Technical Appendix D: Assessment of Water Unavailability Issues Within the Legal Delta

This appendix provides additional background information used to evaluate water unavailability in the Legal Delta portion of the Sacramento-San Joaquin Delta (Delta) Watershed.

Introduction

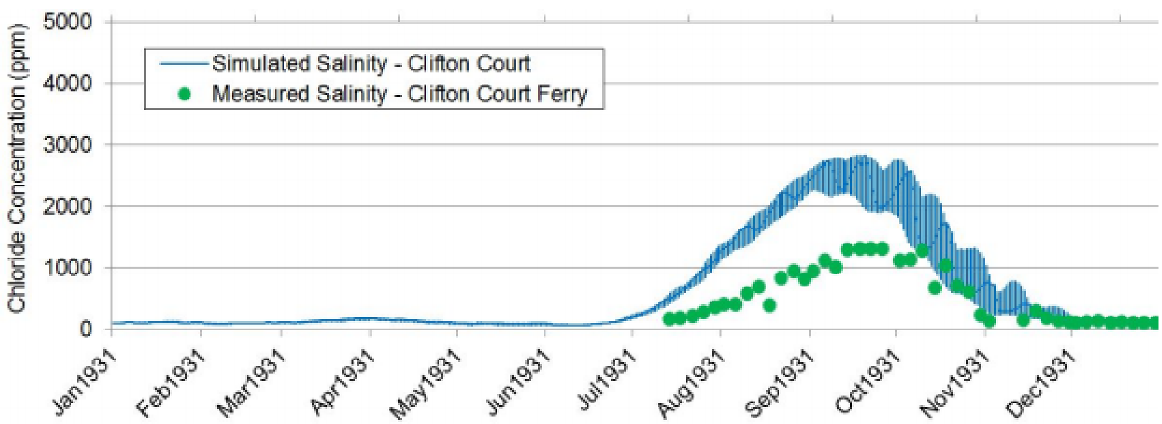
The evaluation of water unavailability for diversion in the Legal Delta is complex due to a number of factors, including (1) the considerations of tidal influence on freshwater residence time in the Legal Delta as well as water quality (e.g., its suitability for agricultural use), (2) the operations of the State Water Project (SWP) and Central Valley Project (CVP) (collectively the “Projects”), that release previously stored water from upstream storage for use in the Legal Delta, over which they retain claim and control for various beneficial uses, and (3) natural depletions of water in the Legal Delta due to aquatic and riparian vegetation, concerning which there is some uncertainty. The Water Unavailability Methodology for the Delta Watershed (Methodology) summary report explains that application of a residence time longer than one month is not warranted at this time given the extremely dry conditions that have persisted for an extended period and the supplementation of flows in the Delta with previously stored Project water for many months. The methodology also explains that only freshwater natural flows from the Sacramento and San Joaquin Rivers are accounted for as part of the considered supplies and does not include any water supplies from tidal inflows to the Legal Delta because saline water entering the Legal Delta from the San Francisco Bay via tidal action is assumed to be of insufficient quality to be usable for agricultural or municipal purposes. This appendix provides further technical support for these assumptions used in the Methodology.

This analysis focuses on water unavailability in the southern Delta because the predominant source of fresh water into the Legal Delta is from the Sacramento River to the north. Therefore, the effects of hydrodynamics on residence time, water quality, and water unavailability would be greatest in the southern Delta.

Appropriate Use of Hydrodynamic Models

Hydrodynamic models may provide useful insights into the complex movement of water within the Legal Delta when appropriately applied and validated. However, during periods of low inflow and high salinity, the commonly used California Department of Water Resources (DWR) Delta Simulation Model II (DSM2) does not accurately replicate observed conditions. For example, in written comments submitted to the State Water Resources Control Board (State Water Board or Board) by the Byron-Bethany Irrigation District (BBID) on May 25, 2021, a report from Dr. Susan Paulsen was referenced that compared observed salinity to modeled salinity values from DSM2 (see Figure 1). The model-calculated chloride concentration (a measure of salinity) is approximately three times higher than the measured chloride concentration in the vicinity of Clifton Court Forebay in the southern Delta in August and twice as high as the measured concentration in October. Additionally, the modeled results show a peak chloride concentration about 3 weeks earlier than observed. It is, therefore, inappropriate to rely solely upon results from a model for time periods when model results are off by almost a factor of three. However, other analyses and methods can be used to understand the relationship between Delta outflow, water unavailability, and water quality. These other methods also demonstrate why models alone may be unable to correctly calculate salinity during low Delta outflow conditions, as very small volumes of high salinity water can have very large effects on chlorides, salinity, and electrical conductivity (EC).

Figure 1. Example Comparison of Observed Salinity and Modeled Salinity in the Vicinity of Clifton Court Forebay, January–December 1931 (Paulsen, 2015)



Residence Time

Simple flow volumes and estimates of residence times based on inflow that are applied broadly to the Legal Delta also may not provide a sufficient answer to inform determinations regarding water unavailability because they do not account for mixing from tidal action and consumptive water use within the Legal Delta. Mixing of water, particularly in Suisun Bay, makes the mixed water from that source too salty for beneficial use far earlier than simple residence times and fingerprinting may suggest because they may not correctly consider the effects of even small volumes of very saline water. For example, fully half of the water at a particular location could come from water that entered from the Sacramento River spanning several months, but if the other half came from Suisun Bay, with an EC of 20,000 microsiemens per centimeter (μs/cm), the water would have an EC of just over 10,000 μs/cm and would be unusable for almost all purposes.

Fortunately, bathymetry data available as a result of recent improvements in digital elevation models (USGS 2017) can be used to better understand the effects of extremely low Delta outflow on water unavailability and water quality in the Legal Delta. To improve hydrodynamic models in the Delta, the USGS and Inter-Agency Ecological Program (IEP) sponsored the development of a 10-meter horizontal grid of bathymetry in the Delta (USGS 2007). The survey determined the volume and area for the various regions of the Delta shown in Figure 2 below.

