Appendix N

Memorandum Regarding Pure Water Monterey Groundwater Replenishment Project - Impacts of Changes in Percolation at the Salinas Industrial Wastewater Treatment Facility on Groundwater and the Salinas River

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February 11, 2015

TECHNICAL MEMORANDUM

To: Alison Imamura, Denise Duffy and Associates

From: Gus Yates, Senior Hydrologist, Todd Groundwater

Re: Pure Water Monterey Groundwater Replenishment Project: Impacts of Changes in Percolation at the Salinas Industrial Wastewater Treatment Facility on Groundwater and the Salinas River

1. INTRODUCTION

The Salinas Industrial Wastewater Treatment Facility (Salinas Treatment Facility) is located adjacent to the Salinas River about 3 miles southwest of the City of Salinas. The plant is owned and operated by the City of Salinas to treat and dispose of water primarily used to wash and prepare vegetable crops at industrial food processing facilities in Salinas. The Salinas Treatment Facility consists of an aeration pond for treatment of incoming water and three large percolation ponds that dispose of water by percolation and evaporation. Additional disposal capacity during the high-inflow season (May-October) is provided by drying beds and by temporary Rapid Infiltration Basins (RIBs) located between the main ponds and the Salinas River channel. **Figure 1** shows the locations of the ponds, RIBs, drying beds, Salinas River, shallow monitoring wells at the Salinas Treatment Facility and nearby irrigation wells.

Water that percolates from the ponds either flows a short distance through the subsurface and emerges as seepage into the Salinas River or flows downward to the shallow aquifer that is present in some places at depths of 0-80 feet, above the regionally extensive Salinas Valley Aquitard. The shallow aquifer is not used directly as a source of water supply, but gradual downward percolation from the shallow aquifer is a source of recharge to the 180-Foot aquifer, which is used for water supply in the Salinas region.

Wastewater currently treated at the Salinas Treatment Facility is one of several supplemental sources of water proposed for recycling and reuse for the Pure Water Monterey Groundwater Replenishment Project (GWR Project). Other sources include municipal wastewater, Blanco Drain, the Reclamation Ditch, Tembladero Slough and urban stormwater runoff from parts of Monterey and Salinas. A description and map of the source waters are included in section 2.7.1 of the GWR Project Draft Environmental Impact Report (DEIR). These sources would be diverted to the municipal wastewater system in varying amounts depending on availability, demand, and conditions of the various permits and agreements. The source waters would all be conveyed to the regional wastewater treatment plant (RTP) operated by Monterey Regional Water Pollution Control Agency (MRWPCA), located next to the Salinas River several miles downstream of the Salinas Treatment Facility. Some of the treated water would be delivered to agricultural users in the Castroville Seawater Intrusion Project (CSIP) service area, which encompasses 12,000 acres of coastal cropland north of the Salinas River (see map in Figure 2-2 of the GWR Project DEIR) . The rest of the water would be further purified at an advanced water treatment facility to be built within the RTP site and then conveyed south for injection into the Seaside Groundwater Basin. The injected water would augment the basin yield to replace existing sources of potable water that serve the Monterey Peninsula area.[1]

The GWR Project would alter the operation of the Salinas Treatment Facility. Currently, the only inflow is industrial wastewater produced by vegetable washing and related agricultural processing facilities in Salinas (agricultural wash water). The only outflows are evaporation and percolation. Under the proposed GWR Project, agricultural wash water would only be sent to the Salinas Treatment Facility during November-April, when irrigation demand is low. During May-October, it would be sent directly to the RTP for immediate treatment, and recycling. In addition, water stored in the Salinas Treatment Facility ponds over the winter would be pumped out and sent to the RTP. Finally, stormwater runoff from the southern part of Salinas would be added as a new source of inflow to the Salinas Treatment Facility ponds. Monthly water balances showing inflows and outflows to and from the Salinas Treatment Facility under existing conditions and with the GWR Project are presented in the following sections.

2. 2013 Salinas Treatment Facility Operations (Existing Conditions)

The water balance of the Salinas Treatment Facility during 2013 was quantified as the starting point for evaluating potential impacts. A water balance is a detailed tabulation of inflows, outflows and storage changes for a defined hydrologic system. In this case, flows and storage changes were calculated monthly. Extra measurements of flow and quality in the Salinas River near the Salinas Treatment Facility during 2013 supported calculations related to the fate of water that percolated from the ponds. Salinas Treatment Facility operations during 2013 differed from “existing conditions” for CEQA purposes in two respects. First, 2013 was an extremely dry year, which resulted in atypical net pond evaporation. Second, inflows to the Salinas Treatment Facility have been increasing in recent years and the amount of agricultural wash water sent to the Salinas Treatment Facility is projected to continue increasing in the future. Another potentially appropriate definition of baseline conditions for CEQA purposes would include inflows at the time the GWR Project goes on-line (assumed here to be 2017) and average rainfall and evaporation. That condition is described in Section 4, below. Both the existing conditions (represented as the 2013 conditions) and this future baseline are used in the analysis of impacts to thoroughly comply with the requirements of CEQA.

A diagram of flow routing among the Salinas Treatment Facility ponds is shown in **Figure 2** (City of Salinas; Operations and Maintenance Manual, January 30, 2003; recreated by DD&A and Todd

[1] The area proposed for use of the purified water is the Monterey District service area of the California American Water Company.

Groundwater, February 2014). In 2013, all agricultural wash water was sent to the Salinas Treatment Facility, and those flows were metered upon arrival. During the past ten or more years, the percolation ponds have been continuously full or nearly so, which has precluded normal maintenance activities such as drying and disking the pond bottoms. Consequently, percolation rates in Ponds 1-2-3 have declined (Margaretten, 2013). The ponds are approximately flat-bottomed and 6-10 feet deep, which means that pond surface area remains relatively constant over most of the range of storage volumes.

Table 1 presents a monthly water balance for the ponds and drying beds during 2013. Entries in the table are shown to three or four significant digits for arithmetic consistency. However, estimates of evaporation and percolation are probably accurate to only two significant digits. Accordingly, percolation and evaporation values extracted from the table are rounded in the text to two significant digits or the nearest 10 acre-feet. Agricultural wash water inflow totaled 3,240 acre-feet (AF) during 2013. Monthly rainfall is from the Salinas municipal airport station and is the same data used for urban runoff calculations in the Salinas River Inflow Impacts Report (Schaaf & Wheeler 2015). Annual rainfall during calendar year 2013 was 3.3 inches, or 25 percent of the 1932-2013 average, making it the driest year in the 81-year period of record. The rainfall rate was multiplied by the combined area of all the ponds (118.4 acres) to obtain the volume of rainfall accretion to pond storage. Rainfall added about 50 AF to the ponds in 2013 but would add 200 AF in a year with normal rainfall. Evaporation was similarly estimated from CIMIS reference evapotranspiration data.[2] Pond evaporation totaled 390 AF in 2013 and would be 360 AF in an average year.

The volumes of water spread on the drying beds are not recorded. Due to poor drainage, 13 of the drying bed cells are not used, which corresponds to roughly one-fourth of the 67-acre drying bed complex (Cole, 2014). Due to capacity constraints at the Salinas Treatment Facility, the remaining 75 percent of the drying bed area was more or less continuously wet throughout the year (Cole 2014c), and it was assumed that the per-area evaporation rate equaled the pond evaporation rate. Pond water levels are also not routinely monitored. It was assumed that the net change in storage over the year was zero, given that the facility has been operating near capacity and that excess inflow is handled using the drying beds and RIBs rather than by a long-term increase in pond storage. Finally, the overall percolation volume was obtained as the residual in the water balance and totaled 2,730 AF in 2013. The residual is the amount of percolation that in combination with all other inflows and outflows resulted in a calculated net storage change of zero from December 2012 to December 2013. The percolation rate from the ponds was assumed to be equal in all months.

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[2] Reference evapotranspiration is typically about 75 percent of open-water evaporation from a Class A evaporation pan (Dunne and Leopold, 1979). However, evaporation from lakes is also less than pan evaporation because the larger surface area causes the adjacent air layer to become more saturated with moisture. The pan-to-lake coefficient is also typically about 75 percent, so evaporation from the ponds—which are the size of small lakes—can be approximated by reference evapotranspiration.

Table 1. Monthly Salinas Treatment Facility Water Balance during 2013[3]

Month	Agri-cultural Wash Water Inflow (AF)	Rainfall Rate (in)	Rainfall Volume (AF)	Pond Evaporation Rate (in)	Pond Evaporation Volume (AF)	Drying Bed Evaporation (AF)	Pond + RIB + Drying Bed Percolation (AF)	Pond Storage (AF)
Dec-12								1,100
Jan-13	135	1.04	16	1.90	19	8	227	997
Feb-13	137	0.56	9	2.16	21	9	227	885
Mar-13	174	0.41	6	3.16	31	13	227	794
Apr-13	265	0.27	4	4.30	42	18	227	776
May-13	272	0.01	0	4.99	49	21	227	750
Jun-13	338	0.04	1	4.26	42	18	227	802
Jul-13	376	0.00	0	3.73	37	16	227	898
Aug-13	383	0.02	0	3.87	38	16	227	1,000
Sep-13	318	0.07	1	3.93	39	16	227	1,036
Oct-13	355	0.15	2	3.10	31	13	227	1,122
Nov-13	284	0.47	7	1.99	20	8	227	1,159
Dec-13	193	0.21	3	1.95	19	8	227	1,100
Total (AF):	3,231	3.26	50	39.34	388	165	2,729	
Percent of SIWTF outflow:					12%	5%	83%	

Notes: AF = acre-feet; RIB = rapid infiltration basin; Ponds 1-2-3 + RIB area = 106 acres; drying bed area = 67 acres; average percolation rate = 0.043 feet per day; aeration pond area = 12.4 acres, which is included in rain and evaporation but not percolation.

