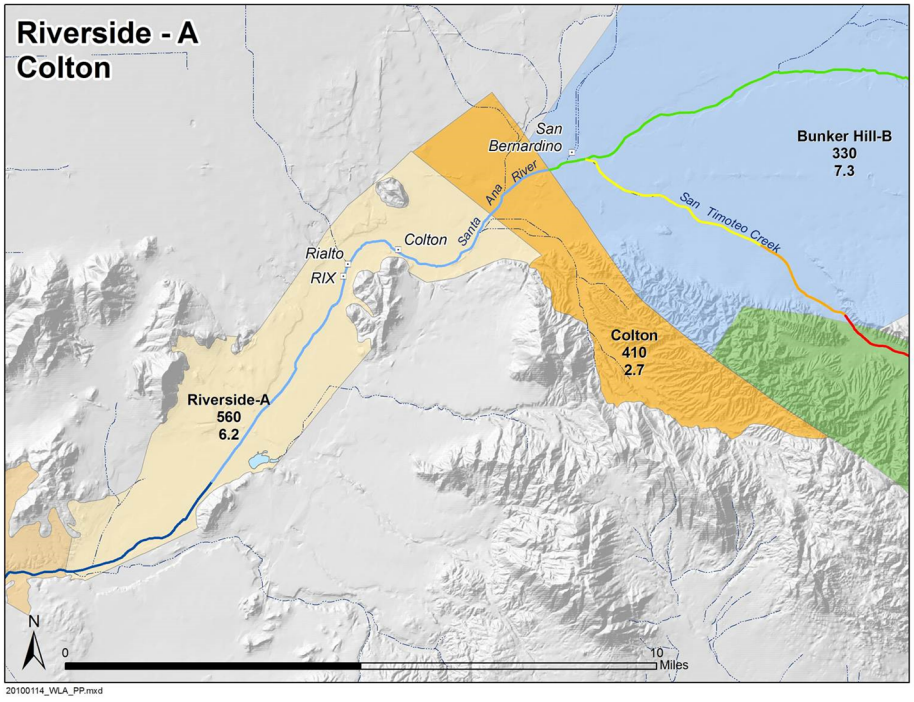
Rationale Supporting an Allocation of Assimilative Capacity to Encourage Groundwater Recharge Using Recycled Water in the Riverside-A Management Zone

1.0: Background

In 2004, the Santa Ana Regional Water Quality Control Board amended the Basin Plan to establish the Riverside-A Management Zone. The Riverside-A Management Zone underlies the uppermost section of Reach 3 and all of Reach 4 of the Santa Ana River (see Fig. 1).[1] Recycled water produced by the cities of San Bernardino, Colton and Rialto is released into these segments of the Santa Ana River and some of it subsequently recharges the Riverside-A Management Zone.

Fig. 1: Riverside-A Groundwater Management Zone



[1] Map provided courtesy of Wildermuth Environmental, Inc.

When the Basin Plan was amended in 2004, the Regional Board revised the water quality objectives for Total Inorganic Nitrogen (TIN) and Total Dissolved Solids (TDS) for the Riverside-A Management Zone. These objectives were based on the estimated average concentration of TIN and TDS in the 20-year period between 1954-1973 including statistical adjustments intended to account for spatial and temporal variability in the water quality data.

Every three years, the Basin Monitoring Program Task Force (BMPTF)[2] commissions a team of technical consultants to recompute the average ambient TIN and TDS concentrations based on the most recent 20-year period. The current estimate, for the period between 1993 and 2012, shows that the average concentration for both remains well below the water quality objective. Thus, there is assimilative capacity for TIN and TDS in the Riverside-A Management Zone (see Table 1).

Table 1: Average Water Quality in the Riverside-A Groundwater Management Zone

Parameter	TIN[3]	TDS[4]
Water Quality Objective	6.2 mg/L	560 mg/L
Current Average Quality	5.4 mg/L	420 mg/L
Est. Assimilative Capacity	0.8 mg/L	140 mg/L

Every six years, the BMPTF commissions a team of technical consultants to update the Wasteload Allocation Model (WLAM) used to determine whether TIN and TDS levels in local rivers and streams meets the applicable water quality objectives in the underlying groundwater management zone(s)under a wide range of different assumptions regarding the reuse or discharge of recycled water. Results from the WLAM analysis are used to establish appropriate effluent limits governing TIN and TDS concentrations in recycled water discharged to surface waters throughout the region.

The most recent WLAM report was prepared and published by Wildermuth Environmental, Inc. in 2015.[5] The data indicate that average TIN and TDS concentrations in the Santa Ana River will continue to meet the applicable basin plan objectives as surface water percolates to the Riverside-A Management Zone. However, these discharges may cause some water quality degradation. This is discussed in greater detail below.