Figure 2. Map of Delta Regions and Suisun Bay (USGS 2007), with State Water Board Decision 1641 Delta Outflow Compliance Locations (red), Relevant CDEC Gages (blue), and Other Points of Interest Added

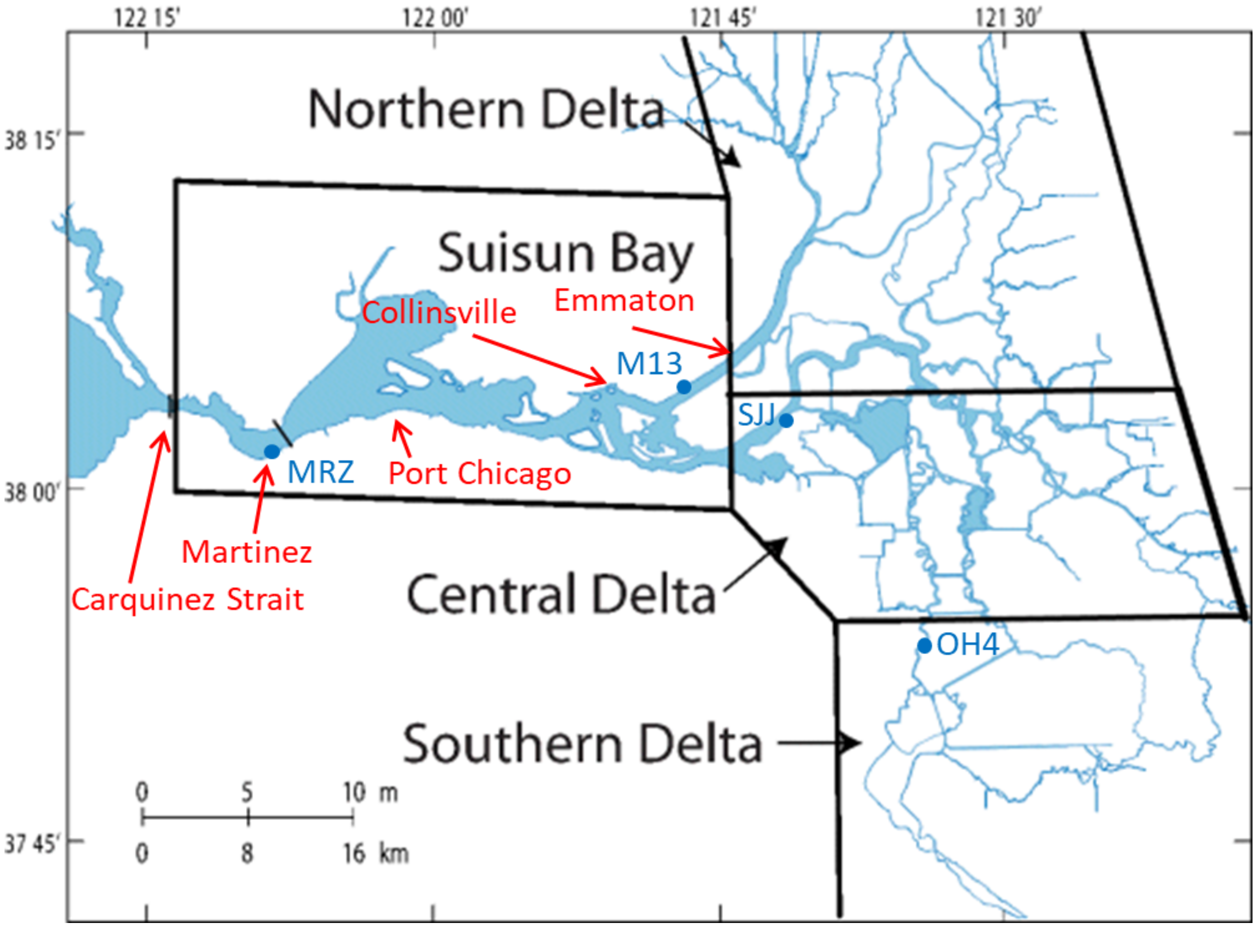


Table 1 contains the summary areas and volumes from the USGS report, with a conversion to volumes in thousand acre-feet (TAF).

Table 1 also contains tidal flux volumes based on variable tidal ranges for the four regions from California Data Exchange Center (CDEC) river stage gages. The tidal variation is greatest to the west in Suisun Bay and decreases in the eastern, northern, and southern regions of the Delta.

Table 1. Legal Delta and Suisun Bay Channel Volumes and Tidal Flux, July 2021

Region	**Water Surface Area** (million meters [2])	**Volume** (million meters^3)	**Water Surface Area** (acres)	**Volume** (TAF)	**Tidal Range** (feet)	**Tidal Flux*** (TAF/day)	**Exchange Rate*** (days)
Suisun Bay	165	954	40,772	773	3.6	297	2.6
Northern Delta	74	407	18,286	330	2.9	108	3.1
Central Delta	66	267	16,309	216	2.4	78	2.8
Southern Delta	10	28	2,471	23	2.4	12	2.0
Total	***316***	***1,656***	***78,085***	***1,343***		***494***	***2.7***
Total without Suisun Bay	***150***	***702***	***37,066***	***569***		***197***	***2.9***
Areas and volumes from USGS (2007).							
Tidal ranges from CDEC river stage data for gages MRZ, M13, SJJ, and OH4 (see Figure 2): http://cdec4gov.water.ca.gov/dynamicapp/wsSensorData							

* Tidal flux is the volume of water exchanged each day, which is calculated by multiplying water surface area by the tidal range multiplied by the frequency (i.e., twice per day). The exchange rate is calculated by the channel volume divided by the tidal flux.