A key result of the water balance analysis is that only 17 percent of Salinas Treatment Facility outflow was by evaporation at the ponds and drying beds during 2013. Therefore, it can be concluded that percolation is the primary means of wastewater disposal at this facility.

[3] Volumes in the table are shown in units of acre-feet (AF), which is customary for analysis of groundwater flow. The corresponding rates are acre-feet per month (AF/mo) or per year (AFY). Water and wastewater studies typically express volumes and rates in million gallons (mgal; 1 mgal = 3.069 AF) and million gallons per day (mgd). River flows are usually expressed in cubic feet per second (cfs; 1 cfs = 725 AFY = 0.65 mgd). This memorandum uses whichever units are customary for the topic under discussion.

3. FATE OF SALINAS TREATMENT FACILITY PERCOLATION WATER

Water that percolates from the Salinas Treatment Facility ponds travels through the subsurface using two pathways: a short path from beneath the ponds to the Salinas River and a longer flow path into the shallow aquifer away from the river. These pathways are part of a complex three-dimensional groundwater flow system that interacts dynamically with water levels in the river and the Salinas Treatment Facility ponds. This system is portrayed in **Figure 3**, which shows a cross-section through the Salinas Treatment Facility perpendicular to the river (see Figure 1 for cross section location). In addition to water levels in the ponds and river, groundwater levels are shown for two of the eight onsite monitoring wells. These wells monitor the shallow aquifer, which is discontinuously present and overlies the Salinas Valley Aquitard, which is a fine-grained layer that restricts downward flow of water from the shallow aquifer to the 180-Foot aquifer. The 180-Foot aquifer is the shallowest aquifer used for water supply in the Salinas region. As its name implies, it is typically present at depths of approximately 180 feet below ground surface. It is underlain by the 400-Foot and deep aquifers, which are also used for water supply. Intervening fine-grained layers restrict flow between the aquifers. An average water level is shown on the figure for nearby wells that are screened in the 180-Foot aquifer. The water surface elevations of the ponds are higher than the water surface of the river and shallow aquifer, and all three are higher than water levels in the 180-Foot aquifer. Pond percolation creates a water-table mound that sends groundwater in all directions. Because the river is only 200 feet from the ponds along the entire 1.5-mile length of the Salinas Treatment Facility and has a much lower water surface, a substantial percentage of percolated water is likely to flow to the river. Percolated water that disperses into the shallow aquifer is likely to percolate down to the 180-Foot aquifer (see Section 3.2 “Recharge to the Shallow and 180-Foot Aquifers”, below).

These water-level relationships can also be seen in **Figure 4**, which shows hydrographs of daily water levels measured in eight monitoring wells at the Salinas Treatment Facility site during 2009-2012 (see Figure 1 for well locations). The plot also includes a hydrograph of water level in the Salinas River, which was estimated from daily flow recorded at the USGS gage at Spreckels (2.5 miles upstream of the Salinas Treatment Facility) and the flow-stage rating curve for that gage. Stream elevations were projected to the Salinas Treatment Facility location based on the average gradient of the river channel and were consistent with elevations determined from Google Earth. Several high-flow events can be seen in the hydrographs. Water levels in the two wells on the river side of Ponds 1-3 (wells MW-1 and MW-2) track river stage closely. Monitoring wells on the far side of the ponds (wells MW-3, -4, -5 and -6) have relatively stable water levels 12-15 feet higher than the river that show little response to fluctuations in river stage. This pattern confirms that shallow groundwater in close proximity to the river is hydraulically connected to flow in the river. Water can readily flow from the aquifer into the river or vice versa, depending on which is higher, the surface of the river or the water table. The pattern also confirms that pond percolation is the dominant influence on groundwater levels in areas on the far side (northeast) of the ponds. This is expected given that the ponds are 10-15 times wider than the river.

3.1 Seepage into the Salinas River

The subsurface flow of pond percolation into the river (seepage) is not routinely measured. However, two sets of measurements were made in October and November, 2013. These used two different methods:

- **Water quality mixing model**. MRWPCA personnel measured water quality in the Salinas Treatment Facility ponds and in the Salinas River at points upstream and downstream of the ponds on October 8, 2013. At that time, pond water was high in chloride (Cl) relative to the river. Chloride is a conservative solute that tends to remain in solution without reacting, adsorbing or precipitating. It is commonly used in mixing model calculations. By comparing the increase in chloride concentration in river water along the Salinas Treatment Facility reach, the amount of seepage from the ponds into the river can be calculated. This approach uses a mixing model represented by the following equation:

$$Q_1C_1 + Q_2C_2 = Q_3C_3$$

where,

Q_1 = river flow upstream of Salinas Treatment Facility
C_1 = concentration in river upstream of Salinas Treatment Facility
Q_2 = percolation from ponds toward the river
C_2 = concentration in ponds
Q_3 = river flow downstream of Salinas Treatment Facility
C_3 = concentration in river downstream of Salinas Treatment Facility

Using the concentrations C_1, C_2 and C_3 measured on October 8, 2013, the value of Q_1 measured at the Spreckels stream gage on that date, and noting that $Q_3 = Q_1 + Q_2$, the mixing model can be solved to obtain Q_2, which is the rate of subsurface flow from the ponds into the river. The variables are listed in **Table 2**, and the calculated estimate of seepage from the ponds to the river was 3.67 cfs.

Transpiration by riparian vegetation between the ponds and river does not materially affect the calculations. The vegetation transpires essentially pure water, but correcting for this loss only slightly changes the calculations. The strip of riparian vegetation between the RIBs and the river channel averages 175 ft wide and has a total area of 31.5 acres. Multiplying that area by the reference ET rate measured at the CIMIS station in Salinas on October 8, 2013 (0.10 inches) results in an estimated 0.13 cfs of water consumption. In terms of the above system of equations, $Q_3 = Q_1 + Q_2 – Q_{ET}$. Conservatively assuming that all of the evapotranspiration is of pond percolation and none is of river underflow, the resulting estimate of pond percolation becomes 3.72 cfs. The initial and adjusted estimates differ by only 1.3 percent, which is less than the uncertainty in other factors in the equation. For practical purposes, the effect of water loss to evapotranspiration can safely be ignored.

Table 2. Variables Used for Chloride Mixing Model Calculation of Subsurface Flow of Salinas Treatment Facility Pond Seepage into the Salinas River

Parameter	Value	Units
Q_1 =	15	cfs
C_1 =	26	mg/L
Q_2 =	Q_2	cfs
C_2 =	292	mg/L
Q_3 =	$15 + Q_2$	cfs
C_3 =	79	mg/L

- **Change in river flow**. River flow at Salinas Treatment Facility is usually at its annual minimum in November, after upstream reservoir releases have ceased and before natural rainfall runoff has commenced. Those conditions are optimal for direct measurement of seepage derived from pond percolation, which is only a small percentage of total flow at other times of the year. River flow upstream and downstream of the Salinas Treatment Facility was measured on November 13, 2013. Visual inspection revealed that flow was zero upstream of Davis Road, although pools were still present in the channel. Flow was measured using a propeller-type ("pygmy") flow meter 1,000 ft downstream of Pond 3, which produced a value of 2.4 cfs. The accuracy of the measurement was probably only +/- 20% due to deep, low-velocity conditions. However, this result was similar to the estimate from the mixing model.

For the purposes of the SIWTF percolation analysis in this memorandum, the two estimates of seepage into the river were simply averaged, with a resulting estimate of 3.0 cfs. If this rate were constant throughout the year, it would amount to 2,170 AFY, or 80 percent of total SIWTF pond percolation during 2013. This percentage is expected to remain approximately the same with the higher expected SIWTF inflow in 2017, provided that the RIBs and drying beds continue to be operated in the present manner.

There are several sources of uncertainty in estimating the future effects of SIWTF pond percolation on river flows. First, the operators of the SIWTF have flexibility to modify their operations in ways that might influence the relative proportions of seepage into the river and percolation that flows downward to the 180-Foot aquifer. For example, if percolation is shifted from the RIBs back to Ponds 1, 2 and 3 (assuming percolation rates in one or more of those ponds were restored by drying and disking) or to the drying beds, then the center of percolation would shift slightly away from the river, and the proportion of percolation that goes to the 180-Foot aquifer could increase. Such future changes are outside the control of the GWR Project. Reservoir releases to the Salinas River could also change in the future in response to evolving water demands along the Salinas Valley or changes in seawater intrusion near the coast. Finally, climate change could impact seasonal runoff patterns, average annual rainfall and runoff, and the yield of upstream water supply reservoirs.