[2] The BMPTF is organized by the Santa Ana Watershed Project Authority (SAWPA) and is comprised of representatives from all of the major recycled water producers in the Santa Ana region (see Appendix A).

[3] Wildermuth Environmental, Inc. Recomputation of Ambient Water Quality in the Santa Ana Watershed for the Period 1993 to 2012. August, 2014. (See Table 3-2)

[4] Wildermuth Environmental, Inc. Recomputation of Ambient Water Quality in the Santa Ana Watershed for the Period 1993 to 2012. August, 2014. (See Tables 3-1)

[5] Wildermuth Environmental, Inc. Addendum to the 2008 Santa Ana River Wasteload Allocation Model Report - Scenario 8. January, 2015.

2.0: TDS Evaluation

The water quality objective (WQO) for TDS in the Riverside-A Management Zone is 560 mg/L. The current ambient concentration (CAQ) of TDS in this zone is 420 mg/L. Thus, there is 140 mg/L of assimilative capacity available.[6] In addition, since the 420 mg/L is also the lowest TDS concentration attained since 1968, the current ambient quality is also the "baseline quality" for purposes of implementing the state antidegradation policy. Wildermuth Environmental, Inc. estimates that there was 184,590 184,590 acre-feet (227.7 billion liters) of groundwater stored in the Riverside-A Management Zone at the conclusion of 2012.

The volume of surface water percolating from the Santa Ana River to groundwater in the Riverside-A Management Zone varies depending on the amount of reclaimed water that is reused rather than discharged. In the 2020 planning period, the estimated recharge to the Riverside-A Management Zone from the Santa Ana River ranges is approximately 18,849 acre-feet/year if RIX and Rialto are discharging 100% of their treated effluent ("Scenario 8f").

The average TDS concentration in the surface water percolating from the Santa Ana River to groundwater in the Riverside-A Management Zone varies depending on the amount of reclaimed water that is reused rather than discharged. It also varies, from year to year, based on the volume stormwater runoff in the river that is recharging the aquifer (see Table 2).

Table 2: Summary of TDS Concentrations Recharging the Riverside-A Management Zone from Reach 3 and Reach 4 of the Santa Ana River.

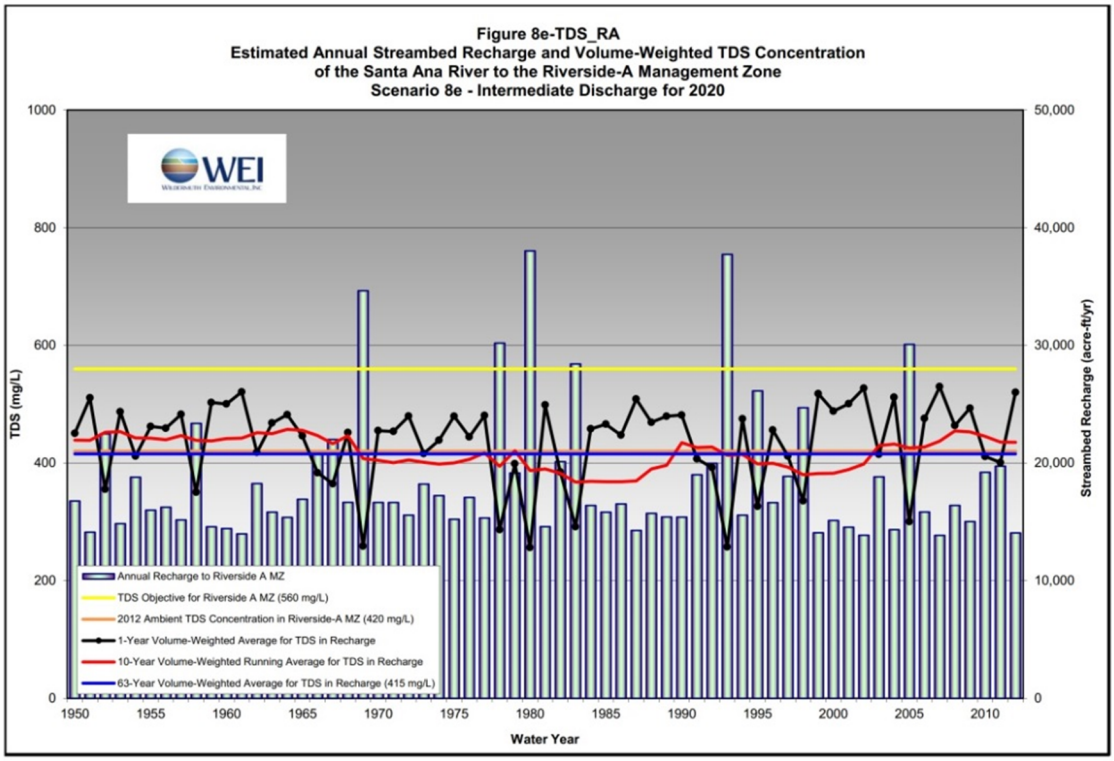
Streambed Recharge Quality (WQO=560 mg/L; CAQ=420 mg/L; AC=140 mg/L)	**WLAM: Recycled Water Planning Scenario**	
	8e (Intermediate)	*8f (Max. Discharge)*
Highest Estimated Single Year Value	530	530
Highest Value of All 10-yr. Rolling Averages	457	458
Average of All 10-yr. Rolling Averages	415	417
Pct. of All 10-yr. Periods Exceeding 420 mg/L	52%	52%

