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TECHNICAL MEMORANDUM

DATE: June 16, 2016 Project No.: 693-20-16-01
SENT VIA: EMAIL

TO: SRWA Technical Advisory Committee

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SUBJECT: Preliminary Phasing and Water Treatment Plant Sizing for the SRWA Surface Water Supply Project

OVERVIEW

This Technical Memorandum (TM) presents preliminary sizing and phasing for the Stanislaus Regional Water Authority (SRWA) Surface Water Supply Project (Project) Water Treatment Plant (WTP). These preliminary estimates are based on West Yost Associates' (West Yost's) review of current supply and demand projections, prepared for the 2015 Urban Water Management Plans of the City of Turlock and the City of Ceres, and based on input provided by the SRWA Technical Advisory Committee at a workshop held May 2, 2016.

Following this overview, this TM presents the following:

- Ceres Demand and Supply Projections;
- Turlock Demand and Supply Projections;
- Other Potential Participants;
- Turlock Irrigation District Supply Reliability; and
- Preliminary Water Treatment Plant Sizing and Phasing.

These latest demand projections, discussed below, were presented and discussed at the May 2, 2016 workshop. Based on the demand projections developed by each individual city, preliminary Phase 1 and Phase 2 WTP capacities were identified to be:

- Ceres - 10 million gallons per day (mgd) Phase 1, increasing to 15 mgd Phase 2; and
- Turlock - 20 mgd Phase 1, increasing to 30 mgd Phase 2.

The Preliminary WTP Sizing and Phasing section reviews contract terms of the Water Sales Agreement between Turlock Irrigation District (TID) and the SRWA, monthly distribution of demands based on historical use patterns and demand projections, and evaluates potential surface water and groundwater deliveries with reductions in surface water during dry years.

Based on the preliminary WTP sizing and phasing identified, it appears that Ceres and Turlock will be able to conjunctively manage surface water and groundwater supplies in normal and drought years. Preliminary WTP sizing may be refined later in the Project, once capital and annual cost estimates are developed.

CERES DEMAND AND SUPPLY PROJECTIONS

Ceres demand and supply projections are presented based on information provided by Ceres, developed for their 2015 Urban Water Management Plan. Future demand projections were based on future land use estimates developed for Ceres' 2011 Water Master Plan Update (West Yost, 2011). Although Ceres is in the initial stages of a General Plan update, Ceres anticipates similar projected buildout population and land use as was used in the 2011 Water Master Plan Update.

Current and Projected Demand

Table 1 summarizes Ceres' current and projected potable water use through 2035. Water use in recent years has been significantly impacted by the drought, with a 2015 per capita water use of 123 gallons per capita per day (gpcd), compared with a 2010 per capita water use of 155 gpcd. Water use projections for 2020 through 2035 are based on buildout land use acreages estimated in the 2011 Water Master Plan, and per capita water use estimates that increase to 166 gpcd by 2035 (estimated as buildout). The estimate of 166 gpcd includes a base water use of 150 gpcd, and a 10 percent intensification of water use to account for plans to attract water intensive industries. The buildout per capita use is less than Ceres' 2020 per capita water use target of 194 gpcd that Ceres has adopted to comply with the Water Conservation Act of 2009 (Senate Bill x7-7). The bottom portion of the table summarizes the average daily water use. Current average daily water use is 5.8 mgd, projected to increase to 16.0 mgd by 2035. Table 1 does not include irrigation demand at Ceres city parks that is met from non-potable irrigation wells.

Table 1. City of Ceres Water Use Projections through 2035

	2015	2020	2025	2030	2035
Annual Potable Water Use (acre-feet-year)[(a)]	6,500	9,800	12,500	15,100	17,900
Average Daily Water Use (mgd)	5.8	8.8	11.1	13.5	16.0

[(a)] City of Ceres projections provided by Jeremy Damas, May 2016, prepared for Ceres' 2015 UWMP.