3.2 Recharge to the Shallow and 180-Foot Aquifers

By ruling out other potential pathways, it can be concluded that percolation from the Salinas Treatment Facility to the shallow aquifer that does not seep to the Salinas River percolates downward and becomes recharge to the 180-Foot aquifer. Other outflow pathways that were considered and rejected included:

- **Evapotranspiration by phreatophytic vegetation.** Phreatophytes are plants such as willow, cottonwood and sycamore with roots that can extract water directly from the water table. They are common along rivers and other shallow water-table areas in California. No phreatophytes are present in the cropland north and east of the Salinas Treatment Facility. A band of phreatophytes is present along both sides of the Salinas River channel downstream of Spreckels. The width, stature and vigor of the riparian vegetation between the Salinas Treatment Facility and the river are no different than on the opposite bank or along upstream and downstream reaches. Therefore, from a water balance standpoint, the riparian vegetation is supplied by shallow groundwater associated from the river, and riparian evapotranspiration does not constitute a separate outflow pathway from the Salinas Treatment Facility.

- **Passive seepage into Blanco Drain.** Blanco Drain is a ditch that conveys agricultural drainage water from a 6,400-acre area to the Salinas River. The Drain approximately parallels the river about 1.2 miles northeast of the Salinas Treatment Facility, which is 37 times farther from the Salinas Treatment Facility than the river channel is. The Drain is also shallower than the river channel. Therefore, it is not hydraulically plausible that recharge at the Salinas Treatment Facility would flow to the Drain instead of the river.

- **Active removal by agricultural tile drains.** Agricultural tile drains are parallel rows of perforated pipe buried several feet beneath the ground surface over the entire area of certain fields to prevent the crop root zone from becoming waterlogged. The pipes drain to a sump, where the water is pumped up into a ditch that carries it away. Tile drains are common in the Blanco Drain watershed—which includes the Salinas Treatment Facility site—and the primary purpose of Blanco Drain is to convey tile drain discharge to the Salinas River. The source of the water that causes the soil saturation problem can be either a shallow water table—such as one receiving excess recharge from Salinas Treatment Facility percolation—or applied irrigation water that cannot percolate downward through the root zone due to restrictive layers in the soil horizon. In the former case, drain discharges would be greatest in spring, following winter rainfall recharge of the shallow aquifer. In the latter case, discharges would be greatest during the peak of the irrigation season. Measured monthly flows in Blanco Drain peak in July at a level two times greater than the minimum monthly flow in November (Schaaf & Wheeler 2015). This seasonal pattern suggests that the primary source of the drainage water is applied irrigation water, not a shallow water table caused by Salinas Treatment Facility percolation.

- **Subsurface flow through the shallow aquifer, parallel to the river with eventual discharge into the Salinas River lagoon or Monterey Bay.** This flow is negligible because the shallow aquifer is patchy and discontinuous (Kennedy/Jenks Consultants, 2004), the distances to those discharge points are large, and the hydraulic gradients are correspondingly low. Groundwater flow is proportional to the water-level gradient, which is the difference in potentiometric head[4] at two points in a groundwater flow system divided by the distance between the points. The gradient from the water table beneath the Salinas Treatment Facility ponds downward to the 180-Foot aquifer is about 0.24 foot per foot (ft/ft). By comparison, the Salinas River lagoon and Monterey Bay are 6-8 miles away, and water-level gradients between the Salinas Treatment Facility and those locations range from 0.0007 ft/ft to 0.0008 ft/ft. These are about 300 times smaller than the downward gradient to the 180-Foot aquifer. The cross-sectional area available for downward flow is also about two orders of magnitude larger than for horizontal flow through the shallow aquifer, assuming the shallow aquifer were continuous to the lagoon and ocean. However, the discontinuous pattern of shallow aquifer deposits overlying the Salinas Valley Aquitard greatly diminish the cross-sectional area available for flow and increase the length of the flow path. These factors favoring downward over horizontal flow very likely outweigh the lower average permeability in the downward direction.

- **Underflow through Salinas River channel deposits.** Permeable sand deposits are present beneath and adjacent to the river channel, at least in places. Anecdotal evidence of these deposits include the high percolation rates of the rapid infiltration basins adjacent to the channel at the Salinas Treatment Facility and the high rate of dewatering pumping that was required during construction of the Salinas River Diversion Facility and a pipeline crossing beneath the river. The underflow through sand deposits can be estimated by applying the Darcy equation using estimates of cross sectional area, hydraulic conductivity and gradient. Assuming a continuous body of sand extending to 15 feet below the water surface and to 100 feet on either side of the channel center line, with a typical hydraulic conductivity for clean sand of 100 feet per day (Freeze and Cherry, 1979), and a gradient along the river of 0.0008 feet per foot, then the subsurface flow would be 240 cubic feet per day, which is equivalent to 0.003 cubic feet per second, or one-thousandth the estimated amount of seepage from the Salinas Treatment Facility ponds to the river. Thus, over long distances, one thousand times more water would travel as surface flow than as underflow. This result does not contradict the anecdotal observations; the key difference is the long flow path and small hydraulic gradient. Over shorter flow paths—such as from the rapid infiltration basins to the river or from the river to nearby dewatering wells—the amount of subsurface flow can be significant.

To reach the 180-Foot aquifer, groundwater in the shallow aquifer must flow downward through the Salinas Valley Aquitard (SVA). The SVA is a shallow fine-grained layer that has traditionally been viewed as an extensive, continuous, impermeable clay cap that restricts direct downward recharge to the 180-Foot aquifer. Water levels in the 180-Foot aquifer are much lower than shallow groundwater levels, which suggests that overall vertical permeability is low but not necessarily zero. In 2011, groundwater elevation in the 180-Foot aquifer near Salinas Treatment Facility was -18 ft (i.e., below sea level), while

[4] Potentiometric head is represented by the water level in a well that is screened at a point within the flow system. In this case, the water level in a well screened at the water table beneath the Salinas Treatment Facility ponds would be about 30 ft above sea level, while the water level in a well at the same location screened in the 180-Foot aquifer would be about 18 ft below sea level.

water levels in shallow wells near the ponds were 12-33 ft above sea level. This substantial downward gradient will induce downward flow if permeable pathways are present.

Evidence that recharge occurs through the SVA comes from detailed stratigraphic analyses and groundwater model calibration. One of the most detailed evaluations of aquifer stratigraphy in the vicinity of the Salinas Treatment Facility focused on the area encompassed by Alisal Slough, Highway 68 and the Salinas River, which includes the Salinas Treatment Facility (Heard, 1992). Texture descriptions from 117 cable-tool driller's logs were classified into coarse and fine categories and mapped at 20-foot depth intervals from the ground surface down to 340 feet. Overlaying these maps reveals vertical continuity of coarse deposits through all but one of the top seven layers (a total vertical interval of 140 feet) in several locations, each covering about 1 square mile:

- Near the Salinas Treatment Facility across South Davis Road
- Near the intersection of Blanco Road and Highway 68, about 2.5 miles east of the Salinas Treatment Facility
- Along Davis Road between Blanco Road and Castroville Road, about 2.5 miles northeast of the Salinas Treatment Facility

A small amount of horizontal flow within the remaining depth interval would allow groundwater flow to link up gaps between clay lenses and continue moving downward.

Heard also evaluated groundwater quality patterns and discovered that groundwater in the 180-Foot aquifer in the study area was slightly enriched in sulfur relative to other dissolved minerals. The only geochemically plausible source of the enrichment was determined to be gypsum, which is commonly applied to heavy soils in the area to maintain soil texture. To arrive at the 180-Foot aquifer, the dissolved gypsum would have had to percolate downward through the SVA. Nitrate is also elevated in some 180-Foot aquifer wells in the area and also derives from fertilizers applied at the land surface.

Another detailed stratigraphic study of the region between Spreckels and the coast included cross sections showing the SVA missing at various locations (Kennedy/Jenks Consultants, 2004). The cross sections were developed from geologic logs prepared by well drillers, and most of the logs were from irrigation wells. Although often close to other wells where the SVA is present, wells that show gaps in the SVA include several near the Salinas Treatment Facility in the region between Salinas and the Salinas River (at wells APN-414021010, 15S/03E-04T50, 15S/03E-17B3, and 15S/03E-17M1). The description of SVA hydrogeology in the Monterey County Groundwater Management Plan reiterates the concept of local discontinuity (MCWRA 2006).

A groundwater flow model of the Salinas Valley, called the Salinas Valley Integrated Surface and Groundwater Model (SVISGM), has been used extensively by Monterey County Water Resources Agency (MCWRA) for water planning studies over nearly 20 years. The calibrated model includes recharge from the ground surface to the 180-Foot aquifer. The 180-Foot aquifer is present only in the Pressure Area, which occupies the southwestern half of Salinas Valley between Gonzales and Monterey Bay. In most parts of the Pressure Area, recharge to the 180-Foot aquifer from the ground surface would have to pass through the SVA (MWH, 1997). The shallow aquifer and SVA are not explicitly represented in the model, but their effects are reflected in the amount of downward recharge that accrues to the 180-Foot aquifer. During the 1970-1994 calibration period, there was an average of 54,000 AFY of recharge to the 180-Foot aquifer in the Pressure Area from deep percolation of rainfall and applied irrigation water and 60,000 AFY of recharge from Salinas River infiltration, some of which must also pass through the SVA. Together, these recharge sources accounted for 79% of total recharge to the 180-Foot aquifer in the Pressure Area. However, much of the downward recharge to the 180-Foot aquifer in the model could have been in the southern part of the Pressure Area (between Gonzales and Chualar), where the SVA is known to be discontinuous or absent.