Results from the WLAM indicate that the TDS concentration in the surface water of Reach3 and 4 of the Santa Ana River will be greater than current ambient quality of the Riverside-A Management Zone in 52% of 10-year averaging periods. However, the average TDS concentration of the river recharge (417 mg/L over the entire 63-year modeling period) is less than the current ambient TDS concentration in the Riverside-A Management Zone (420 mg/L).

[6] Wildermuth Environmental, Inc. Recomputation of Ambient Water Quality in the Santa Ana Watershed for the Period 1993 to 2012. August, 2014.

During drought conditions, as occurred between 1955-1964 or1988-1997, the combined recharge of wastewater and stormwater will tend to degrade water quality in the Riverside-A Management Zone. However, over the long-term, this adverse effect is more than offset by the high quality (low TDS) recharges that occur during very wet ("El Niño") years (see Fig 2 & 3).

Fig. 2: TDS Concentration for Streambed Percolation in Intermediate Discharge Scenario[7]



If there is 227.7 billion liters of groundwater in storage and 140 mg/L of assimilative capacity available, then the Riverside-A Management Zone can absorb up to 35,139 dry-weight tons of additional salt before exceeding the water quality objective for TDS.

In the worst case planning conditions, represented by the highest 10-year average concentration observed in the 63-year modeling period, the TDS concentration was about 458 mg/L for Scenario 8e and 8f (see Table 3). During prolonged drought conditions, TDS concentrations in the river water that percolates to groundwater are likely to exceed the current ambient average TDS concentrations in the Riverside-A Management Zone by as much as 38 mg/L.

[7] Wildermuth Environmental, Inc. Addendum to the 2008 Santa Ana River Wasteload Allocation Model Report: Scenario 8. January 5, 2015. (Figure 8e-TDS_RA)

Fig. 3: TDS Concentration for Streambed Percolation in Maximum Discharge Scenario[8]