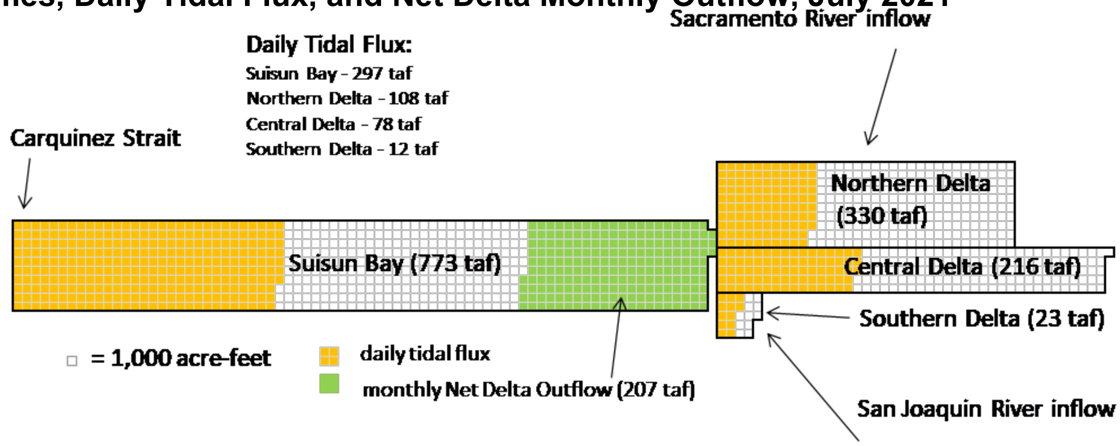
The Stockton and Sacramento Deep Water Ship Channels were deepened and widened for navigation, altering Legal Delta hydrodynamics by increasing tidal flow volumes and therefore increasing seawater dispersion into the Legal Delta (CCWD 2010). These large channels, not present in the early part of the century, are part of the reason that channel volumes are so much bigger in the northern and central Delta than the southern Delta.

Table 1 may suggest, based on volume alone, that a pool of water in Suisun Bay and the Legal Delta could provide a prolonged water supply in the Legal Delta. However, Table 1 also shows that an amount of water equal to the entire volume of Suisun Bay is exchanged by the tides over less than three days. Similarly, in each of the Delta regions an amount of water greater than the total volume is exchanged by the tides over less than three days (less than two days in the southern Delta). The large tidal influence greatly reduces the residence time of fresh water in the Legal Delta and thus has a large effect on the water quality (as discussed below in the following section).

Figure 3 shows the four regions of the Delta scaled according to their channel volumes. Superimposed on the graphic is a scaled representation of the 297 TAF/day tidal flux and the net Delta outflow to Suisun Bay in July; it is this positive net outflow that stops saltwater from flowing into the Legal Delta. This schematic shows how large the daily tidal flux is in comparison to the volume of the regions of the Delta. For example, tidal flux in the southern Delta is equal to approximately half its channel volume. Figure 3 makes two things visually clear:

1. The importance of tidal flux compared to the total volume of water in Suisun Bay and regions of the Delta, and
2. The relatively small volume of water in southern Delta channels compared to Suisun Bay and other regions of the Delta.

Figure 3. Schematic of Suisun Bay and Delta Regions with Scaled Channel Volumes, Daily Tidal Flux, and Net Delta Monthly Outflow, July 2021



In addition to tidal exchanges, irrigated and riparian vegetation consumes a large volume of water from Legal Delta channels. Consumptive use of water in the Legal Delta, as estimated for regulatory purposes, is presented in the DAYFLOW documentation (DWR 2019); DAYFLOW results for 2021 are summarized in Table 2 below. Table 2 shows that consumptive water use in the southern Delta is very large, especially when compared with the channel volumes in Table 1.

The monthly depletions for each Delta region are shown as a percent of channel volume in Table 3. Table 3 shows that consumptive water use in the southern Delta is more than three times (313%) the volume of water in the southern Delta channels in the month of July and just under that in June and August. Therefore, without considering the twice daily tidal flux discussed above, and without considering diversions by the Projects from Clifton Court Forebay and the Jones Pumping Plant, there are three full exchanges of water in the southern Delta that are attributable to consumptive use. Without considering tidal flux, the residence time of water in the southern Delta is about 10 days throughout June, July, and August. Tidal flux has the effect of exchanging an amount equivalent to the volume of water in southern Delta channels around 15 times per month (one exchange every two days).

Table 2. Gross Channel Depletions Distributed by Delta Region, March-October 2021

Month	**DAYFLOW Delta Gross Channel Depletions** (TAF)	**Northern Delta Depletions*** (TAF)	**Central Delta Depletions*** (TAF)	**Southern Delta Depletions*** (TAF)
March 2021	80	41	18	22
April 2021	112	57	25	30
May 2021	149	76	33	40
June 2021	223	114	49	60
July 2021	267	136	59	73
August 2021	232	118	51	63
September 2021	156	80	34	42
October 2021	114	58	25	31

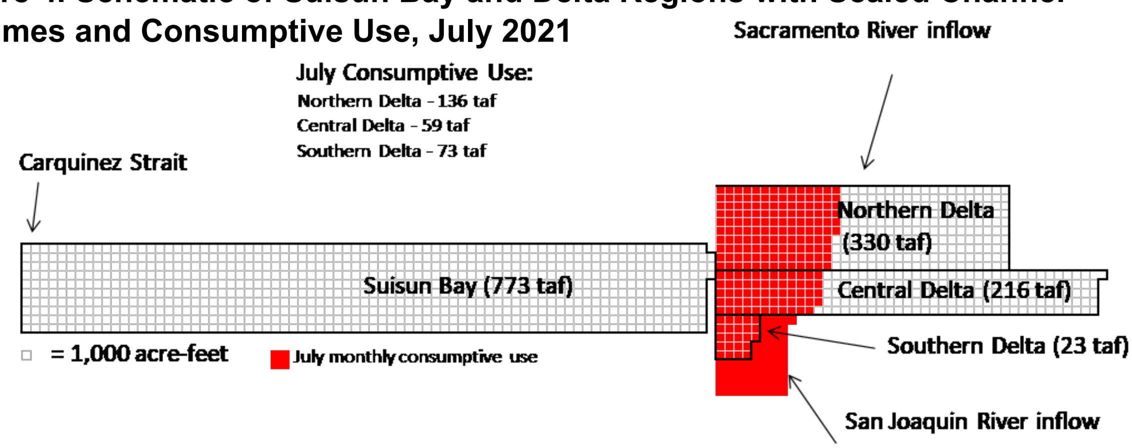
* Depletions for the three regions are based on a proportional distribution of total DAYFLOW Delta gross channel depletions based on the service areas of the North, Central, and South Delta Water Agencies.