Current and Projected Annual Supply

Ceres' current supplies include groundwater, and a nominal amount of recycled water used for landscape irrigation at the Ceres Wastewater Treatment Plant. Ceres has a total of 15 potable groundwater wells, 12 of which are active, and three that are currently off-line due to water quality

issues. Total well capacity is 10,200 gallons per minute (gpm) (14.7 mgd). Ceres estimates that its firm well capacity, assuming its largest well is out of service, is 8700 gpm (12.5 mgd). Ceres plans to bring on two new wells in 2016 and 2017, which will increase total well capacity to 12,400 gpm (17.9 mgd), and firm capacity to 10,900 gpm (15.7 mgd). Several wells have been decommissioned due to water quality concerns. Water quality contamination includes arsenic, uranium, nitrate and 1,2,3-trichloropropane (TCP). TCP, a chlorinated hydrocarbon, is currently an unregulated contaminant that has been identified by the U.S. Environmental Protection Agency as a contaminant that may require future regulation. California Office of Environmental Health Hazard Assessment has established a Public Health Goal (PHG) of 0.0007 parts per billion for TCP. Although no maximum contaminant level (MCL) has been established for TCP, the State Health and Safety Code requires that when MCL's are established, that they are as close to PHG's as technologically and economically feasible. Ceres estimates that up to 70 percent of Ceres' water supply could be impacted if regulatory standards are established for TCP.

The sustainable yield of the groundwater basin from which Ceres extracts groundwater supply has not been evaluated or estimated. From 2001 through 2010, Ceres historically pumped an annual average of 9,900 acre-feet/year of groundwater. The City's groundwater level monitoring program indicates that during this period, average water levels in wells remained relatively stable, so annual production of 10,000 acre-feet/year has historically been used as an estimated upper operational bound for annual groundwater extractions. Since 2010, average annual production has dropped due to the drought, with an annual average groundwater production of 7,600 acre-feet/year for the years 2011 through 2015. Through 2014, average groundwater levels have risen slightly, suggesting that the 10,000 acre-feet/year is a reasonable estimate for the upper operational bound for groundwater production.

To maintain groundwater quality once surface water is online, Ceres estimates that wells would be operated on a daily basis for 2 hours for wells without treatment systems and for 6 hours for wells with treatment systems. Of the existing and planned wells, Ceres anticipates needing to operate 12 wells on a daily basis, producing up to 2.0 mgd of groundwater.

Table 2 summarizes demand to be met from groundwater and surface water, on an annual, average daily and maximum daily basis. The maximum daily water use is calculated as 1.8 times the average daily use, as estimated in Ceres' June 2011 Water Master Plan (West Yost, 2011).

Table 2. City of Ceres Existing and Projected Demands to be Met by Surface Water and Groundwater

	2015	2020	2025	2030	2035
Annual Potable Water Use (acre-feet/yr)[a]	6,500	9,800	12,500	15,100	17,900
Average Daily Water Use (mgd)	5.8	8.8	11.1	13.5	16.0
Maximum Daily Water[b]	10.4	15.8	20.0	24.2	28.7
Minimum Daily Groundwater Use to Maintain Well Water Quality	2.0	2.0	2.0	2.0	2.0

[a] City of Ceres projections provided by Jeremy Damas, May 2016.
[b] City of Ceres, 2011 Water Master Plan, Table 3-9.

TURLOCK DEMAND AND SUPPLY PROJECTIONS

Turlock demand and supply projections are presented based on information in Turlock's 2015 Urban Water Management Plan Public Review draft, dated May 2016 (West Yost, 2016).

Current and Projected Demand

Table 3 summarizes Turlock's current and projected annual raw and potable water use through 2040. Similar to Ceres, water use in recent years has been significantly impacted by the drought, with a 2015 per capita water use of 233 gpcd, compared with a 2012 per capita water use of 277 gpcd. Projections for 2020 through 2040 are based on 2012 per capita water use, which is a reasonable non-drought baseline, and an estimated population growth of 2.15 percent annually through 2040, based on growth anticipated in Turlock's 2012 General Plan. The buildout per capita use is less than Turlock's 2020 per capita water use target of 284 gpcd that Turlock has adopted to comply with Senate Bill x7-7.

Turlock currently serves recycled water to customers within its retail service area for irrigation at a sports field and cooling for the TID Walnut Energy Center. Future recycled water use by the energy center is anticipated to increase, and industrial use of recycled water is also planned.

The bottom portion of Table 3 summarizes the average daily water use. Current average daily water use is 16.5 mgd, projected to increase to 37.5 mgd by 2040.