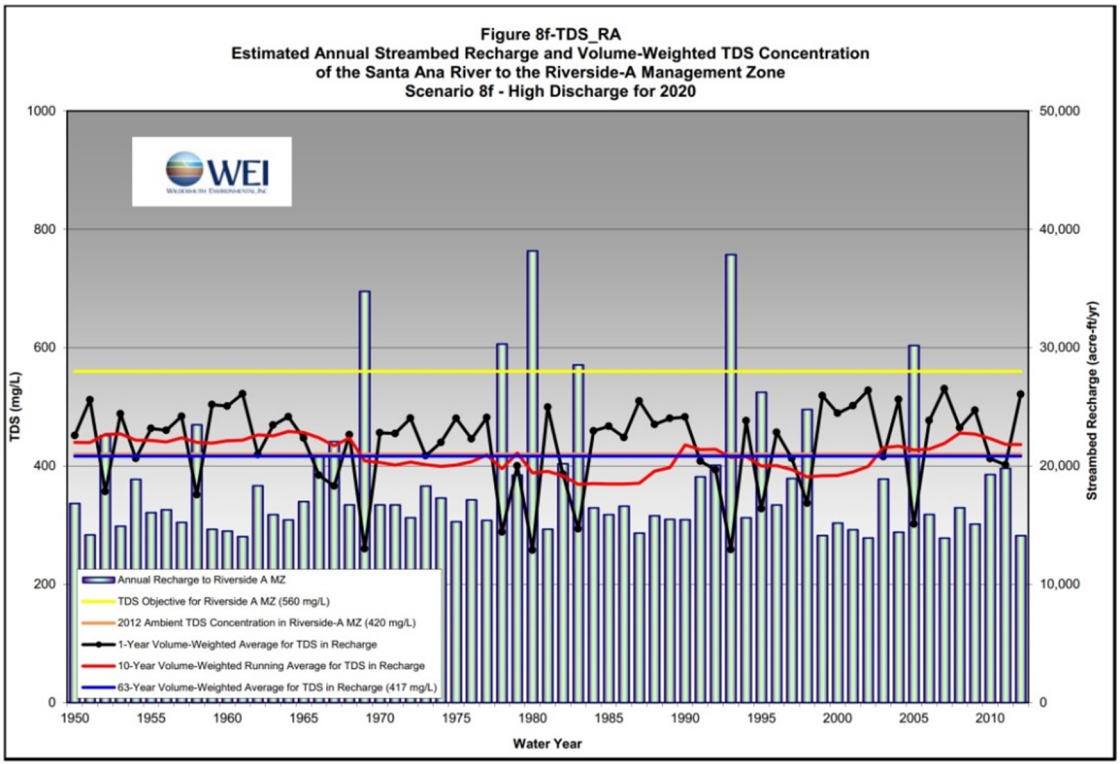


Table 3: Short-Term (10-year) Consumptive Use of Assimilative Capacity for TDS in Riverside-A Management Zone Under Drier than Average Conditions

Streambed Recharge Quality (WQO=560 mg/L; CAQ=420 mg/L; AC=120 mg/L)	**WLAM: Recycled Water Planning Scenario**	
	8e (Intermediate)	*8f (Max. Discharge)*
Total Annual Streambed Recharge	18,346 ac.-ft.	18,849 ac.-ft.
Highest Value of All 10-yr. Rolling Averages	457 mg/L	458 mg/L
Current Ambient Average TDS Concentration	420 mg/L	420 mg/L
Excess TDS Percolating to Groundwater	37 mg/L	38 mg/L
Avg. Annual Assimilative Capacity Used	2,025 tons/yr	2,081 tons/yr
Max. Pct. of Assim. Capacity Used (2015-2020)	5.8%/yr	5.9%/yr

[8] Wildermuth Environmental, Inc. Addendum to the 2008 Santa Ana River Wasteload Allocation Model Report: Scenario 8. January 5, 2015. (Figure 8f-TDS_RA)

If the next 10 years are significantly drier than average, incidental recharge of recycled water, through streambed percolation, may degrade water quality in this management zone. However, such effects are expected to be temporally-limited and more than offset when the next El Niño winter occurs.

It is important to note that all of the above calculations are intended to estimate the marginal potential for streambed percolation to degrade water quality in the underlying aquifer. There are a number of other factors which may also influence groundwater quality. These factors are presumed to be constant for the purposes of this illustration.

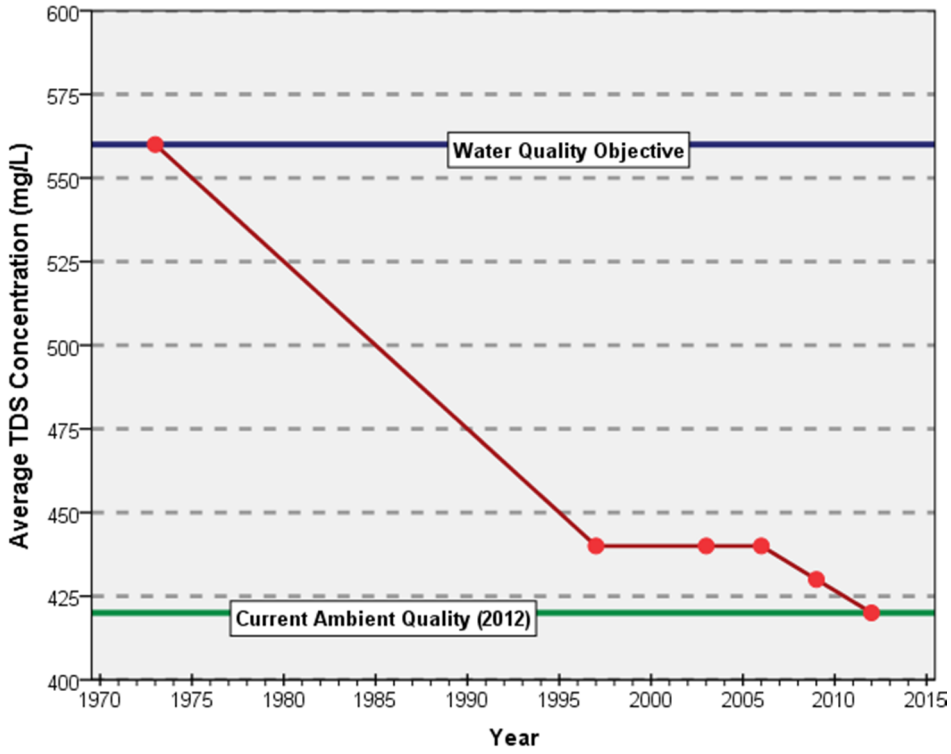
The WLAM also assumes that the general long-term weather pattern expected to occur over the next 63 years will generally resemble that which occurred over the previous 63 years (1950-2012).