Table 3. Monthly Depletions as a Percent of Channel Volume, March–October 2021

Month	DAYFLOW Delta Gross Channel Depletions (TAF)	Northern Delta	Central Delta	Southern Delta
March 2021	80	12%	8%	94%
April 2021	112	17%	11%	132%
May 2021	149	23%	15%	176%
June 2021	223	34%	23%	263%
July 2021	267	41%	27%	315%
August 2021	232	36%	24%	274%
September 2021	156	24%	16%	184%
October 2021	114	18%	12%	135%

Figure 4 shows the July 2021 gross monthly depletions[1] from Table 3 for different regions of the Delta in relation to their channel volumes. This schematic clearly shows how the volume of consumptive use in the southern Delta greatly exceeds the volume of water that can be stored in southern Delta channels.

Figure 4. Schematic of Suisun Bay and Delta Regions with Scaled Channel Volumes and Consumptive Use, July 2021



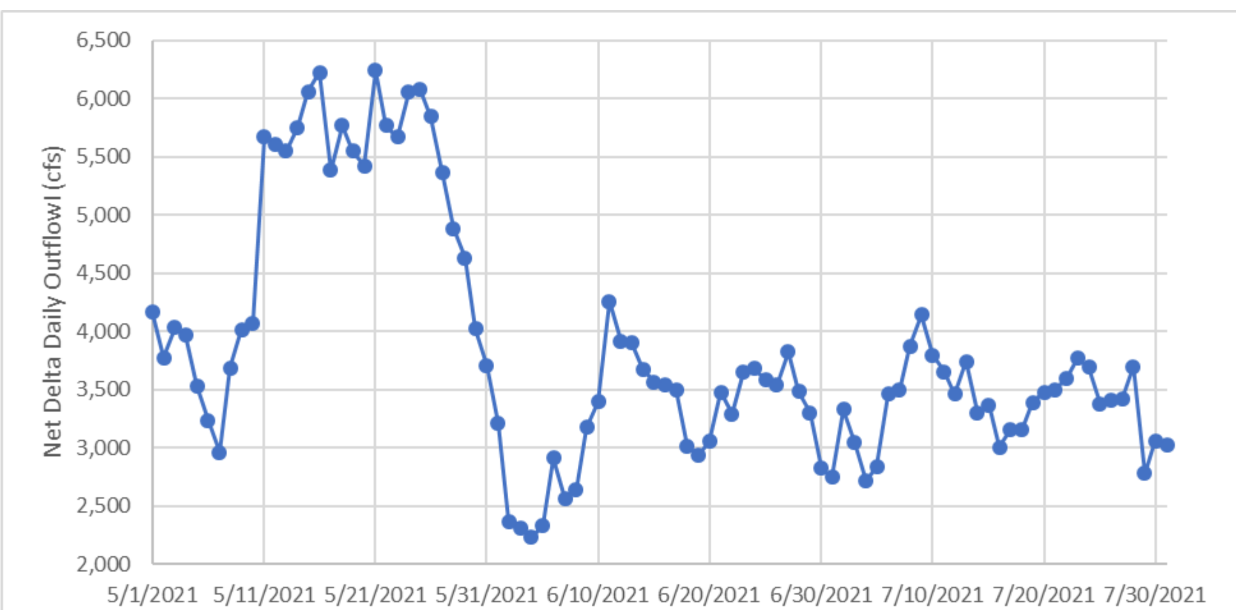
[1] Shown in the figure as consumptive use because in July and other months with no precipitation, channel depletions and consumptive use are the same value.

Simple estimates of residence time that only consider the total volume of the Legal Delta and inflow overestimate the residence time because they do not consider the enormous twice daily tidal flux, the variable channel volumes in different regions of the Delta, or consumptive water use. When these factors are considered, the residence time is less than three days for Suisun Bay and the northern, central, and southern Delta. The northern Delta has a longer residence time than the other regions, but it is still well under a month.

Water Quality

In addition to decreased residence times attributable to tidal flux and consumptive use, the effects of reduced Delta outflow on water quality must also be considered for determining water unavailability. Although there is water present at all times in the channels of the Legal Delta, in the absence of releases of water from storage upstream by the Projects that water is not necessarily of suitable quality for agricultural use. One of the principal purposes of the Projects is to release adequate water to maintain Delta outflow at levels sufficient to repel water in Suisun Bay from entering the Legal Delta. During low flow conditions, the typical minimum flow needed to maintain a freshwater barrier to repel salinity from entering the Legal Delta is a net Delta outflow of 3,000 to 4,500 cubic feet per second (cfs). Flows in this range and higher have been maintained during May, June, and July this year (Figure 5). Flows approaching, and lower than, 3,000 cfs even for short periods can result in salinity intrusion into the Legal Delta.

Figure 5. Net Delta Outflow, May–July 2021



Absent Project storage releases in 2021, water quality in much of the Legal Delta would have been of a quality unsuitable for agriculture much of this summer. While historical records of similarly dry periods may show that water was of sufficient quality for use throughout the summer, these periods did not include changes to the geography such as the deepening of ship channels or the increase in demand by more senior water users upstream, both of which have further degraded water quality.

Evaluation of Flows in the Legal Delta

Another way to evaluate the natural and abandoned flows that may be present in the Legal Delta is to evaluate conditions absent Project operations to determine how much water would be present in the Delta absent supplementation of Delta inflows with previously stored Project water and absent diversions by water users that have contracts with the Projects. The analysis conservatively assumes that all diversions by Project contractors are from Project previously stored water even though many of these water users have their own water rights and claims of right under which they would divert some portion of natural and abandoned flows reducing to some extent the water present in the Delta. This section presents an estimate of Legal Delta conditions without the operations of the Projects.

The amount of Project water released from previously stored water in Project reservoirs can be estimated by computing the difference between reservoir outflow and inflow (Project water is equal to outflow minus inflow). This assumes that all reservoir inflow is natural or abandoned. If the outflow is less than the inflow, the reservoir is storing water and there is no release of stored Project water occurring. To estimate the portion of Legal Delta inflow that originated as stored water releases from Project reservoirs upstream, the large deliveries of contract water by the Projects in the Sacramento, Feather, and American River basins need to be accounted for. Figure 6 shows the stretches of the rivers with Project reservoirs where Project contractors divert water and downstream locations that do not have significant Project contract diversions, described as Project or non-Project, respectively (described in more detail below).