Table 3. City of Turlock Water Use Projections through 2040

	2015	2020	2025	2030	2035	2040
Annual Water Use (acre-feet/year)[a]						
Raw and Potable Water[b]	17,400	26,000	28,800	32,000	35,600	39,500
Recycled Water	1,100	1,600	2,000	2,400	2,400	2,400
Total	18,500	27,600	30,800	34,400	38,000	41,900
Average Daily Water Use (mgd)						
Raw and Potable Water	15.5	23.2	25.7	28.6	31.7	35.3
Recycled Water	1.0	1.4	1.8	2.2	2.2	2.2
Total	16.5	24.6	27.5	30.8	33.9	37.5

[a] City of Turlock, 2015 Urban Water Management Plan, May 2016 Draft, Table 4-5, Table 6-6.
[b] Raw water is groundwater supplied to a local park using non-potable irrigation wells.

Current and Projected Annual Supply

Turlock's current supplies include groundwater, and a small amount of recycled water. Turlock has a total of 41 groundwater wells, 20 of which are active and connected to the potable water system, one standby well, 16 inactive wells and 4 non-potable irrigation wells. Total well capacity is 31,650 gpm (45.6 mgd), of which 900 gpm is for non-potable wells. Turlock estimates its firm well capacity by deducting 6,000 gpm of well capacity for wells that are out of service due to maintenance or water quality. Thus, the firm well capacity is estimated to be 25,650 gpm. Several

wells have been decommissioned due to water quality concerns, including nitrates, arsenic, and tetrachloroethylene.

Turlock city staff have estimated that the groundwater basin can sustain an annual water demand of just under 25,000 acre-feet/year, based on historical analysis of groundwater levels and pumpage (Dyett & Bhatia, 2012). This estimate was made prior to the current drought, and likely represents an upper bound that could be lower.

Turlock currently has four wells (Wells 4, 8, 20, 30) that have experienced groundwater quality issues and must be operated continuously to maintain water quality. These wells have a total capacity of 7.0 mgd. It is currently uncertain whether these wells will continue to be used once surface water comes online.

The Turlock Regional Water Quality Control Facility collects wastewater from Turlock, Keyes Community Services District (CSD), Denair CSD and up to 2 mgd of primary treated wastewater from Ceres and produces tertiary treated water that meets Title 22 standards for unrestricted use. In addition to the recycled water demands within its retail service area, noted above, Turlock also plans to serve recycled water to neighboring agricultural users in TID and Del Puerto Water District.

Table 4 summarizes demand to be met from groundwater and surface water, on an annual, average daily and maximum daily basis. The maximum daily water use is calculated as 1.65 times the average daily use, as estimated in Turlock's May 2009 Water Master Plan (Carollo, 2009).

Table 4. City of Turlock Existing and Projected Demands to be Met by Surface Water and Groundwater

	2015	2020	2025	2030	2035	2040
Annual Water Use (acre-feet/yr)[a]	17,400	26,000	28,800	32,000	35,600	39,500
Average Daily Water Use (mgd)	15.5	23.2	25.7	28.6	31.7	35.3
Maximum Daily Water Use[b]	25.6	38.3	42.5	47.2	52.4	58.2
Minimum Daily Groundwater Use to Maintain Well Water Quality[c]	6.6	6.6	6.6	6.6	6.6	6.6

[a] City of Turlock, 2015 Urban Water Management Plan, May 2016 Draft, Table 6-6. Includes landscape irrigation, industrial use and industrial cooling water uses.
[b] City of Turlock, 2009 Water Master Plan Update, Table 4.3.
[c] Assumes continuous operation of wells 4, 8, 20 and 30, due to a history of water quality problems.

OTHER POTENTIAL PARTICIPANTS

In January and February 2016, SRWA sent letters to other local communities and agencies to identify potential other project partners. Letters were sent to Delhi County Water District, Denair CSD, Hickman, Hilmar County Water District, City of Hughson, Keyes CSD, City of Modesto, Stanislaus County and TID. Of those agencies, five expressed interest in learning more

about the project and potentially participating. These agencies are: Denair CSD, Hickman, Hilmar County Water District, City of Hughson, and Stanislaus County. In early May 2016, SRWA requested agencies who expressed interest to identify potential contract amounts. As of the date of this TM, only Hilmar County Water District and Denair CSD have responded. Hilmar responded (verbally to the SRWA interim General Manager) saying that they don't know how much surface supply they would like from the SRWA. Denair CSD has requested an average delivery amount of 0.5 mgd, to be varied seasonally based on demands.