Over the long-term, and on average, TDS concentrations are expected to decline and assimilative capacity is expected to increase in the Riverside-A Management Zone (see Table 4). However, the trend is also expected to "level off" as average groundwater quality approaches the average TDS concentration of the recharge from the overlying river (see Fig. 4).

Table 4: Long-Term (63-year) Consumptive Use of Assimilative Capacity for TDS in the Riverside-A Management Zone

Streambed Recharge Quality (WQO=560 mg/L; CAQ=420 mg/L; AC=140 mg/L)	**WLAM: Recycled Water Planning Scenario**	
	8e (Intermediate)	*8f (Max. Discharge)*
Total Streambed Percolation Recharging	18,346 ac.-ft.	18,849 ac.-ft.
Average of All 10-yr. Rolling Averages	415	417
Current Ambient Average TDS Concentration	420 mg/L	420 mg/L
Excess TDS Percolating to Groundwater	(-5 mg/L)	(-3 mg/L)
Avg. Annual INCREASE in Assimilative Capacity	125 tons/year	75 tons/year

Fig. 4: Trend for Average TDS Concentration in the Riverside-A Management Zone[9]



3.0 TIN Evaluation

The water quality objective (WQO) for TIN in the Riverside-A Management Zone is 6.2 mg/L. The current ambient concentration (CAQ) of TDS in this zone is 5.4 mg/L. Thus, there is 0.8 mg/L of assimilative capacity available.[10] Wildermuth Environmental, Inc. estimates that there was 184,590 acre-feet (227.7 billion liters) of groundwater stored in the Riverside-A Management Zone at the conclusion of 2012.

The best water quality attained in the Riverside-A Management Zone since 1968 occurred when TIN concentrations reached 4.4 mg/L in 1997. Normally, this value would serve as the "baseline" level when assessing compliance with the state antidegradation policy. However, the slow degradation that occurred between 1997 and 2012 was authorized by a number of NPDES permits issued after the Basin Plan objectives were updated in 2004 (see Table 5). Consequently, in accordance with SWRCB Administrative Update #90-004, the current ambient quality could be considered the new baseline for purposes of implementing the state antidegradation policy.

[9] Wildermuth Environmental Inc. Recomputation of Ambient Water Quality in the Santa Ana Watershed for the Period 1993 to 2012. Final Technical Memorandum. August, 2014.

[10] Wildermuth Environmental, Inc. Recomputation of Ambient Water Quality in the Santa Ana Watershed for the Period 1993 to 2012. August, 2014.

Table 5: Authorizations to Discharge TIN at Concentrations Higher than the 1997 Baseline Level at Locations Overlying the Riverside-A Management Zone

POTW Name	NPDES Permit #	Effluent Limit for TIN	Reg. Bd. Resolution
RIX	CA8000304	10 mg/L	R8-2006-0052 R8-2013-0032
Rialto	CA0105295	10 mg/L	R8-2007-0006 R8-2014-2010
San Bernardino WRF *(not RIX)*	CA0105392	10 mg/L	R8-2012-0051
Colton WRF *(not RIX)*	CA0105236	10 mg/L	R8-2012-0050