From the Sacramento River, the largest CVP deliveries are to the Sacramento River Settlement Contractors that were allocated 75% of the contract amount, or about 1.6 million acre-feet (MAF), in 2021. These diversions primarily occur above Wilkins Slough. Therefore, it was assumed that the Projects were responsible for providing storage withdrawals to meet all depletions between Keswick Dam and Wilkins Slough. This is a very conservative assumption because the Sacramento River Settlement Contractors also have their own water rights and claims of right under which they would divert natural and abandoned flows that would not constitute a contract delivery. From Wilkins Slough to Freeport it was assumed that all depletions were from stream losses and non-Project diversions and therefore are not the responsibility of the Projects.

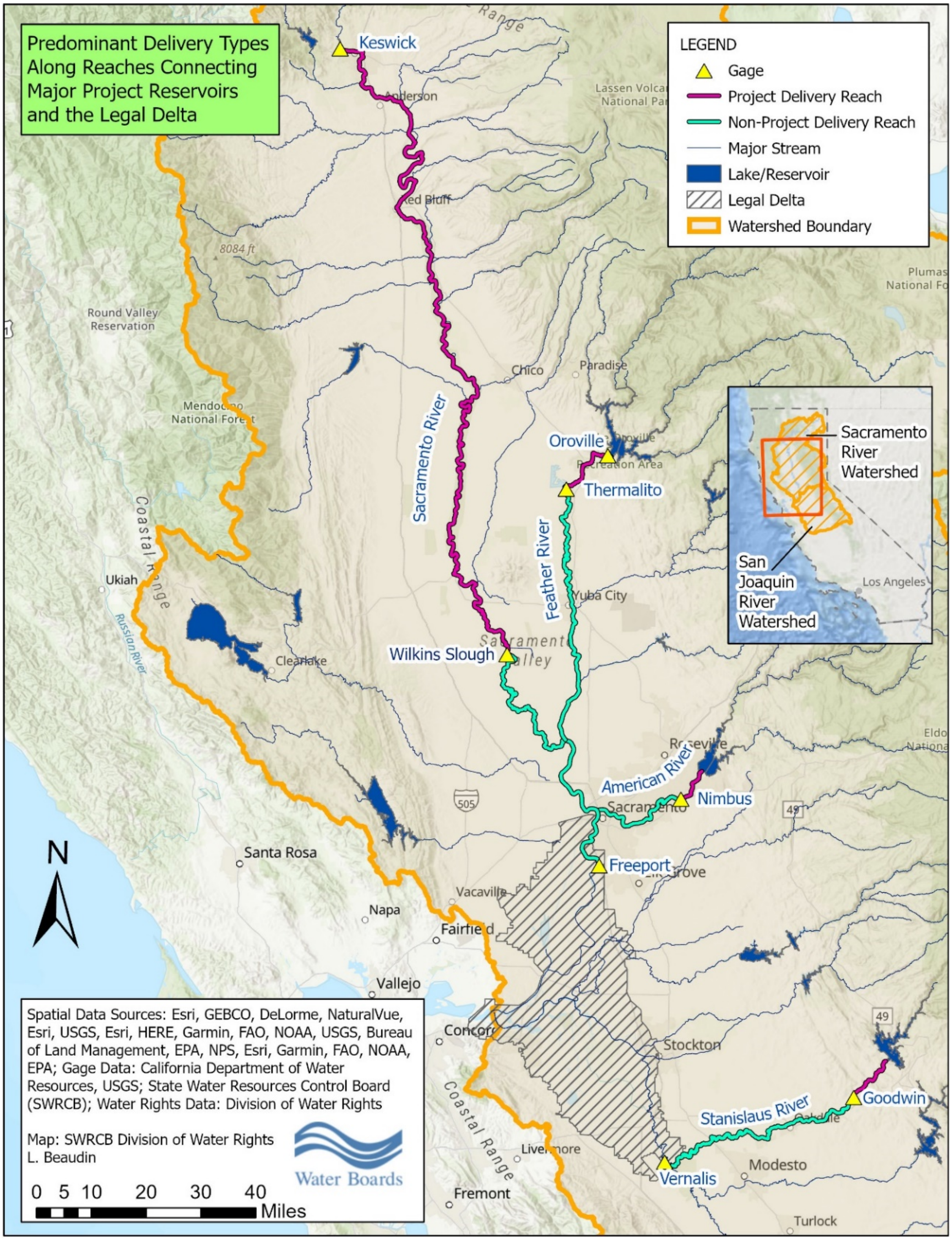
From the Feather River, the largest SWP deliveries are to the Feather River Service Area Contractors, which primarily divert from the Thermalito Complex below Oroville Dam. Similar to the Sacramento River, it was assumed that the Projects are responsible for all depletions between Oroville Dam and Thermalito Dam. Like the Sacramento River Settlement Contractors, this is also a very conservative assumption because the Feather River Service Area Contractors also have their own water rights and claims of right for which they would divert natural and abandoned flows. It was also assumed that inflows to the Feather from Kelly Ridge were abandoned. Depletions from below Thermalito Dam to Freeport were assumed to not be the responsibility of the Projects.

On the American River, most Project deliveries to urban contractors are directly from Folsom Reservoir or from the Folsom South Canal that diverts from Lake Natoma. Therefore, it was assumed that all Project storage releases below Nimbus Dam were present at Freeport.

On the San Joaquin River, Project deliveries occur above Goodwin Dam. Therefore, it was assumed that all depletions between New Melones Dam and Goodwin Dam were from previously stored Project water. Again, this is a conservative assumption because water users in this stretch also have their own water rights that they divert natural and abandoned flows under. All depletions between Goodwin Dam and Vernalis were then assumed to be from natural and abandoned flows.