The above lines of evidence lead to a conclusion that Salinas Treatment Facility percolation that does not seep into the river very likely becomes recharge to the 180-Foot aquifer. During 2013, this recharge amounted to 550 AF, or 20% of total Salinas Treatment Facility percolation.

4. FUTURE NO-PROJECT SALINAS TREATMENT FACILITY WATER BALANCE

The 2013 Salinas Treatment Facility water balance described in Section 2 was not representative of existing or no-project conditions for the purpose of evaluating impacts. Rainfall was extremely low that year, and inflows of agricultural wash water were less than the inflows expected at the time the GWR Project is constructed. A more appropriate baseline for evaluating impacts is the Salinas Treatment Facility water balance under normal climatic conditions and with the inflows expected to occur in 2017 (the approximate date of construction). This is consistent with the Salinas River Inflows Impact Report (Schaaf & Wheeler 2015), which evaluated 2017 Salinas Treatment Facility inflows and normal climatic conditions.

The estimated baseline (no-project) Salinas Treatment Facility water balance is shown in **Table 3**. Agricultural wash water inflows are expected to total 3,730 in 2017. Monthly rainfall and evaporation rates are long-term averages for stations in Salinas. As in the 2013 water balance (see Table 1), it was assumed there would be no net increase in pond storage over the year. The assumed percolation rate was increased to achieve zero net storage change, and the relative proportions of seepage to the river and percolation to groundwater are the same as in the 2013 water balance. The resulting estimate of seepage into the river is 2,730 AFY, and the estimate of percolation to the 180-Foot aquifer is 680 AFY.

Table 3. Monthly Baseline (No-Project) Salinas Treatment Facility Water Balance

Month	Agri-cultural Wash Water Inflow (AF)	Rainfall		Pond Evaporation		Drying Bed Evaporation (AF)	Pond + RIB + Drying Bed Percolation (AF)	Pond Storage (AF)
		Rate (in)	Volume (AF)	Rate (in)	Volume (AF)			
DEC								1,100
JAN	156	2.62	40	1.21	12	5	285	995
FEB	158	2.35	36	1.54	15	6	285	883
MAR	201	2.11	33	2.88	28	12	285	791
APR	307	1.10	17	4.08	40	17	285	773
MAY	311	0.30	5	4.56	45	19	285	740
JUN	391	0.08	1	5.16	51	22	285	775
JUL	435	0.02	0	4.47	44	19	285	863
AUG	444	0.04	1	4.30	42	18	285	962
SEP	367	0.17	3	3.20	32	13	285	1,002
OCT	410	0.57	9	2.75	27	12	285	1,098
NOV	329	1.41	22	1.50	15	6	285	1,143
DEC	223	2.35	36	1.23	12	5	285	1,100
Total (AF):	3,732	13.12	203	36.88	364	154	3,416	
Percent of SIWTF outflow:					9%	4%	87%	

Notes: AF = acre-feet; RIB = rapid infiltration basin; Ponds 1-2-3 + RIB area = 106 acres; drying bed area = 67 acres; wash water inflows are the expected amounts in 2017; rainfall and evaporation are long-term averages; percolation rate = 0.054 feet per day; aeration pond area = 12.4 acres, which is included in rain and evaporation but excluded from percolation.

5. LOCAL HYDROLOGIC EFFECTS OF THE GWR PROJECT

The GWR Project would alter the operation of the Salinas Treatment Facility in terms of the amounts and types of water stored at the facility. Those changes would locally alter the quantity and quality of percolation, which would affect the quantity and quality of river flow and groundwater recharge. This memorandum focuses on local effects. However, those effects should be considered in a regional context because surface and groundwater throughout the northern Salinas Valley area are intensively managed as a single, interconnected system. Effects on operation and yield of the Salinas Valley Water Project are described in the Salinas River Inflow Impacts Report (Schaaf & Wheeler 2015). The combined effects of all elements of the GWR Project on regional groundwater pumping and seawater intrusion are described in Chapter 4 of the DEIR. Potential local hydrologic impacts evaluated in this memorandum are the following:

- Changes in Salinas River flow
- Decreased groundwater recharge and local well yields
- Changes in river and groundwater quality

All of these impacts stem from changes in the amount of water percolated at the Salinas Treatment Facility. Accordingly, the first step in the impact analysis is to calculate the amount of percolation by month and year type for each potential example scenario of operation of the GWR Project (see Section 5.2 for a description of these scenarios). This depends in part on the distribution of percolation among the various ponds, basins and drying beds at the Salinas Treatment Facility.

5.1 Percolation Patterns at the Salinas Treatment Facility

Water percolates from Ponds 1, 2 and 3, the RIBs and the drying beds, but percolation rates vary substantially among those areas. Therefore, percolation under existing and project conditions must be estimated for each area separately to the extent available data support such an analysis. The aeration pond is lined and percolation is assumed to be negligible. Percolation from Ponds 1-2-3 historically declined due to accumulation of fine-grained material and/or biofilms on the pond bottoms. As annual inflows increased, the ponds no longer drained completely at any point during the year, which prevented the normal maintenance procedure of drying and disking the pond bottoms to restore percolation rates (Margaretten, 2013). This led to reliance on the RIBs and drying beds to provide additional disposal capacity during the past decade. The drying beds have actually been operated more like percolation basins in recent years. Low berms divide the drying bed area into 54 cells or beds separated by low berms. Each bed is flooded to a depth of 1.0-1.5 feet then allowed to percolate, which takes anywhere from 5 days to several weeks (Cole, 2014c). The three RIBs are long, narrow basins that occupy a strip along the river side of Ponds 1-2-3. They have consistently provided relatively high rates of percolation but cover only a small area. Unfortunately, available records for Salinas Treatment Facility operations do not document the volumes of water sent to each of the three areas; only the total amount is known. However, soils information and semi-quantitative anecdotal data can be used to estimate the amounts percolated at each area during 2013 and/or 2014, as follows:

- **Percolation at RIBs.** Two methods were used to estimate percolation rate: the rate at which water was pumped into the RIBs and the time required for them to drain. The two diesel-powered pumps that transferred water from Ponds 1, 2 and 3 to the RIBs operated 1,000 hours each at an estimated discharge of 800 gallons per minute (Cole, 2014c). These figures produce an estimate of 300 AF pumped during the year. However, the pump discharge was estimated from its rated capacity under 150 feet of lift, whereas the actual lift was about -10 feet (the pumps were moving water downhill from the ponds to the RIBs). Consequently, the actual discharge rate was probably higher. After drying and disking, each RIB would drain in 2-3 days; however, percolation rates decreased noticeably as the season of use progressed (Cole, 2014c). A decrease in percolation rate due to clogging of the bed with fine-grained material or organic biofilms is a nearly universal occurrence in percolation basins operated for prolonged periods. The long-term average percolation rate assuming periodic disking and drying typically averages about 25 percent of the initial percolation rate (Bouwer, 1985; Schuh and Shaver, 1989; Miele, 2011). Assuming a ponding depth of 2 feet and 10-day average percolation cycle, the combined 1.67 acres of RIBs would percolate 120 AF per year. This estimate is considerably smaller than the pump-operation estimate. The resulting range of plausible RIB percolation volume during 2013 is roughly 100-400 AF.

- **Percolation at drying beds.** Percolation rates are highly variable among the drying bed cells and appear to be influenced by soil variability, season, and depth to the underlying water table (Cole, 2014c). Individual beds are flooded to a depth of 1.0-1.5 feet then allowed to completely infiltrate, which takes anywhere from 5 days to many weeks. About 18 of the beds percolate only once per season or not at all. Thus, the long-term average percolation rate is about 1.25 foot over 20-100 days. Assuming year-round operation over the 67-acre drying bed area, annual percolation is roughly 200-1,400 AFY (after subtracting 130 AFY of normal-year net evaporation).

- **Percolation from Ponds 1, 2 and 3.** The percolation rate from Ponds 1-2-3 can estimated from the observed change in storage during spring 2014, when all inflows to the Salinas Treatment Facility were diverted to the Regional Treatment Plant. Based on manual readings of staff gages in the three ponds, water levels declined 4.5-5.5 feet during April and May, 2014. Water was being pumped from those ponds to the drying beds and RIBs throughout that period, so percolation at Ponds 1-2-3 equaled the change in storage minus percolation at the other two facilities and minus net evaporation from all of the facilities. Net evaporation over 173 acres of wetted area was 150 AF, which leaves 380 AF of the total storage change attributable to percolation. To be consistent with the annual percolation rate estimated for 2013, this 2-month estimate of percolation during April-May, 2014 was increased 20 percent to 460 AF. Percolation at the RIBs during the two months probably equaled one-sixth of the annual percolation during 2013, or 17-67 AF. Percolation from the drying beds can similarly be estimated as one-sixth of the 2013 annual percolation volume, or 33-230 AF. Subtracting the minimums and maximums of these percolation ranges from the total percolation volume produces an estimated range of Pond 1-2-3 percolation of 160-400 AF. Using the midpoint of that range as an estimate of the average results in 280 AF of estimated percolation during April-May, which is equivalent to an annual rate of 1,680 AFY or 140 AF per month. Based on the above information regarding percolation at the individual facilities, Ponds 1-2-3 account for 62% of total percolation when all three facilities are in operation, the RIBs account for 9%, and the drying beds account for 29%.