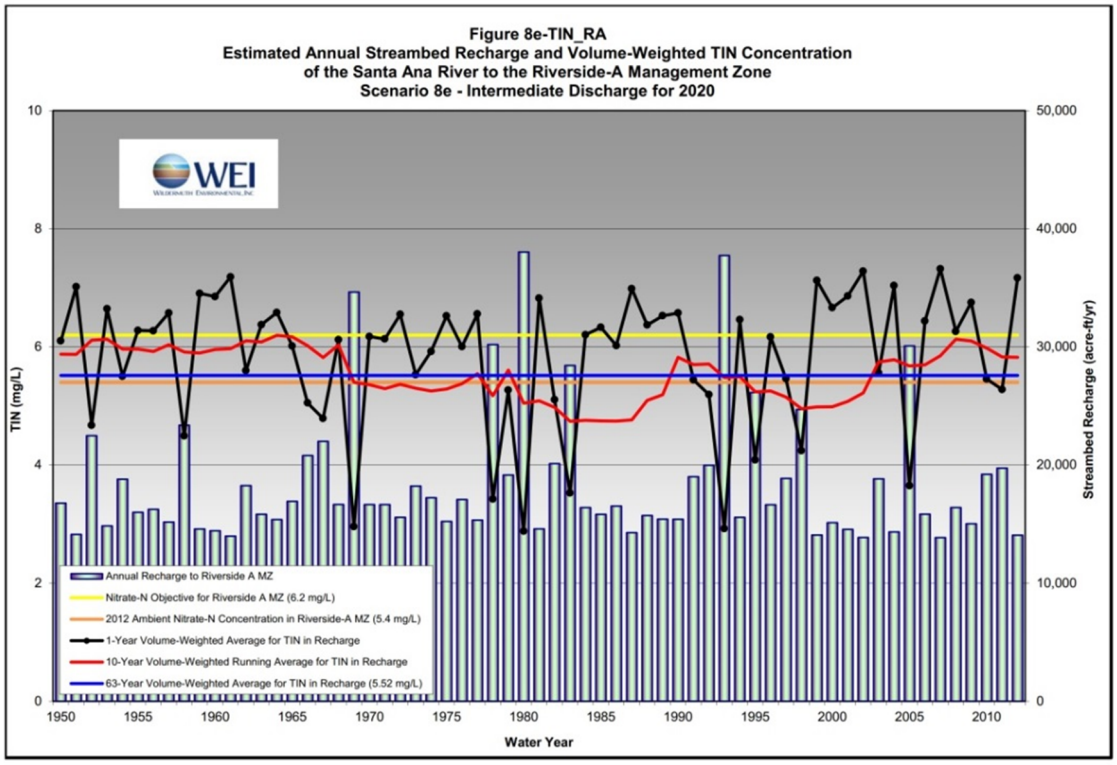
The volume of surface water percolating from Reach-3 of the Santa Ana River to groundwater in the Riverside-A Management Zone varies depending on the amount of reclaimed water that is reused rather than discharged. In the 2020 planning period, the estimated recharge to the Riverside-A Management Zone from the Santa Ana River ranges is approximately 18,849 acre-feet/year if RIX and Rialto are discharging at maximum capacity ("Scenario 8f"). The average TIN concentration in the surface water percolating from the Santa Ana River to groundwater in the Riverside-A Management Zone varies depending on the amount of reclaimed water that is reused rather than discharged and the volume stormwater runoff in the river (see Table 6).

Table 6: Summary of <u>TIN</u> Concentrations Recharging the Riverside-A Management Zone from Reach 3 and Reach 4 of the Santa Ana River.

Streambed Recharge Quality (WQO=6.2 mg/L; CAQ=5.4 mg/L; AC=0.8 mg/L)	**WLAM: Recycled Water Planning Scenario**	
	8e (Intermediate)	*8f (Max. Discharge)*
Highest Estimated Single Year Value	7.3 mg/L	7.3 mg/L
Highest Value of All 10-yr. Rolling Averages	6.2 mg/L	6.2 mg/L
Average of All 10-yr. Rolling Averages	5.5 mg/L	5.5 mg/L
Pct. of All 10-yr. Periods Exceeding 5.2 mg/L	57%	59%