TURLOCK IRRIGATION DISTRICT SUPPLY RELIABILITY

As noted in the 2006 Regional Surface Water Supply Project Environmental Impact Report, historically, surface water supplies from the Tuolumne River have been extremely reliable for both municipal and industrial (M&I), and agricultural purposes. TID has both pre-1914 and post-1914 water rights and has used them to deliver upwards of 600,000 acre-feet/year historically. TID also has an actively managed conjunctive use program where TID uses its drainage wells for water supply and to supplement TID's surface water supply in dry years. In the 1987 through 1992 drought, TID used this program to supplement decreased surface water supply (EIP, 2006).

The recent drought has significantly reduced surface water supply in the Tuolumne River. The San Joaquin 60-20-20 Index, which is used to establish flow requirements at Vernalis, on the San Joaquin River, classifies year types based on estimated unimpaired flow for four rivers: the Stanislaus River below Goodwin Reservoir, Tuolumne River below La Grange, Merced River below Merced Falls and San Joaquin River inflow to Millerton Lake.[1] The average index, calculated for 1901 through 2015 is 3.29 million acre-feet/year (MAFY), with 2013, 2014, and 2015 all classified as critically dry years, with the 2015 index of 0.81 MAFY the lowest for the historical record. During 2014, TID had agricultural delivery reductions of 58 percent and during 2015, TID had agricultural delivery reductions of 62 percent.

Although reliability estimates have not been made for the project, delivery reductions are likely in extended drought years. The Water Sales Agreement between TID and the SRWA calls for agricultural and M&I customers to be treated on a parity basis, with cutbacks in equal proportions based on their base allocation amounts.

PRELIMINARY WATER TREATMENT PLANT SIZING AND PHASING

Based on the demand projections, preliminary Phase 1 and Phase 2 WTP capacities were identified by Ceres (10 mgd Phase 1, increasing to 15 mgd Phase 2) and Turlock (20 mgd Phase 1 increasing to 30 mgd Phase 2). This section reviews contract terms of the water sales agreement between TID and the SRWA, provides example monthly deliveries of surface water and groundwater, and evaluates average and maximum day surface water deliveries with drought year reductions.

[1] The index is calculated using 0.6 times the current April-July runoff + 0.2 times the current October-March runoff + 0.2 times the previous year's index.

Water Sales Agreement

On July 28, 2015, the SRWA entered into an agreement with TID for purchase of up to 30,000 acre-feet/year of water from TID. The following contract provisions relate to project delivery amounts and timing:

- TID to petition the State Water Resources Control Board for a Long-term Transfer of up to 30,000 acre-feet/year, and to add municipal and industrial uses to its post-1914 water rights License 11058.
- On or before January 1, SRWA to provide two-year monthly delivery schedule to TID. Water deliveries cannot vary by more than 10 percent from prior year to current year, unless approved by TID. Monthly delivery rates will be at a fixed flow rate.
- If water availability has changed significantly in the year, TID can amend the delivery schedule in April or May for the remaining months of the year.
- Drought year reductions are the same percentage for agricultural and M&I users.

Example Monthly Deliveries

Figures 1 and 2 show example monthly deliveries for normal hydrologic years for Ceres and Turlock, based on the Phase 1 and Phase 2 capacity requests. Example monthly deliveries are based on the following assumptions:

- Monthly use patterns are based on historical average monthly production for Ceres (2000 through 2016) and Turlock (2005 through 2015);
- Monthly deliveries are based on projected annual demands for 2025 (Phase 1) and buildout (2035 for Ceres and 2040 for Turlock) for Phase 2;
- Surface water deliveries are maximized; and
- Minimum groundwater production of 2 mgd for Ceres and 3 mgd for Turlock, based on operating wells 2 hours/day to maintain water quality for wells without treatment systems, and 6 hours/day for wells with treatment systems.[2]

Based on the assumptions above, total surface water deliveries are estimated at 28,400 AFY, close to the maximum delivery amount of 30,000 in the 2015 Water Sales Agreement. Phase 2 total surface water deliveries are just under 43,000 AFY, which would require purchase of additional surface water from TID.

