HARRF RECYCLED WATER QUALITY

The MFRO facility will receive HARRF Title 22 recycled water. HARRF has a permitted wastewater treatment capacity of 18 mgd and 9 mgd tertiary capacity. The plant uses conventional activated sludge for secondary treatment and includes the following major processes: influent pump station, bars screens, grit chambers, primary clarifiers; aeration basins, secondary clarifiers; tertiary filters and chorine disinfection. Historical water quality of HARRF recycled water is provided in Table 2-1 below.

Table 2-1 – Summary of HARRF Recycled Water Quality

PARAMETER[1]	N (NO. OF DATA POINTS)	TYPICAL AVERAGE	TYPICAL MINIMUM	TYPICAL MAXIMUM	90TH PERCENTILE
Temperature[2](Deg C)	85	26.6	21.9	30.9	29.2
Conductivity (µS/cm)	59	1576	1378	1812	1719
pH (standard units)	98	7.7	7.5	7.9	7.8
Total Dissolved Solids (mg/L)	57	923	811	1029	1000
Turbidity (NTU)	153	1	0.5	1.6	1.3
Alkalinity (mg/L as CaCO3)	53	181	119	241	201
Chloride (mg/L)	30	188	166	221	205
Fluoride (mg/L)	30	0.72	0.46	0.84	0.81
Sulfate (mg/L)	30	196	137	267	250

PARAMETER[1]	N (NO. OF DATA POINTS)	TYPICAL AVERAGE	TYPICAL MINIMUM	TYPICAL MAXIMUM	90TH PERCENTILE
Nitrate (mg-N/L)	31	6	1	17	12
Total Organic Carbon[2] (mg/L)	9	12.9	10.2	16.4	15.1
Calcium (mg/L)	11	66	48	88	84
Iron (µg/L)	10	76	52	100	95
Magnesium (mg/L)	11	26	21	31	31
Potassium (mg/L)	8	19	18	21	21
Ortho Phosphate (mg-P/L)	13	0.9	0.1	2	1.4
Total Phosphate[2] (mg-P/L)	11	1.2	0.2	3	2.4
Silica (mg/L)	7	14.6	13.0	16.9	16.8
Sodium (mg/L)	12	171	150	188	187
Aluminum (µg/L)	8	404	272	560	560
Barium (µg/L)	9	32	18	54	47
Manganese (µg/L)	10	55	31	113	90
Strontium (µg/L)	3	924	921	936	933
Ammonia (mg/L-N)	31	16	0.8	33	26
TKN (mg/L-N)	30	18	0.8	35	28
Color (std. units)	4	18	15	21	20

[1] All parameters measured in HARRF recycled water (i.e. tertiary effluent) between 2009 and2014 unless indicated otherwise. Sampling period varies by parameter.

[2] Measured in HARRF secondary effluent (2012-2014).

TREATED WATER QUALITY OBJECTIVES

The Feasibility Study discussed water quality requirements for the City's agriculture producers with a key focus on avocado production which is one of the most important crops grown in Escondido. The limits of various water quality parameters that can diminish avocado crop productivity are provided in Table 2-2. This information was obtained based on meetings with members of the Escondido Growers of Agriculture Preservation (EGAP) as well as published information in the literature. Based on discussions with EGAP, it is desired to reduce the chloride concentration to 80 mg/L to prevent leaf burn, root rot and the need for excessive flushing however chloride concentrations up to 100 mg/L can be tolerated. It should be noted historical water quality provided by the City shows the average chloride concentration in raw source water supplies varies as follows: Lake Henshaw = 39 mg/L; Dixon Lake = 80 mg/L; and imported water via SDCWA = 81 mg/L. The average chloride concentration of the treated water from EVWTP is 75 mg/L.

Table 2-2 – Agriculture Water Quality Criteria for Key Parameters

PARAMETER	UNITS	CONCENTRATION
Total Dissolved Solids (TDS)	mg/L	540-600
Chloride	mg/L	80 (maximum 100)
Sodium Adsorption Ratio (S.A.R)	ratio	10
Electrical Conductivity	µS/cm	500-1,000
Boron	mg/L	<0.5
pH	---	6.5-7.0

The water quality of the blend water will vary, based on the blend ratio of Title 22 recycled water bypass to RO permeate. Table 2-2 summarizes the estimated water quality for blend ratios ranging from 0 to 1.95, which corresponds to initial total recycled water flows available for agricultural users of 0.5 to 5.9 mgd. The initial minimum flow condition would occur during times when Title 22 recycled water is not available for blending and the MFRO facility is operating at minimum production flow of 0.5 mgd. The initial average and maximum total blend flows represent the estimated 2050 summer agriculture recycled water demands as identified in the Feasibility Study. During such conditions it is anticipated the MFRO facility would be operated at the initial design production capacity of 2 mgd. An example blending scenario for the future condition of increasing the RO permeate capacity by 1 mgd is also shown.