  A lower estimate of the percolation rate for Ponds 1-2-3 is obtained if the 2014 results are not adjusted to be consistent with the 2013 results. In that case, the percolation rate is 103 AF per month.

5.2 Decreased Groundwater Recharge and Local Well Yields

A spreadsheet operations model was developed to estimate which source waters would be selected for the GWR Project under six operating scenarios: two phases of diversion rate for surface water sources and three types of years related to the status of the drought reserve (See the Draft EIR Project Description Section 2.7.1 for a description of the source water availability and assumed diversion scenarios). The model indicated the amount of water sent to or pumped from the Salinas Treatment Facility for each month of the year. The model was based on two unique sets of monthly inflows and outflows: in normal/wet years and in drought years. Simulated Salinas Treatment Facility operations were not affected by the maximum surface water diversion rate or the current storage level of the drought reserve.

Some of the water that percolates from the Salinas Treatment Facility flows downward through gaps in the Salinas Valley Aquitard and becomes recharge to the 180-Foot aquifer, which is one of several aquifers tapped by water supply wells in the northern Salinas Valley. A decrease in percolation would decrease recharge and tend to lower groundwater levels in wells near the Salinas Treatment Facility that pump from the 180-Foot aquifer. If the decline in water levels were large, it could impact groundwater availability to well owners by physically damaging wells or by decreasing their pumping rates. Quantifying that impact begins with estimating the decrease in percolation from the Salinas Treatment Facility that would result from the GWR Project.

5.2.1 Change in Percolation Volumes

Operation of the Salinas Treatment Facility would change substantially under the GWR Project. In spite of new inflows of urban storm runoff, total annual inflow would decrease substantially because agricultural wash water inflows would be diverted to the Regional Treatment Plant during half the year for recycling and use by the CSIP irrigators and for advanced treatment and injection into the Seaside Groundwater Basin. The drying beds and RIBs would no longer be needed. The primary purpose of the Salinas Treatment Facility would switch from disposal to storage; any water that does not percolate or evaporate during the November-April storage season would be pumped back out to supply the GWR Project. Only Ponds 1, 2 and/or 3 would be used for storage. The effect of reoperation under the GWR Project depends on the amount of percolation that continues to occur during the storage and pump-out seasons. This can be determined from monthly water balance calculations for the ponds, given the percolation rates estimated above.

Table 4 shows the monthly pond water balance in normal/wet years, and **Table 5** shows the balance during drought years. Inflows of agricultural wash water and Salinas urban storm runoff were obtained from the Salinas River Inflows Impact Report (Schaaf & Wheeler 2015). The rainfall and evaporation rates in Table 4 are average annual rates, and the rates in Table 5 are the 2013 rates. The percolation rate from Ponds 1-2-3 equals the rate of 140 AF per month estimated from 2014 data adjusted to be consistent with 2013 percolation.

In both tables, the amount of stored water that can be pumped out of the ponds during April-October is limited by percolation losses. Although percolation rates have declined over the past decade, the ponds still retain substantial percolation capacity and hence are not optimal for storage. In the tables, all of the water was assumed to be pumped out during May and June to avoid additional percolation losses that would occur if the stored water were pumped out over a longer period. The amount of water pumped out to supply the GWR Project during May-June would be approximately 380 AF in normal or wet years and 120 AF in dry years. Annual percolation from all Salinas Treatment Facility facilities would be approximately 1,110 AFY in normal and wet years (Table 4), which is 2,300 AFY less than under baseline conditions (Table 3). The proportion of percolated water that seeps into the Salinas River (80 percent) would remain about the same as under baseline conditions because the center of percolation volume would remain under Ponds 1-2-3. That is, the two percolation facilities that would be discontinued (RIBs and drying beds) are closer and farther from the river, respectively, than Ponds 1-2-3. Therefore, seepage into the river would be approximately 890 AFY (1.2 cfs), and recharge to the 180-Foot aquifer would be approximately 220 AFY.

Table 4. GWR Project Salinas Treatment Facility Water Balance in Normal/Wet Years

Month	Agricultural Wash Water (AF) Total Available	Agricultural Wash Water (AF) Sent to STF	Salinas Urban Storm Water Inflow (AF)	Rainfall Rate (in)	Rainfall Volume (AF)	Pond Evaporation Rate (in)	Pond Evaporation Volume (AF)	Pumped Outflow to RTP (AF)	Ponds 1-2-3 Percolation (AF)	Pond Storage (AF)
DEC										353
JAN	156	156	52	2.62	25	1.21	12	0	140	435
FEB	158	158	41	2.35	23	1.54	15	0	140	502
MAR	201	201	34	2.11	20	2.88	28	0	140	590
APR	307	307	16	1.10	11	4.08	40	0	140	745
MAY	311	0	2	0.30	3	4.56	44	190	140	376
JUN	391	0	0	0.08	1	5.16	50	190	136	0
JUL	435	0	0	0.02	0	4.47	0	0	0	0
AUG	444	0	0	0.04	0	4.30	0	0	0	0
SEP	367	0	2	0.17	2	3.20	4	0	0	0
OCT	410	0	8	0.57	6	2.75	14	0	0	0
NOV	329	329	23	1.41	14	1.50	15	0	140	212
DEC	223	223	47	2.35	23	1.23	12	0	140	353
Total (AF):	3,732	1,374	225	13.12	128	36.88	233	380	1,113	
Percent of SIWTF outflow:							14%	22%	64%	

Notes: AF = acre-feet; RIB = rapid infiltration basin; ponds 1-2-3 area = 104.3 acres; drying beds and RIBs inactive; wash water inflows are the expected amounts in 2017; rainfall and evaporation are long-term averages; ponds 1-2-3 percolation rate = 0.044 feet per day; aeration pond area = 12.4 acres, which is included in rain and evaporation but not percolation.

Table 5. GWR Project Salinas Treatment Facility Water Balance in Drought Years

Month	Agricultural Wash Water (AF) Total Available	Agricultural Wash Water (AF) Sent to STF	Salinas Urban Storm Water Inflow (AF)	Rainfall Rate (in)	Rainfall Volume (AF)	Pond Evaporation Rate (in)	Pond Evaporation Volume (AF)	Pumped Outflow to RTP (AF)	Ponds 1-2-3 Percolation (AF)	Pond Storage (AF)
DEC										264
JAN	156	156	17	1.04	10	1.90	18	0	140	289
FEB	158	158	14	0.56	5	2.16	21	0	140	306
MAR	201	201	11	0.41	4	3.16	31	0	140	352
APR	307	307	5	0.27	3	4.30	42	0	140	485
MAY	311	0	1	0.01	0	4.99	49	60	140	238
JUN	391	0	0	0.04	0	4.26	41	60	137	0
JUL	435	0	0	0.00	0	3.73	0	0	0	0
AUG	444	0	0	0.02	0	3.87	0	0	0	0
SEP	367	0	1	0.07	1	3.93	1	0	0	0
OCT	410	0	3	0.15	1	3.10	4	0	0	0
NOV	329	329	8	0.47	5	1.99	19	0	140	182
DEC	223	223	16	0.21	2	1.95	19	0	140	264
Total (AF):	3,732	1,374	75	3.26	32	39.34	246	120	1,114	
Percent of SIWTF outflow:							17%	8%	75%	

Notes: AF = acre-feet; RIB = rapid infiltration basin; ponds 1-2-3 area = 104.3 acres; drying beds and RIBs inactive; wash water inflows are the expected amounts in 2017; rainfall and evaporation are 2013 values; ponds 1-2-3 percolation rate = 0.044 feet per day; aeration pond area = 12.4 acres, which is included in rain and evaporation but not percolation.

Percolation from the Salinas Treatment Facility would be more seasonally variable than under baseline conditions. The maximum change in percolation would occur during July-October, when percolation would be zero. Seepage into the Salinas River follows a short subsurface flow path that would respond quickly to changes in percolation. Thus, during July-October, seepage into the river would decrease by 3 cfs. During November-June, seepage into the river would be about 1.9 cfs, or about 1.1 cfs less than under baseline conditions. In drought years, annual percolation would decrease by about 2,230 AFY. Monthly river flow would decrease by 1.1-3.0 cfs depending on the month (same as in normal/wet years), and the annualized average decrease would be 2.5 cfs.

Recharge to the 180-Foot aquifer might also vary somewhat seasonally, but by less than the variations in pond percolation. This is because the relatively low average permeability along the downward flow path would tend to smooth out short-term fluctuations in pond percolation. For the purpose of evaluating water supply and well impacts, the change in average annual percolation is a reasonable basis for comparison with baseline conditions.

It would be possible to line the ponds to reduce percolation and maximize the amount of stored water that could be pumped out to supply the GWR Project. This option could theoretically reduce percolation to near zero year-round. Thus, depending on whether Ponds 1-2-3 are modified or left as is, percolation could range from essentially zero to the amounts shown in Tables 4 and 5. The evaluation of impacts on river flow assumes a year-round decrease of 3 cfs, which represents a worst-case scenario as described in the Salinas River Inflows Impact Report (Schaaf & Wheeler 2015).