Drought Year Reductions

As noted above, surface water dry-year reliability has not been evaluated for the project. Table 5 presents example surface water reductions to evaluate the impact on average day and maximum

[2] Turlock currently has four wells that are operated continuously: Wells 4, 8, 20 and 30, for water quality purposes, with a total daily capacity of 6.6 mgd. Calculations assume that once Turlock is using surface water, these wells could be retired. The minimum amount of 3 mgd is based on operating all other wells for 2 hours/day.

day groundwater use. The table summarizes potential average daily and maximum daily deliveries assuming: 1) normal years with full delivery of surface water; 2) dry years with 25 percent reduction in surface water and no reduction in demands; and 3) extreme dry years with 50 percent cutbacks in surface water with 20 percent reduction in demands. The top part of the table summarizes 2025 demand conditions, using Phase 1 capacity estimates. The bottom part of the table summarizes buildout demand conditions, using Phase 2 capacity estimates.

Table 5. Average Day and Maximum Day Deliveries with Reduced Surface Water Deliveries

Year Type and Demand, mgd	2025					
	Ceres			Turlock		
	SW	GW	Total	SW	GW	Total
Normal Year						
Average Day	7.8	3.3	11.1	17.6	8.2	25.7
Maximum Day	10.0	10.0	20.0	20.0	22.5	42.5
25 Percent Reduction in Surface Water, no reduction in demand						
Average Day	5.8	5.3	11.1	13.2	12.6	25.7
Maximum Day	7.5	12.5	20.0	15.0	27.5	42.5
50 Percent Reduction in Surface Water, 20 percent reduction in demand						
Average Day	3.9	5.0	8.9	8.8	11.8	20.6
Maximum Day	5	11.0	16.0	10	24.0	34.0
Year Type and Demand, mgd	Buildout					
	Ceres			Turlock		
Normal Year						
Average Day	12.0	4.0	16.0	26.1	9.2	35.3
Maximum Day	15.0	11.4	26.4	30	28	58.2
25 Percent Reduction in Surface Water, no reduction in demand						
Average Day	9.0	7.0	16.0	19.6	15.7	35.3
Maximum Day	11.3	15.1	26.4	22.5	35.7	58.2
50 Percent Reduction in Surface Water, 20 percent reduction in demand						
Average Day	6.0	6.8	12.8	13.0	15.2	28.2
Maximum Day	7.5	13.6	21.1	15	31.5	46.5

For Phase 1, Ceres maximum day groundwater production ranges from 10 to 13 mgd, and for Phase 2, maximum day groundwater production ranges from 11 to 15 mgd. As noted above, estimated firm capacity with planned new wells and abandonment of existing wells is just under 16 mgd. Thus, it is likely that Ceres will need to maintain its near-term well capacity to provide adequate total supply capacity in dry years.

For Phase 1, Turlock maximum day groundwater production ranges from 23 to 28 mgd, and for Phase 2, maximum day groundwater production ranges from 28 to 36 mgd. Turlock's current firm well capacity is 37 mgd. If wells that currently have water quality issues are taken off line, firm capacity would be reduced to 30 mgd. Similar to Ceres, it is likely the Turlock will need to maintain well capacity close to current amounts to provide adequate total supply capacity in dry years.

Table 6 summarizes annual production estimates for surface water and groundwater for the three supply reliability scenarios listed above. For Ceres, maximum annual groundwater use is estimated at 5,900 AFY in 2025 and 7,800 AFY by buildout. For Turlock, maximum annual groundwater use is estimated at 14,000 AFY in 2025, and 17,600 AFY by buildout. As the table shows, estimates of average year and dry year groundwater use are below the upper bound estimates for sustainable yields for the two cities.

Table 6. Annual Production of Surface Water and Groundwater for Normal and Dry Years

	Ceres			Turlock			Total	
Year Type and Demand	SW	GW	Total	SW	GW	Total	SW	GW
2025								
Normal Year	8,700	3,700	12,400	19,700	9,100	28,800	28,400	12,800
25 Percent Reduction in Surface Water	6,500	5,900	12,400	14,800	14,000	28,800	21,300	19,900
50 Percent Reduction in Surface Water	4,400	5,500	9,900	9,900	13,100	23,000	14,300	18,600
Buildout								
Normal Year	13,400	4,500	17,900	29,200	10,300	39,500	42,600	14,800
25 Percent Reduction in Surface Water	10,100	7,800	17,900	21,900	17,600	39,500	32,000	25,400
50 Percent Reduction in Surface Water	6,700	7,600	14,300	14,600	17,000	31,600	21,300	24,600

SUMMARY

Based on the preliminary WTP sizing and phasing identified, it appears that Ceres and Turlock will be able to effectively manage surface water and groundwater supplies in normal and drought years. Preliminary WTP sizing may be refined later in the Project, once capital and annual cost estimates are developed.