With the exception of pH, the agricultural water quality requirements are only exceeded when the blending ratio is above 1. Because the RO process rejects the majority of the minerals in the feedwater, the RO permeate is corrosive and can damage the downstream storage and conveyance system. As a result, chemical post treatment to adjust the pH and stabilize the water for corrosion control will be provided. The post treatment strategy is presented in Section 4.13

Table 2-3 - Estimated Water Quality under Various Blending Conditions

PARAMETER	UNITS	VALUE			
		INITIAL MIN FLOW	INITIAL AVG FLOW	INITIAL MAX FLOW	FUTURE
Projected Blend Capacity					
Title 22 Bypass: RO Permeate	ratio	0.00	0.48	1.95	1.30
Title 22 Bypass flow	mgd	0.00	0.95	3.90	4.00
RO Permeate flow	mgd	0.50	2.00	2.00	3.00
Total Blend flow	mgd	0.50	2.95	5.89	7.00
Estimated Blend Water Quality (before post treatment)					
Calcium	mg/L	3	23	45	38
Magnesium	mg/L	1	9	18	15
Sodium	mg/L	7	60	115	100
TDS	mg/L	37	324	623	538
Chloride	mg/L	8	66	127	110
Boron	mg/L	0.21	0.26	0.30	0.29
pH	-------	4.9	6.5	7.0	7.0
Conductivity	µS/cm	63	554	1063	918
S.A.R	ratio	0.9	2.7	3.7	3.4

Note: Estimated blend water quality shown is based on typical average values measured in HARRF recycled water (2009-2014) and RO rejection of 96% for all constituents with the exception of boron (assumed rejection of 40%).

POST TREATMENT / STABILIZATION CHEMICAL ADDITION

The RO permeate will be blended with Title 22 recycled water and stored in the Product Storage Tank prior to being pumped to the agricultural reuse distribution system. Depending on the amount of Title 22 recycled water flow available for blending and the agriculture user demand, the ratio of Title 22 water to RO permeate is anticipated to range from 0 to 2.0. The blended water quality must minimize corrosion of the downstream components of the MFRO Facility including the concrete product water storage tank, pumping equipment, distribution system, and various components of the irrigation systems owned and maintained by the agriculture recycled water users. The stabilization goals for the blend water are provided in Table 4-19 below.

The two corrosion indices considered are langelier saturation index (LSI) and calcium carbonate precipitation potential (CCPP). The LSI is a non-quantitative general indication of corrosivity, which is defined as the difference between the actual pH (measured) and the pH at which the water is saturated with calcium carbonate (calculated). In general, water with a negative LSI is considered aggressive while a positive LSI indicates the water is scale forming (non aggressive). The CCPP is a quantitative indication of calcium carbonate precipitation potential where the values are expressed in mg/L as CaC03. Values indicate the amount of calcium carbonate that would dissolve (negative values) or precipitate (positive values) to reach equilibrium.

Table 4-4 - Stabilization Goals for Blend Water Quality

CONSTITUENT	BLENDED WATER QUALITY GOAL
pH	7.5-8.5
Alkalinity (mg/L as CaC03),	40
LSI	+0.1 - +0.5
CCPP (mg/L as CaCO3)	+2.0 - +8.0

Various post treatment alternatives can be used to achieve the stabilization goals presented above. One method for stabilizing RO permeate is the use of decarbonation towers to strip carbon dioxide to increase pH followed by lime which adds alkalinity and hardness. Though this method offers potential cost savings over other alternatives, the use of lime has been shown to be very O&M intensive and difficult to control dosing. This alternative was discussed with the City during the conceptual design and eliminated for further consideration.

Three other chemical treatment alternatives were considered to stabilize the blend water including:

- Alternative 1: Calcium Chloride (CaCl2) + Sodium Hydroxide (NaOH)+ Sodium Bicarbonate (NaHC03)
- Alternative 2: CaCl2 + NaOH + Carbon Dioxide (note: in this alternative carbon dioxide is added to form alkalinity while maintaining a lower pH)
- Alternative 3: CaCl2 + NaOH

Alternatives 1 and 2 were eliminated for further consideration due to the need for a large chemical storage silos required to store bulk chemicals (which, due to height requirements, would likely need to be outdoors) and the need for outdoor gaseous storage for carbon dioxide, respectively.

The required dose rates to meet the stabilization goals for Alternative 3 were estimated using Water!ProTM Corrosion Control and Treatment Process Analysis Program Version 3. The model inputs included RO permeate and bypass water quality for various constituents which were estimated using RO modeling software and historical water quality data (average values) from HARRF. The chemical dose rates required to meet stabilization goals for Alternative 3 under various blending scenarios are provided in Table 4-20. The results show calcium chloride would only be required for the blend conditions below 0.4 and the amount of sodium hydroxide required decreases with increasing blend ratio. As indicated the analysis was done for two different feed pH conditions (i.e. 6.8 and 7.0). The primary purpose of lowering the feed pH is to lower the scaling potential of the RO concentrate to reduce the risk of membrane fouling, particularly in the 3rd stage tail end elements. The results were used to size the chemical storage and dosing systems as discussed in Section 5.

Table 4-5 – Chemical Post Treatment Chemical Dosing Requirements

BLEND RATIO (TITLE 22 RECYCLED WATER : RO PERMEATE)	**CHEMICAL DOSING REQUIREMENT (MG/L) TO ACHIEVE STABILIZATION GOALS AT DIFFERENT BLENDING CONDITION**		
	SULFURIC ACID @ RO FEED	**CALCIUM CHLORIDE @ RO PERMEATE**	**SODIUM HYDROXIDE @ RO PERMEATE**
RO Feed pH 6.8			
0:1	39	60	60
0.4:1	39	0	29
1:1	39	0	23
2:1	39	0	17
RO Feed pH 7.0			
0:1	22	60	35
0.4:1	22	0	24
1:1	22	0	19
2:1	22	0	15