5.2.2 Uncertainty of Change in Percolation Volumes

The above estimates of percolation from Ponds 1-2-3 under GWR Project operation are subject to substantial uncertainty. The ranges of uncertainty for RIB and drying bed percolation are quite large, and the midpoints of those ranges were used in calculating the “best” estimate of the percolation rate from Ponds 1-2-3. In addition, the resulting percolation rate was increased by 20 percent to make it consistent with annual percolation volumes observed during 2013. The recoverable yield of water stored in Ponds 1-2-3 is quite sensitive to the percolation rate, because percolation occurs throughout the storage and pump-out periods (November to June). To illustrate this sensitivity, plausible alternative estimates of percolation and yield were calculated using the 2014 percolation rate without the 20 percent adjustment. The 2014 estimated percolation rate from Ponds 1-2-3 is 103 AF per month, and the water balance results for GWR Project operation under normal/wet years can be summarized as follows: recoverable storage pumped for GWR Project use during May-June = 620 AF; total percolation = 830 AFY, of which 660 AFY seeps to the Salinas River and 170 AFY recharges the 180-Foot aquifer. During drought years, total annual percolation is only slightly less than during wet/normal years because the duration of pond inundation would be about the same. Recoverable storage would be only about 400 AF, however, due largely to decreased rainfall and stormwater inflows.

5.2.3 Change in Groundwater Levels

Compared with baseline conditions (Table 3) annual pond percolation under GWR Project conditions (Table 4) would decrease by 2,300 AFY, of which 460 AFY would be a decrease in recharge to the 180-Foot aquifer. Recharge from Salinas Treatment Facility pond percolation to the 180-Foot aquifer occurs over a broad area due to the low permeability of the SVA. The ponds are 1.5 miles long, and if 460 AFY of recharge is assumed to be distributed uniformly over a circular area with a radius of 1.5 miles, it would raise water levels in the 180-Foot aquifer by approximately 1.3 feet. Conversely, a decrease in percolation by that amount would tend to lower water levels by 1.3 feet.

The median elevation of the top of the screen in the 23 wells used to monitor water levels in the 180-Foot aquifer is 160 feet below sea level (Feeney, 2014). The water level in wells screened in the 180-Foot aquifer near the Salinas Treatment Facility is approximately 18 feet below sea level, or 142 feet above the top of the screen in a typical well. A decline of 1.3 feet would not lower the water level to below the top of the screen. Therefore, the potential impact of interrupted water supply due to screen corrosion or pump failure would not occur.

Performance curves for typical deep-well turbine pumps indicate that a change in water level of 1.3 feet would in most cases decrease the pump output by 3-4 percent (Driscoll, 1986; Goulds Water Technology, 2014). This small decrease in pump output can typically be accommodated by increased pumping duration.

The change in recharge to the 180-Foot aquifer during drought years would be about 420 AFY less than under baseline conditions, which is a slightly smaller impact than during normal and wet years. Impacts on wells would therefore also be less than significant during drought years.

5.3 Changes in Salinas River and Groundwater Quality

The effect of Salinas Treatment Facility percolation on water quality in the Salinas River and 180-Foot aquifer depends on the concentrations of individual chemical constituents in the Salinas Treatment Facility ponds compared to existing concentrations and water quality objectives for those receiving waters. **Table 6** compares median concentrations of chloride, nitrate, total dissolved solids (TDS) and phosphorus for each water body. These constituents are present in pond water at concentrations that pose a risk of contamination. Data for the Blanco Drain are used as a surrogate for shallow groundwater, because most of the flow in Blanco Drain derives from soil water at the base of the root zone in agricultural fields, which is pumped into Blanco Drain from agricultural drainage tile systems. The data shown in the table were compiled from various monitoring programs with differing suites of constituents and periods of record. Aquifer-specific data for groundwater quality were not available, and data in the table probably reflect a combination of 180-Foot and 400-Foot aquifer groundwater. In spite of these limitations in available data, the table reveals several large contrasts in water quality conditions that can be used to infer impacts of Salinas Treatment Facility percolation on water quality.

Median concentrations were used because average concentrations are often influenced by skewed distributions (for example, high outliers for nitrate).

Table 6. Comparison of Water Quality in Salinas Treatment Facility Ponds, Salinas River and Groundwater

Water Source	Chloride (mg/L)	Nitrate (mg/L as NO_3)	Total Dissolved Solids (mg/L)	Phosphorus (mg/L as P)	Notes
SIWTF Ponds 1-3	301	20	1,090	--	Medians of 12 monthly samples during 2013. Total nitrogen converted to nitrate.
SIWTF Ponds	237	26	1,228	27	Median of six samples collected during July 2013 to February 2014
Salinas River at South Davis Road (upstream of SIWTF)	70	31	618	0.1	CCAMP data. Medians of 92-100 samples during 1998-2011. Primarily low-flow data.
Blanco Drain[a]	274	292	2,003	<0.1	Median of monthly samples collected during July 2013-June 2014 for GWR Project source water investigation (Nellor Environmental Associates, 2015).
Groundwater	100	9	800	0.012	Chloride, nitrate and TDS from GeoTracker GAMA database. Medians of samples from 15-23 well locations between Salinas and the Salinas River. Dates vary. Combination of 180-Foot and 400-Foot aquifers. Phosphorus is the median of 8 samples from the Pressure Area (Kulongoski and Belitz, 2011).
Water Quality Objectives					
Salinas River below Spreckels	250[b]	6.2-28[c]	500-1,000[d]	0.07-0.13[c]	Basin Plan for the Central Coast Region, and CCRWQCB Resolution R3-2013-2008
180-Foot Aquifer	250	4	1,500	no objective	

Notes:
CCAMP = Central Coast Ambient Monitoring Program CCRWQCB = Central Coast Regional Water Quality Control Board
GAMA = groundwater ambient monitoring and assessment SIWTF = Salinas Industrial Wastewater Treatment Facility
[a] Blanco Drain data used as a surrogate for shallow groundwater quality, for which direct measurements are not available.
[b] The drinking water standard for municipal use is shown. Agricultural crops can experience "increasing problems" at concentrations ranging from 142 to 355 mg/L.
[c] Dry-season Total Maximum Daily Load objectives for the lower Salinas River.
[d] The lower and upper secondary drinking water standards are shown. Agricultural crops can experience "increasing problems" at electrical conductivity values that correspond to approximately 500-2,000 mg/L of TDS.

Median concentrations of TDS, chloride and phosphorus are higher in the Salinas Treatment Facility ponds than in the Salinas River and all of those constituents plus nitrate exceed the water quality objectives for the river at least occasionally. During periods when essentially all flow downstream of the Salinas Treatment Facility derives from pond seepage—such as was observed in November 2013—there would be little dilution of pond seepage, and water quality objectives in the river would probably not be met. Mixing model calculations can be applied to estimate the amount of river flow needed to dilute the inflow from pond seepage sufficiently to meet the objectives, as follows:

- In the case of chloride, a flow of only 0.85 cfs would be needed, which is exceeded 92 percent of the time when the river is flowing[5].
- For nitrate, the water quality objective cannot be met by dilution because pond water and river water both already exceed the objective. Concentrations in the ponds and river are similar, and they are 0.7-4.2 times greater than the objective.
- The lower objective for TDS is similarly not achievable by dilution, but the upper objective (1,000 mg/L) would be achieved by dilution with a river flow of 1.8 cfs, which is exceeded 79 percent of the time when the river is flowing.
- The phosphorus concentration in the ponds is 210-390 times greater than the water quality objective for the river. The objective would be achieved by dilution only when river flow exceeds 2,700 cfs, which occurs only 5 percent of the time when the river is flowing. However, phosphorus is not a conservative solute during subsurface transport. It is removed from soil water and groundwater by adsorption and chemical precipitation, which are influenced by pH, dissolved oxygen and the presence of iron, aluminum and calcium. Also, the capacity to remove phosphorus typically diminishes over time under conditions of prolonged high loading rates (such as occur beneath the ponds) due to saturation of the sorption sites on soil minerals. Consequently, results of field studies have been highly variable, ranging from nearly complete removal of phosphorus within a few inches of a field soil surface to high concentrations extending over 2,500 feet from a municipal wastewater percolation pond on Cape Cod (Pitt and others, 1996; Walter and others, 1996; Pettygrove and Asano, 1985). In the case of the Salinas Treatment Facility, the distance from the ponds to the river is only a few hundred feet and loading has been continuous for decades. It is therefore likely that the phosphorus concentration in pond water that reaches the river exceeds the water quality objective.

Thus, seepage into the Salinas River derived from existing Salinas Treatment Facility pond percolation consistently exceeds the water quality objective for nitrate, occasionally degrades Salinas River water quality with respect to TDS and chloride, and probably continually degrades river quality with respect to phosphorus. Because the GWR Project would decrease the annual volume of water percolated at the Salinas Treatment Facility, it would decrease the input of those contaminants to the river and have a beneficial impact on river water quality.

The impact of decreased Salinas Treatment Facility pond percolation on beneficial uses of groundwater in the 180-Foot aquifer depends on the existing groundwater concentration, the concentration in the ponds and the significance threshold for each constituent that affects beneficial use. Those relationships are different for chloride, nitrate, TDS and phosphorus, as explained below.