REFERENCES

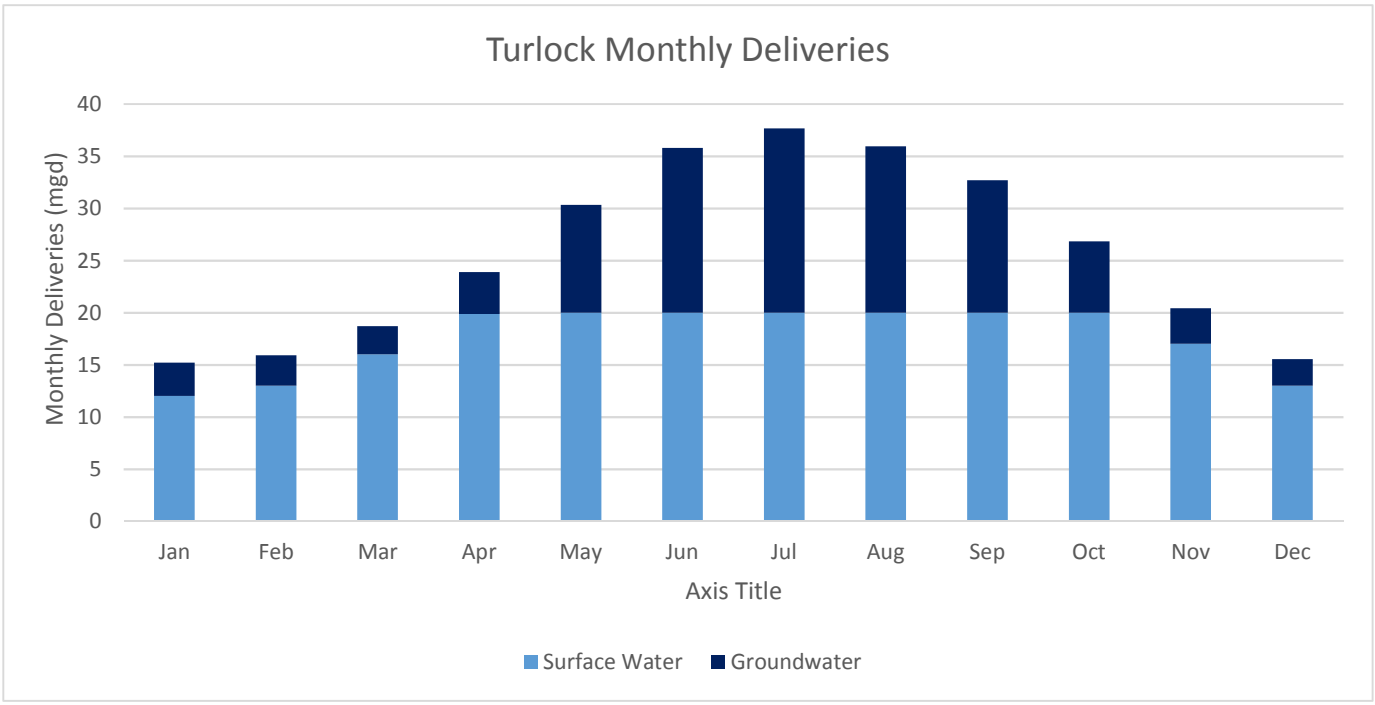
Carollo Engineers Inc, 2009. *City of Turlock Water Master Plan Update.* Final, May 2009.