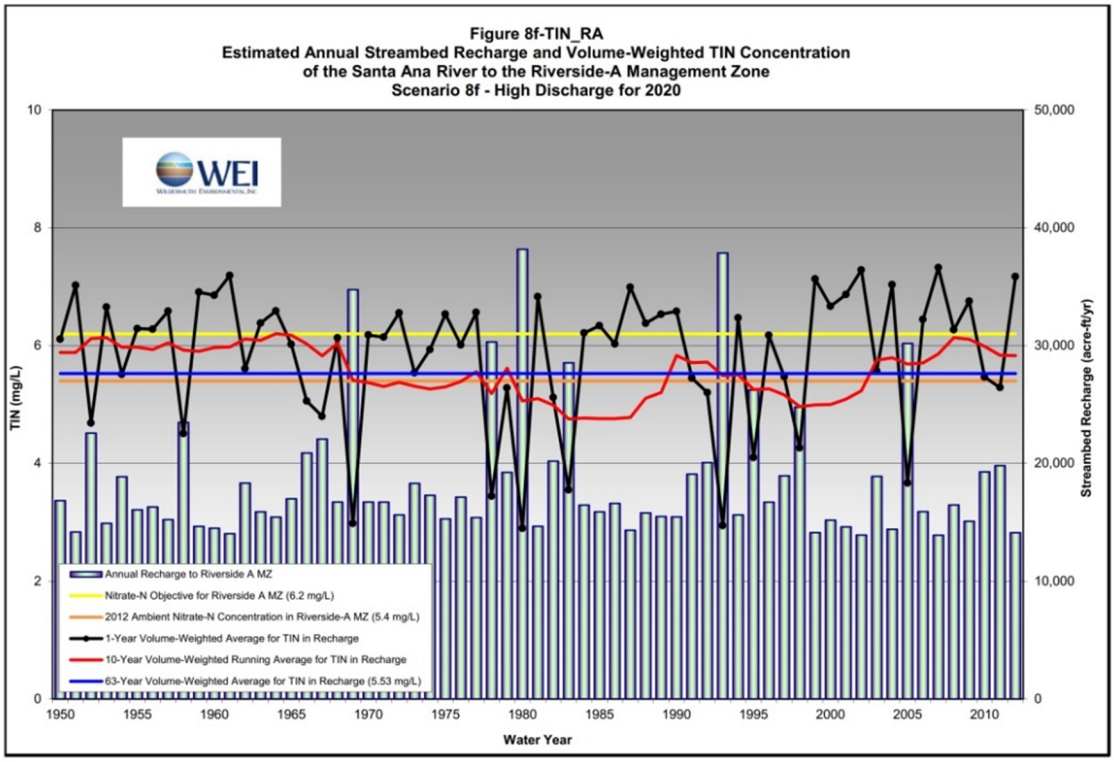
Results from the WLAM indicate that the TIN concentration in the surface water of Reach3 and 4 of the Santa Ana River will be greater than current ambient quality of the Riverside-A Management Zone in about 58% of 10-year averaging periods. The average TIN concentration over the entire 63-year modeling period is also slightly higher than the current average TDS concentration in the underlying groundwater (5.5 vs. 5.4 mg/L, respectively). Consequently, incidental recharge of recycled water is likely to degrade existing water quality in the Riverside-A Management Zone; but, it is not likely to cause or contribute to an exceedance of the water quality objective (6.2 mg/L) for TIN (see Fig. 5 & 6).

Fig. 5: TIN Concentration for Streambed Percolation in Intermediate Discharge Scenario[11]



[11] Wildermuth Environmental, Inc. Addendum to the 2008 Santa Ana River Wasteload Allocation Model Report: Scenario 8. January 5, 2015. (Figure 8e-TIN_RA)

Fig. 6: TIN Concentration for Streambed Percolation in Maximum Discharge Scenario[12]



If there is 227.7 billion liters of groundwater in storage and 0.8 mg/L of assimilative capacity available, then the Riverside-A Management Zone can absorb up to 200.8 tons dry-weight tons of additional TIN before exceeding the water quality objective.

In the worst case (driest) planning conditions, represented by the highest 10-year average concentration observed in the 63-year modeling period, the TIN concentration was 6.2 mg/L for both Scenario 8e and 8f (see Table 7). During prolonged drought conditions, TIN concentrations in the river water percolating to groundwater is likely to exceed the current ambient average TIN concentrations in the Riverside-A Management Zone by approximately 1.0 mg/L. As a result, incidental recharge of recycled water, through streambed percolation, may degrade water quality in this management zone.

Recent trend data confirms that some degradation is already occurring (see Fig. 7). However, under all modeling scenarios, the highest 10-year average TIN concentration in river water percolating to groundwater is not expected to exceed the applicable water quality objective (6.2 mg/L).

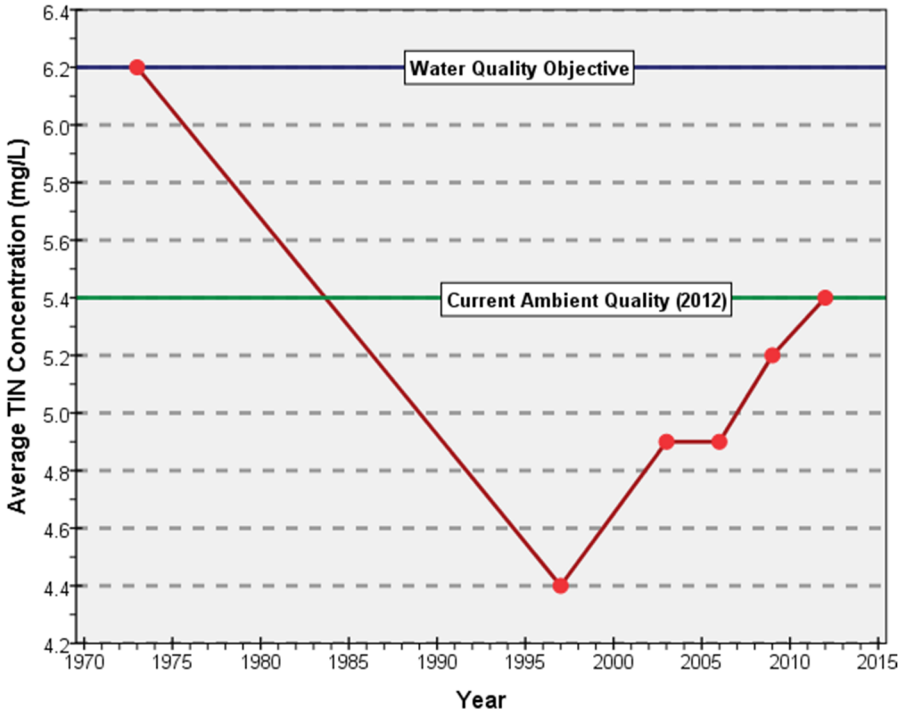
[12] Wildermuth Environmental, Inc. Addendum to the 2008 Santa Ana River Wasteload Allocation Model Report: Scenario 8. January 5, 2015. (Figure 8f-TIN_RA)