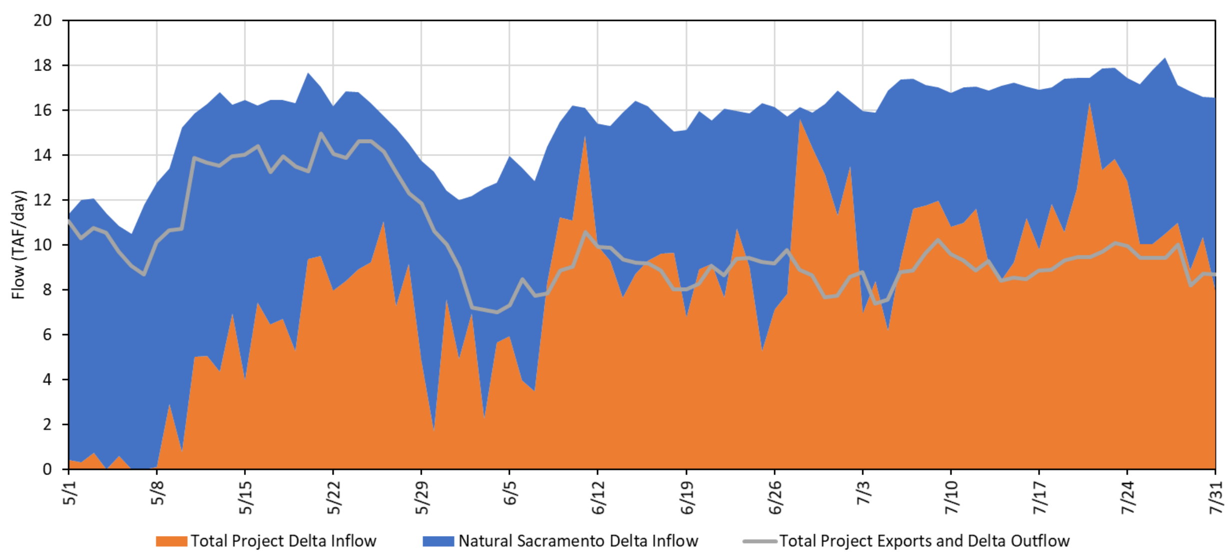
In summary, this method assigns all depletions between the major Project reservoirs and specified downstream control points (Wilkins Slough, Thermalito Dam, Nimbus Dam, and Goodwin Dam) to the Projects. All depletions downstream of these points, and upstream of inflow to the Legal Delta, are assigned to natural and abandoned flow. This method may slightly underestimate depletions of Project water because it does not account for other small Project diversions downstream of these control points (and upstream of the Legal Delta). It also likely underestimates depletions of natural and abandoned flows upstream of these points by Project contractors with their own water rights and other non-Project water right holders in reaches considered to be Project reaches. However, this method captures the major Project water depletions downstream of Project reservoirs and upstream of the Legal Delta. The natural and abandoned inflow estimated using this method is different than the unimpaired flows used in the Water Unavailability Methodology because the Methodology provides a total comparison of natural flow to water demands in the entire Delta watershed before any diversion has taken place. The method described above provides an estimate of natural and abandoned flow that reaches the Legal Delta after upstream diversions have taken place.

Figure 6. Predominant Delivery Types Along Reaches Connecting Major Project Reservoirs and the Legal Delta



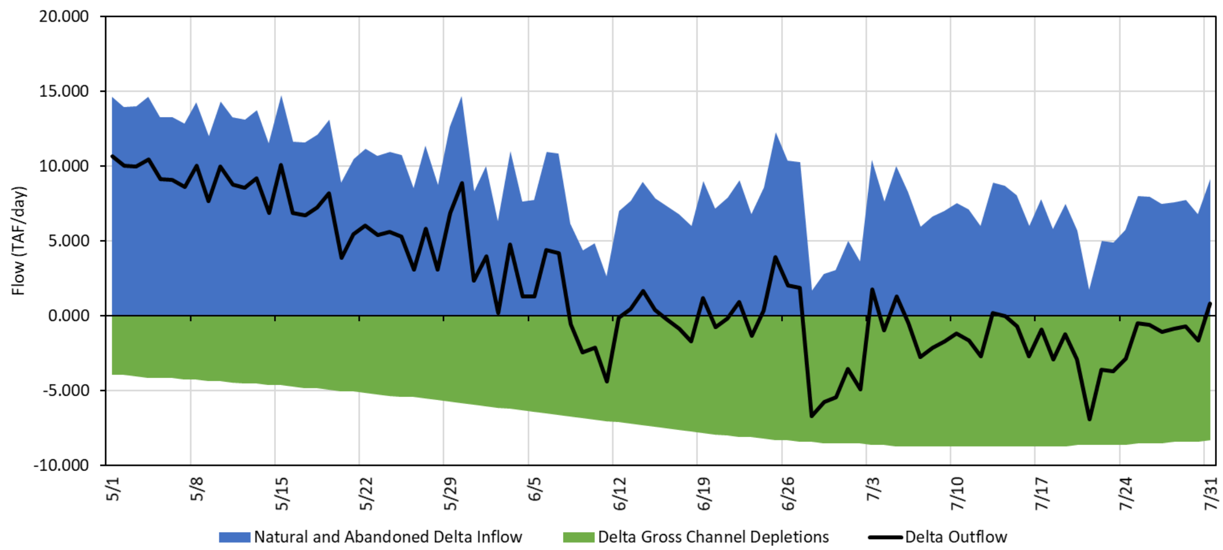
The method also provides an estimate of Project water entering the Delta, which is calculated as the sum of the Project water below the upstream control points described above. The natural and abandoned Delta inflow was estimated as the total observed Delta inflow (including inflows from Delta Eastside Tributaries, Yolo Bypass, and Sacramento Regional Water Treatment Plant) minus the Project Delta inflow. Figure 7 shows estimates of Legal Delta inflow from previously stored Project water and natural or abandoned flow, as well as a line representing total Project exports and Delta outflow. From early June through July, more Project water entered the Legal Delta than was exported and provided as Delta outflow. Total Legal Delta inflow from the Projects increased over these three months to maintain the freshwater barrier so that salt did not intrude into the Legal Delta.

Figure 7. Previously Stored Project Water and Natural and Abandoned Flow entering the Legal Delta, May–July 2021



Without the release of Project Water from storage, the only Delta inflow would be from natural and abandoned flows. If Delta depletions remained the same, they would be met by natural and abandoned flows until fully consumed, and Delta outflow would decrease to zero and then go negative. Figure 8 shows the effect that removing Project water would have on Delta outflow, going from slightly positive in May to negative in June and July. In the absence of Project water, Delta outflow becomes negative (reverse Delta outflow) over these three months because inflow of natural and abandoned flow decreases at the same time that Legal Delta depletions increase from May through July.