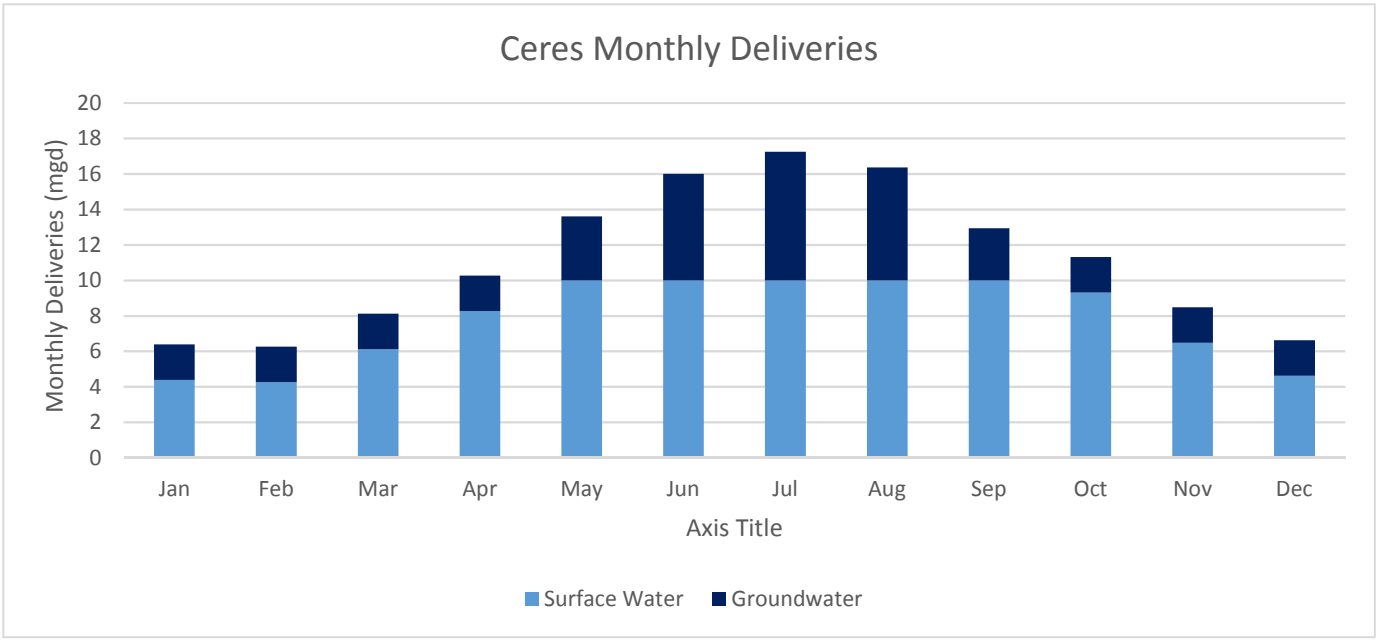
Dyett & Bhatia, 2012. *Turlock General Plan*, adopted September 2012.

EIP Associates, 2006. *Draft Environmental Impact Report, Turlock Irrigation District Regional Surface Water Supply Project*.

West Yost Associates, 2011. *Ceres Water Master Plan Update*.

West Yost Associates, 2016. *Ceres General Plan Update Background Technical Memorandum*. April 25, 2016. Prepared for Sophie Martin, Dyett & Bhatia, by Doug Moore, West Yost Associates.





Notes:

1. Turlock average surface water delivery 18 mgd (19,700 AFY); average groundwater delivery 8 mgd (9,100 AFY).
2. Ceres average surface water delivery 8 mgd (8,700 AFY); average groundwater delivery 3 mgd (3,100 AFY).