Groundwater quality impacts would be greatest near the Salinas Treatment Facility, and for this analysis the impact area previously described for water level impacts was also used for water quality impacts: a circle with a 1.5-mile radius surrounding the Salinas Treatment Facility. The Pressure Area water balance in the SVIGSM groundwater model indicates that groundwater recharge from rainfall and irrigation

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[5] Based on a frequency analysis of daily flows at the Spreckels gage for 1967-2013, there was flow 78 percent of the time.

return flow averages 0.76 ft/yr, which is 38 percent of total groundwater recharge (MWH, 1997). Groundwater recharge from Salinas Treatment Facility percolation averages 0.12 ft/yr when distributed over the circular analysis area. Recharge from Salinas Treatment Facility percolation therefore amounts to approximately 6 percent of total recharge. This means that water quality impacts of changes in Salinas Treatment Facility percolation would be substantially diluted by mixing with other sources of recharge.

Chloride is a relatively conservative solute, which means its concentration does not gradually decrease due to adsorption, degradation or mineral precipitation as it moves through the subsurface. The concentration in the Salinas Treatment Facility ponds is up to three times greater than the existing groundwater concentration, but only 0.9-1.2 times the water quality objective (see Table 4). This means that pond percolation tends to degrade existing groundwater quality and could at most cause groundwater quality to slightly exceed the water quality objective. Therefore, a decrease in Salinas Treatment Facility pond percolation and associated groundwater recharge would probably have a small but beneficial impact on chloride concentration.

Nitrate is usually also a conservative solute in groundwater under typical aerobic conditions. The nitrate concentration in pond water is 2-3 times greater than the existing ambient groundwater concentration and 5-7 times greater than the water quality objective. However, existing nitrate concentrations in the 180-Foot aquifer already exceed the water quality objective by a factor of two. Recharge from pond percolation presently tends to exacerbate an existing degraded condition. Therefore, a decrease in pond percolation would probably have a small but beneficial impact on nitrate concentration.

TDS tends also to be fairly conservative during subsurface transport. The TDS concentration in pond water is 1.5-1.6 times greater than the ambient groundwater concentration. It is greater than the upper secondary MCL for drinking water but less than the Basin Plan water quality objective. Recharge from pond percolation presently tends to degrade groundwater quality with respect to TDS and could impact potable use but does not contribute to an exceedance of water quality objectives. Therefore, a decrease in pond percolation resulting from the GWR Project would tend to improve groundwater quality and maintain beneficial uses.

Finally, the Central Coast Regional Water Quality Control Board has not issued a water quality objective for phosphorus in groundwater. It is not a constituent regulated by drinking water standards or addressed in irrigation water quality guidelines. Therefore, changes in phosphorus concentrations in the 180-Foot aquifer caused by decreased Salinas Treatment Facility pond percolation would not affect beneficial uses.

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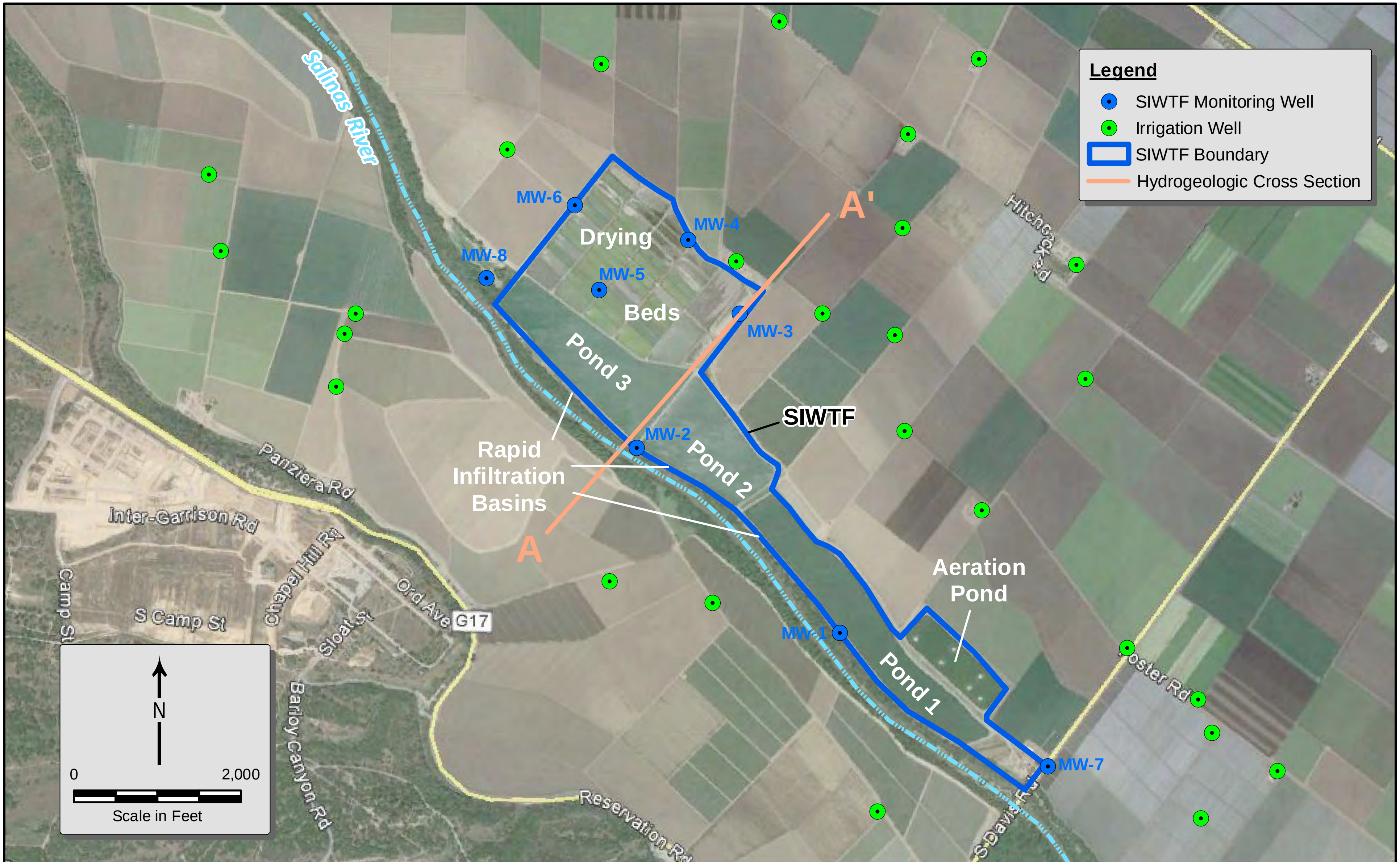

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Figure 1
Salinas Industrial Wastewater Treatment Facility (SIWTF)

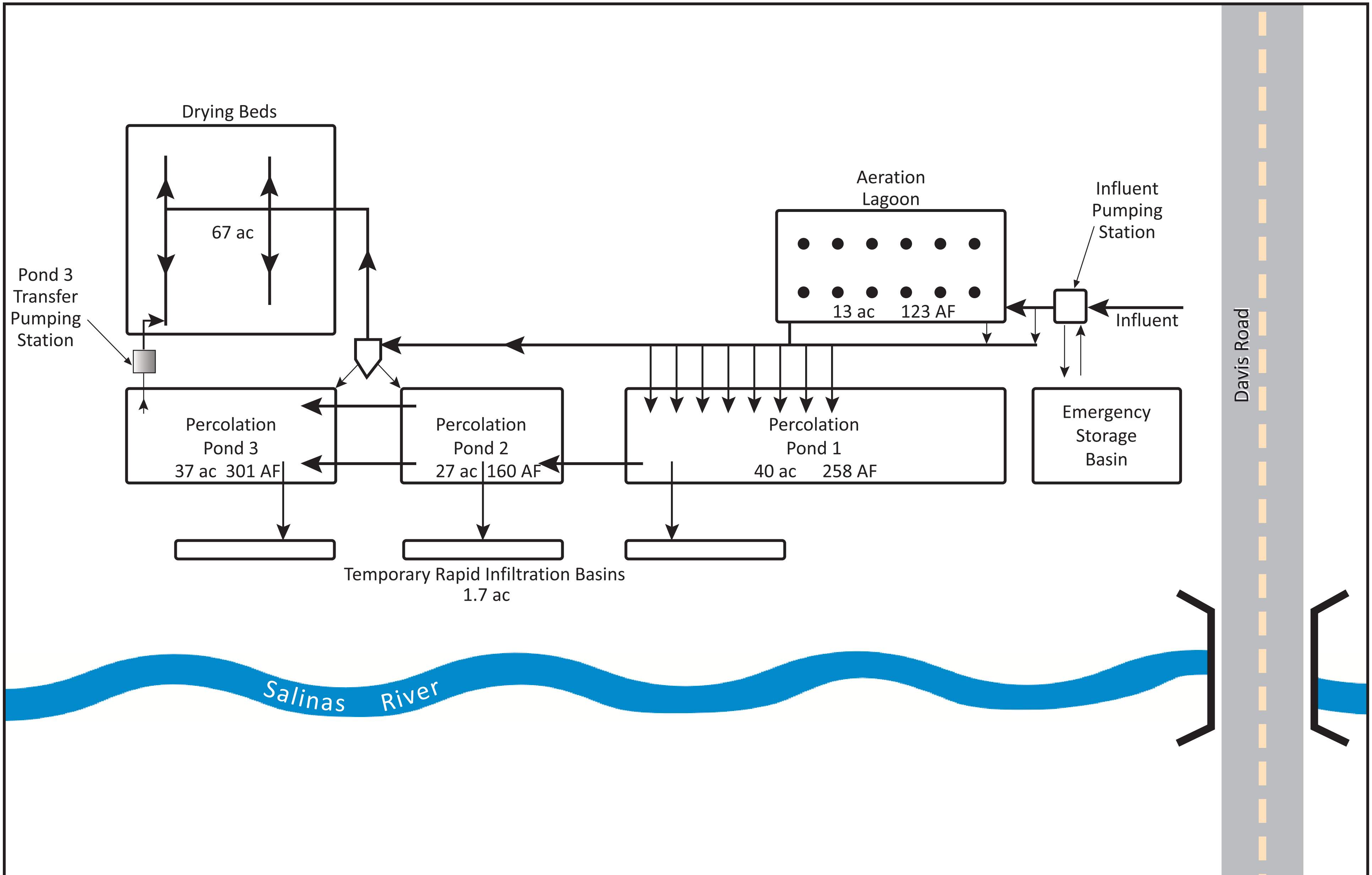

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Figure 2
Diagram of SIWTF Ponds and Flows