Figure 8. Legal Delta Inflows and Outflows without SWP and CVP Storage Releases and Exports, May–July 2021



As shown in Table 4, Legal Delta inflow from natural and abandoned flows exceeded Legal Delta consumptive use in May. Therefore, these inflows could have provided the water consumptively used in the Legal Delta. In June and July, however, with diminishing flows, net consumptive use in the Legal Delta exceeded inflows from natural and abandoned flows.

Table 4. Calculated Net Delta Outflow without Project Inflows, May-July 2021

Month	**Natural and Abandoned Legal Delta Inflow** (TAF)	**Net Delta Consumptive Use** (TAF)	**Calculated Net Delta Outflow** (TAF)	**Calculated Net Delta Outflow** (cfs)
May 2021	302	148	155	2,514
June 2021	194	220	-26	-437
July 2021	198	268	-70	-1,138

Without Project storage releases, there would not have been enough natural and abandoned Legal Delta inflow in June and July 2021 to prevent the net inflow of water from Suisun Bay into the Legal Delta. Instead of the average net Delta outflow of 3,300 cfs that occurred in June and July (Figure 5), there would have been negative net

Delta outflow in June and July.[2] Inflow of higher saline water from the west would have been particularly large in the southern Delta because it has disproportionately small channel volumes relative to its depletions. Table 5 shows that specific effect in the southern Delta, where consumptive use exceeded natural and abandoned inflows from the San Joaquin River in May, June, and July. The combined net inflow into the southern Delta from the central Delta and Suisun Bay for these three months, absent Project water from the San Joaquin River, would have been 115 TAF — five times the 23 TAF volume of southern Delta channels.

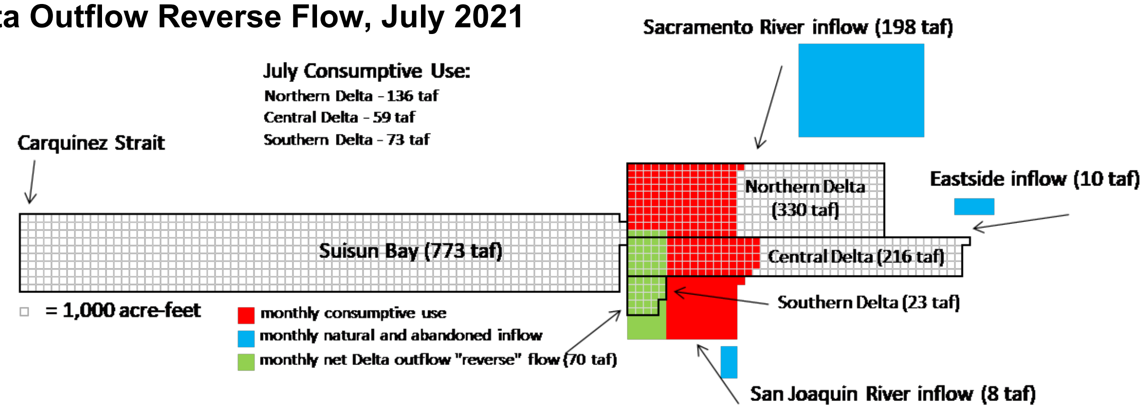
Table 5. Calculated Southern Delta Replacement Water with No Legal Delta Inflow from San Joaquin River Project Releases, May–July 2021

Month	**Natural and Abandoned San Joaquin River Inflow to Legal Delta** (TAF)	**Southern Delta Consumptive Use** (TAF)	**"Replacement" Inflow to Southern Delta** (TAF)
May 2021	37	40	3
June 2021	13	60	47
July 2021	8	72	64
Sum	*57*	*172*	*115*

Figure 9 shows the conditions that would have occurred in July 2021 if there had been no Project water entering the Legal Delta. The figure shows consumptive use in the three Delta regions relative to their channel volumes, the volume of natural and abandoned Legal Delta inflow, and net Delta outflow, which reverses in July. The volume of Sacramento River and eastside tributary natural and abandoned flow (198 + 10 = 208 TAF) is just slightly higher than the combined Northern and Central Legal Delta July consumptive use (136 + 59 = 195 TAF). The volume of San Joaquin River natural and abandoned flows (8 TAF) is a small fraction of southern Legal Delta consumptive use (73 TAF). This shows that, with continued use and in the absence of Project water, southern Legal Delta channels would be pulling water from the central Legal Delta and Suisun Bay. The figure shows that there would be negative net Delta outflow from the central and southern Legal Delta because consumptive use would be disproportionately higher than freshwater inflow.

[2] No additional use or export in the Legal Delta, other than net Legal Delta consumptive use, are considered in this calculation: diversions by the North Bay Aqueduct, Contra Costa Canal, and Byron Bethany Irrigation District are considered to be zero.

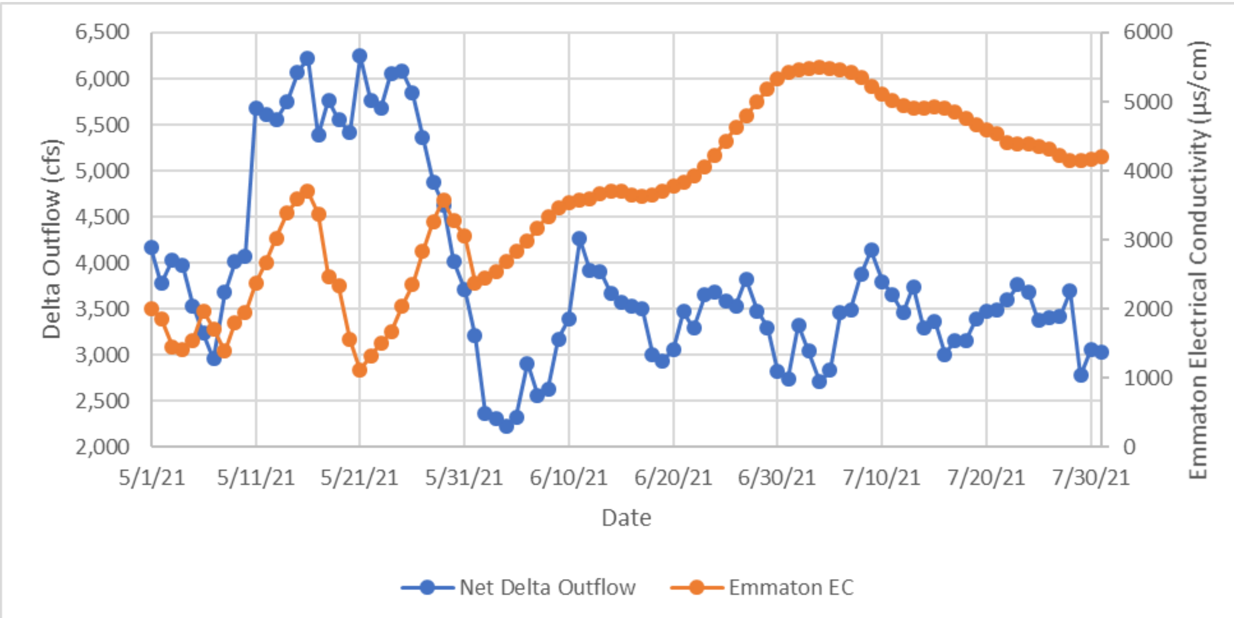
Figure 9. Schematic of Suisun Bay and Delta Regions with Scaled Channel Volumes, Consumptive Use, Natural and Abandoned Legal Delta Inflow, and Net Delta Outflow Reverse Flow, July 2021