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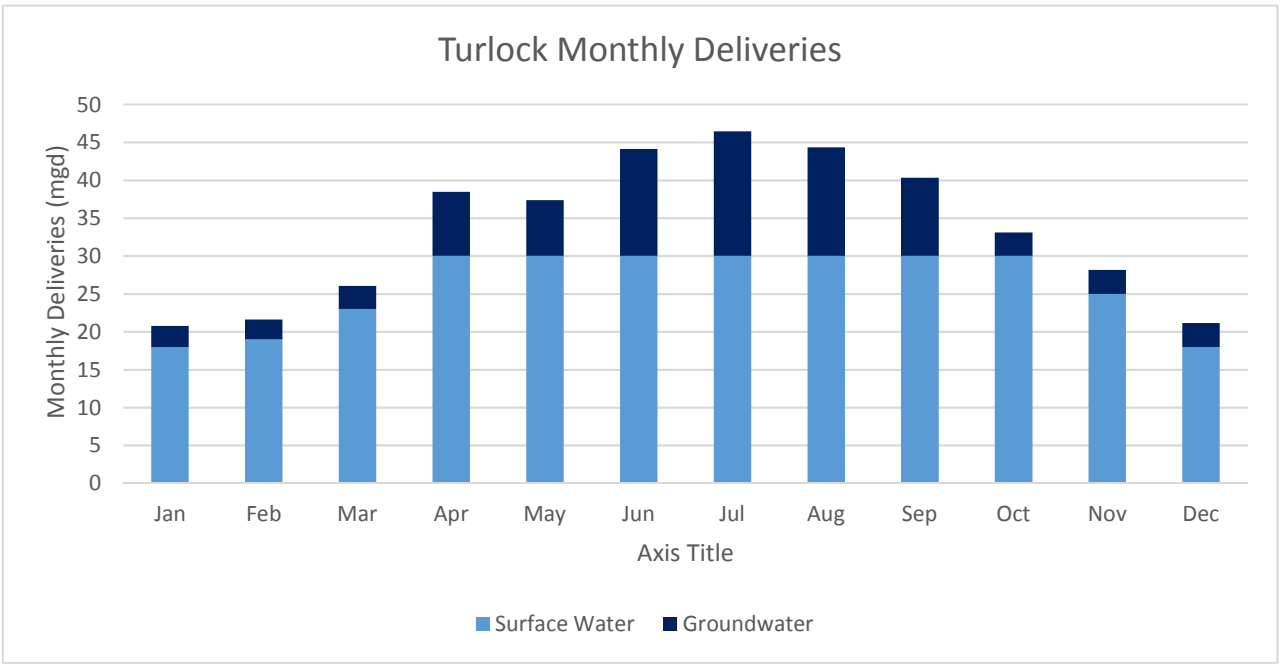
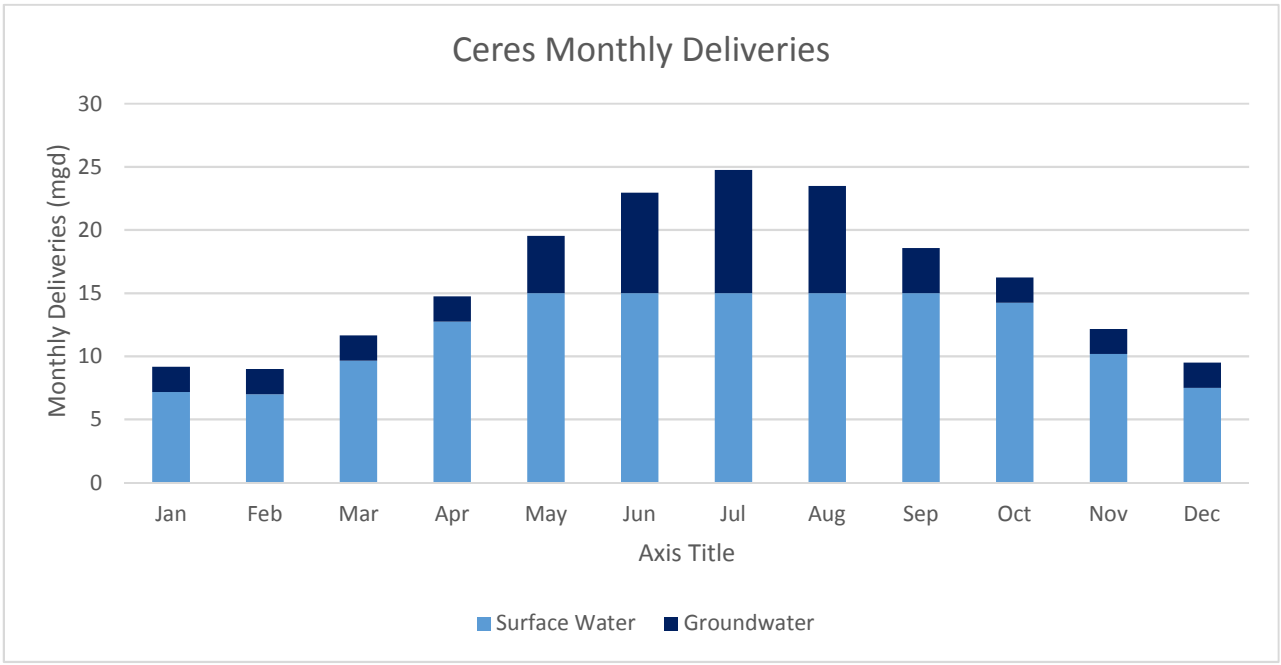
Figure 1

Example Normal Year Deliveries, Year 2025

SRWA
Surface Water Supply Project





Notes:

1. Turlock average surface water delivery 26 mgd (29,200 AFY); average groundwater delivery 9 mgd (10,300 AFY).
2. Ceres average surface water delivery 12 mgd (13,400 AFY); average groundwater delivery 4 mgd (4,500 AFY).

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Figure 2

Example Normal Year Deliveries, Buildout

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