevated nitrate levels as high as 13.3 mg/L are observed in groundwater. About 17% of samples exhibit concentrations of nitrate between 2.0 and 5.0 mg/L, and an additional 7% of samples exceed 5.0 mg/L.

Mass-Balance Model and Septic System Density

General conclusions resulting from the three scenarios analyzed using the mass-balance model in Section 9.3 are listed below.

1. The amount of inflow available to dilute nitrogen loading to the aquifer—both from groundwater flow in the aquifer and other sources—is highly uncertain. For the purposes of this study, a groundwater flow of 95.1 L/s has been used, and no other flows have been assumed (surface inflow or upwelling from the aquifer). This is considered a conservative approach in that it would tend to underestimate the capacity of the aquifer to dilute nitrate rather than overestimate it. The groundwater flow of 95.1 L/s is derived from basic groundwater flow equations and best estimates of hydraulic properties of the aquifer based on available studies and field data.
2. All septic tanks will add some nitrogen to the aquifer, resulting in an increased concentration of nitrate. Using the average background concentration of 1.32 mg/L, the addition of 126 septic tanks in the focused study area above current levels would result in 2.0 mg/L nitrate concentration in the aquifer (half of the selected threshold). This represents an increase of roughly 25% from the current number of septic tanks.
3. The addition of 717 more septic tanks above current levels—which would represent roughly a 150% increase from existing septic tanks in the focused study area—would result in an exceedance of the selected water quality threshold of 5.0 mg/L. The addition of 1,848 more septic tanks above current levels—which would represent roughly a 370% increase from existing septic tanks in the focused study area—would result in an exceedance of the groundwater quality standard of 10 mg/L.
4. Within the undeveloped focused study area, the current overall density of septic systems is 12 acres per one system. A density of one septic system per 9.6 acres would result in a 2.0 mg/L nitrate concentration in the aquifer, a density of one septic system per 4.9 acres would result in a 5.0 mg/L nitrate concentration in the aquifer, and a density of one septic system per 2.6 acres would result in a 10 mg/L nitrate concentrate in the aquifer.
5. The above conclusions are based on average nitrate concentrations across the entire focused study area. There are areas within the aquifer where the selected threshold of 5.0 mg/L has already been exceeded, and further addition of nitrogen from any septic system would have an immediate negative effect on the aquifer. Refer to Section 7.2.1 for site-specific nitrate concentrations.
6. Septic tank contributions account for about 5% of total flow in the aquifer. This contribution roughly doubles to 11% of total flow in the aquifer when enough additional septic tanks are added to reach the 5.0 mg/L threshold. This illustrates the limitation of solely relying on aquifer dilution to control nitrate levels.

7. The extension of sewer systems in the focused study area would allow for a higher density of septic tank development. The extension of sewer systems may be particularly helpful in areas where water quality thresholds have already been exceeded.
8. The use of alternative septic systems would allow for an increase in the number of additional tanks and would also increase the density of septic tanks in the focused study area. If 50% of new septic systems used alternative technology, up to 188 additional tanks (a 38% increase over current levels) would reach the 2.0 mg/L threshold; this represents an additional 62 tanks above the base case scenario using solely traditional septic system technology. If 100% of new septic systems used alternative technology, up to 368 additional tanks (a 74% increase over current levels) would reach the 2.0 mg/L threshold; this represents an additional 242 tanks above the base case scenario using solely traditional septic system technology.