Estimation of Water Quality in the Delta Without Previously Stored Project Water

This section presents a discussion of Legal Delta water quality absent Project operations. Without the presence of upstream Project storage releases in the Legal Delta, diversions in the southern Delta that exceed inflows from upstream would cause water from Suisun Bay and the central Delta to enter the southern Delta. The average EC in the far western boundary of the Legal Delta, at Emmaton (see Figure 2), was approximately 2,200 µs/cm in May 2021, when the average net Delta outflow was over 5,000 cfs. The EC increased to an average of over 4,000 µs/cm in June and July 2021, when the average Delta outflow dropped to an average 3,300 cfs (Figure 10). This relatively large increase in salinity occurred in response to a relatively small reduction in net Delta outflow from 5,000 to 3,300 cfs. This minimal Delta outflow was still enough to maintain a freshwater barrier between Suisun Bay and the Legal Delta, but salinity increased due to more water from Suisun Bay being mixed with Sacramento River water at Emmaton. Absent any Delta outflow, large volumes of Suisun Bay water and its associated salts would start entering the Legal Delta.

Figure 10. Historical Net Delta Outflow and Electrical Conductivity at Emmaton, May–July 2021



The EC at the far eastern boundary of Suisun Bay, downstream of Emmaton, would have been far higher if there had been no Delta outflow to freshen water in Suisun Bay. Further west in Suisun Bay, the average EC from May–July 2021 was 11,000, 20,000, and 31,000 µs/cm at Collinsville, Port Chicago, and Martinez, respectively (east to west, see Figure 2). Without the benefit of Project water flowing into the Delta, this high EC water would have intruded into the Legal Delta and would mix much more with water already present because of the large daily tidal flux. It does not take much of this high salinity water to have a large effect on water quality; a 50/50 mix of 20,000 µs/cm water from central Suisun Bay would result in a mixed water quality of over 10,000 µs/cm, assuming there was no salt in the other components of the mix.

Without Project water, conditions in the southern Delta in July 2021 would have been far worse than a 50/50 mix of Martinez-quality water because there would be very little low-salinity water present to mix with. Only 8 TAF of San Joaquin River water would have flowed into the southern Delta in July 2021 (see Table 5), while consumptive use was 73 TAF (see Table 2). Only 11 percent of the monthly consumptive use would have been met by low-salinity water from the San Joaquin River. The other 89 percent would have to have been met with water that flowed into the southern Delta through the central Delta from Suisun Bay. A 90/10 mix of Martinez and San Joaquin River water could approach 18,000 µs/cm.

Although some salt-tolerant crops can continue to be grown with relatively saline water, doing so requires very high leaching fractions to move the salts through the root zone. The types of soils in the southern Delta do not provide the high leaching requirements needed to support high salinity irrigation water, and salt-tolerant crops are not generally grown in the southern Delta. Even if such crops were grown in the southern Delta and such leaching were possible, there is nowhere for the leached water to go except back into the southern Delta channels. With no net Delta outflow, the southern Delta is a closed system where the salt levels would continue to rise.

Slight to moderate restrictions on use are generally considered for irrigation water with salinity between 700 and 3,000 µs/cm, with severe restrictions for salinity over 3,000 µs/cm (Ayers and Westcot, 1985). Determining the sensitivity of crops to highly saline water is not a simple matter because the effect on the crop is based on the salinity in the root zone, which can be higher than the salinity of applied irrigation water. This is because soil salinities generally increase as water is consumed by the plant and salts are left behind in the soil.

Sensitive crops start showing declines in yield for soil-water salinities (soil extract EC) over 2,000 µs/cm, with 100% yield reduction at 8,000 µs/cm. Moderately sensitive crops start showing reductions at 3,000 µs/cm, with 100 percent reduction at 16,000 µs/cm. Moderately tolerant and tolerant crops start showing reductions at 7,000 and 10,000 µs/cm, with 100 percent reduction at 24,000 to 32,000 µs/cm (Hoffman 2010). These effects would occur at lower thresholds of applied water salinity depending on initial soil salinity and leaching fractions of the soils, among other things. In 2007, less than ten percent of the crops grown in the southern Delta were moderately tolerant or tolerant (Hoffman 2010).

An additional problem associated with applying highly saline water to crops is that salts will eventually have to be flushed from the root zone before yields can be restored. When that occurs, the salts will continue to impair the use of the receiving water as an agricultural supply until such time as all the salts are flushed from channels in the Legal Delta.

Conclusions

Although there will always be water in the Delta channels that are at or below sea-level, by August 2021 the quality of the water in those channels would be too salty for agricultural or urban beneficial uses absent the releases of previously stored water by the Projects. This analysis shows that when tidal flux, consumptive use, Delta outflow, the operations of the Projects, and water quality are considered, the assumptions regarding residence time and water quality in the Water Unavailability Analysis are valid.

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