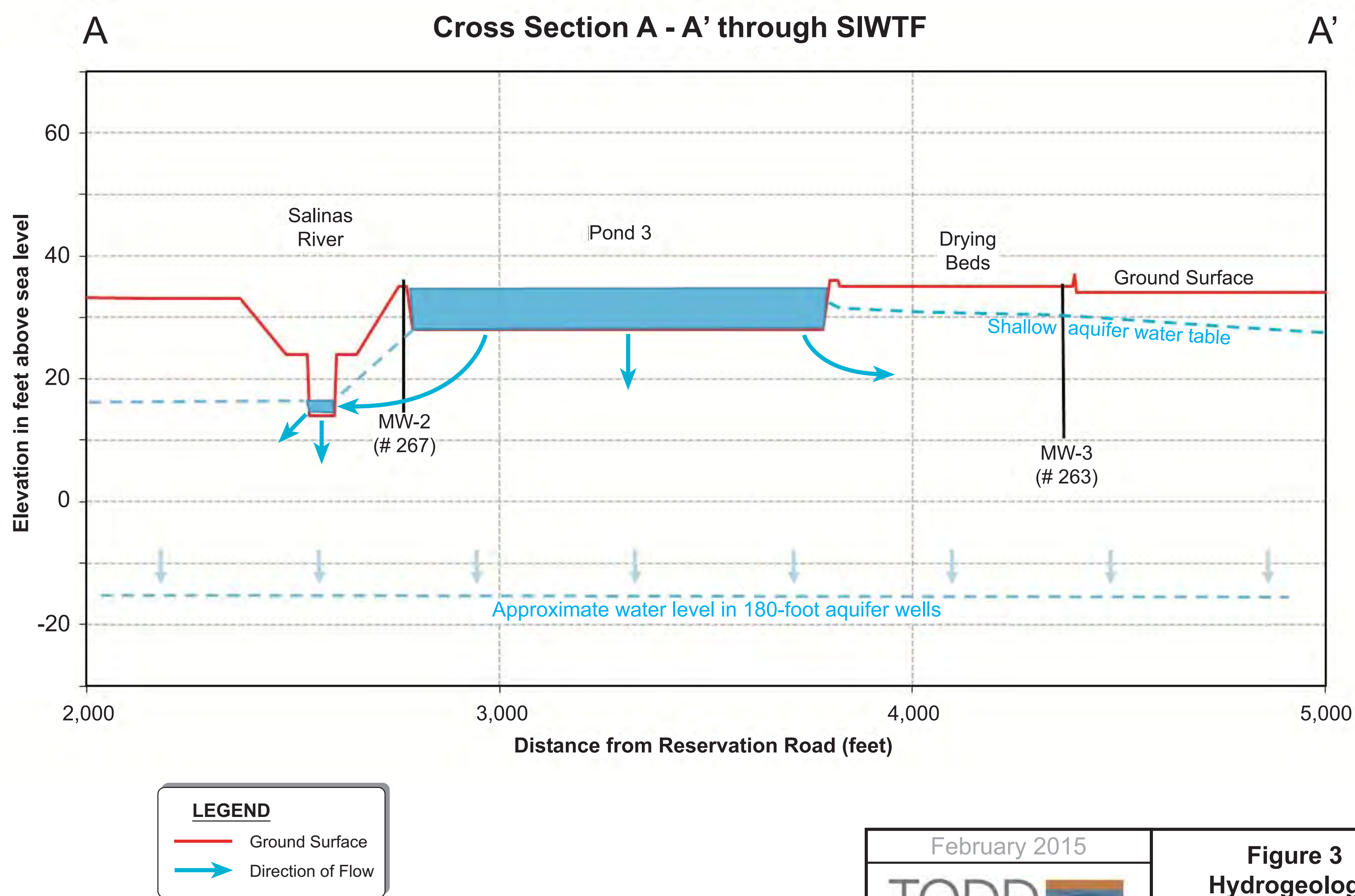

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Figure 3
Hydrogeologic Cross Section A - A’

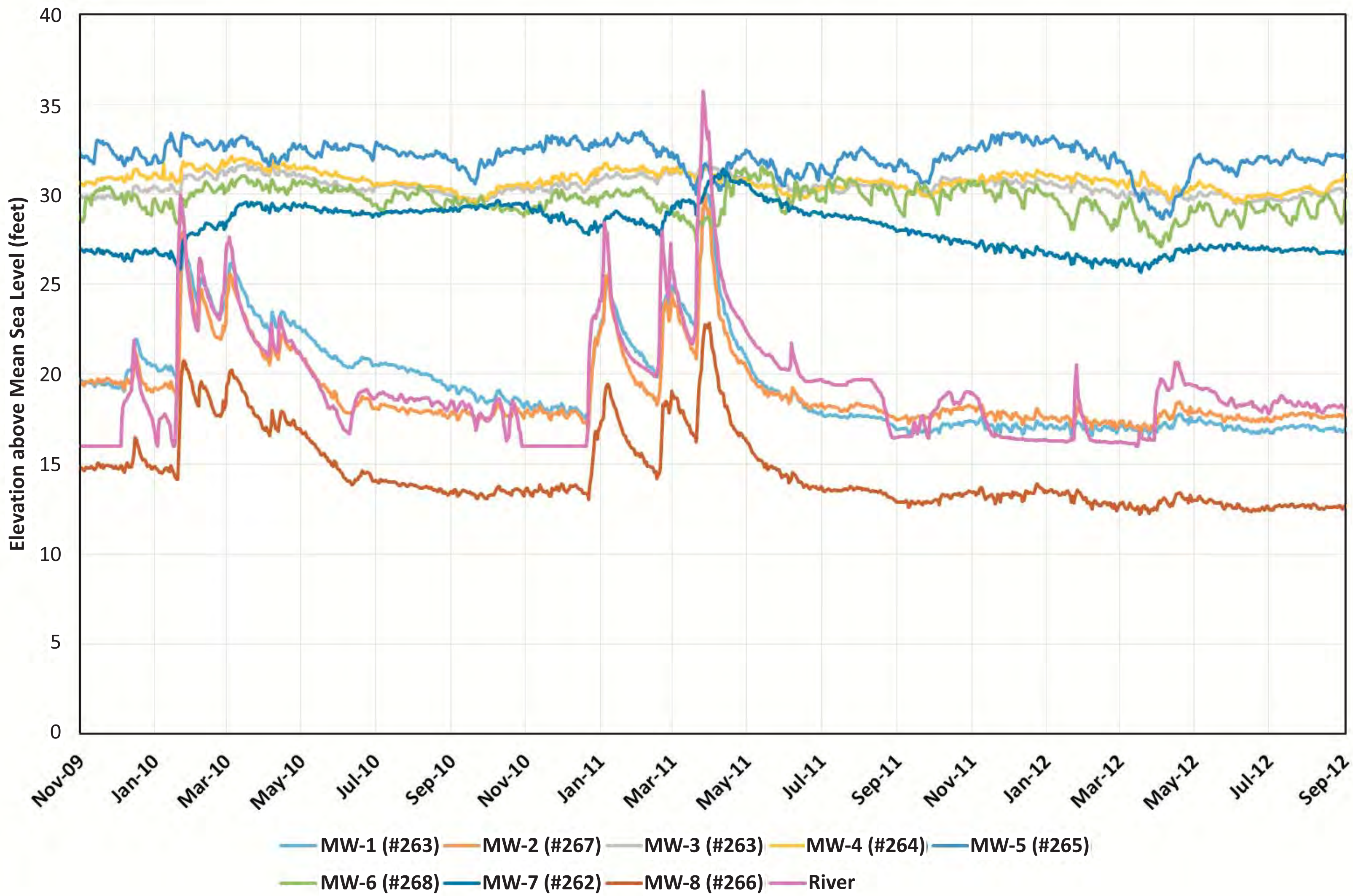

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Figure 4
Water Levels in SIWTF Monitoring Wells and the Salinas River