Table 7: Short-Term (10-year) Consumptive Use of Assimilative Capacity for TIN in Riverside-A Management Zone during Dry Hydrological Conditions

Streambed Recharge Quality (WQO=6.2 mg/L; CAQ=5.4 mg/L; AC=0.8 mg/L)	WLAM: Recycled Water Planning Scenario	
	8e (Intermediate)	*8f (Max. Discharge)*
Total Streambed Percolation Recharging	18,346 ac.-ft.	18,849 ac.-ft.
Highest Value of All 10-yr. Rolling Averages	6.2 mg/L	6.2 mg/L
Current Ambient Average TDS Concentration	5.4 mg/L	5.4 mg/L
Excess TDS Percolating to Groundwater	0.8 mg/L	0.8 mg/L
Avg. Annual Assimilative Capacity Used	20 tons/yr	21 tons/yr
Pct. of Available Assimilative Capacity Used	10%/yr	10%/yr

All of the above calculations are intended to estimate the marginal potential for streambed percolation to degrade water quality in the underlying aquifer. There are a number of other factors which may also influence groundwater quality. These factors are presumed to constant for the purposes of this illustration. The WLAM further assumes that the weather pattern likely to occur over the next 63 years will generally resemble that which occurred from 1950-2012.

Fig. 7: Trend for Average TIN Concentration in the Riverside-A Management Zone[13]



[13] Wildermuth Environmental Inc. Recomputation of Ambient Water Quality in the Santa Ana Watershed for the Period 1993 to 2012. August, 2014.

Over the long-term, average ambient TIN concentrations in the Riverside-A Management Zone will begin to approach the average quality of the recharge. In this instance, assuming that streambed percolation was the sole source of recharge to the Riverside-A aquifer, one would expect the ambient average TIN concentration to degrade from 5.4 mg/L to 5.6 mg/L. (see Table 8). Other factors may mitigate or aggravate this effect. However, as noted earlier, allowing the incidental recharge of recycled water to continue under existing permit conditions is not, by itself, expected to cause or contribute to any actual exceedance of the water quality objective (6.2 mg/L) in the Riverside-A Management Zone.

Table 8: Long-Term (63-year) Consumptive Use of Assimilative Capacity for TIN in the Riverside-A Management Zone

Streambed Recharge Quality (WQO=6.2 mg/L; CAQ=5.4 mg/L; AC=0.8 mg/L)	**WLAM: Recycled Water Planning Scenario**	
	8e (Intermediate)	*8f (Max. Discharge)*
Total Streambed Percolation Recharging	18,346 ac.-ft.	18,849 ac.-ft.
Average of All 10-yr. Rolling Averages	5.5 mg/L	5.5 mg/L
Current Ambient Average TDS Concentration	5.4 mg/L	5.4 mg/L
Excess TDS Percolating to Groundwater	0.1 mg/L	0.1 mg/L
Avg. Annual Assimilative Capacity Used	2.5 tons/year	2.6 tons/year
Pct. of Available Assimilative Capacity Used	1.2%/year	1.3%/year

Since both the short-term (10-year) and long-term TIN concentration in Reach-3 and 4 of the Santa Ana River are higher than the current ambient quality in the underlying groundwater, incidental recharge of wastewater is likely to lower water quality in the Riverside-A Management Zone over time. Consequently, an allocation of assimilative capacity is necessary in order to permit continued discharge of recycled water at the current quality.

4. Antidegradation Analysis for TDS

A) Will discharge permits issued with effluent limits similar to those assumed in the WLAM cause water quality in the Riverside-A Management Zone to degrade to a level less than the applicable baseline condition?

Yes, groundwater quality may degrade during prolonged periods of drought. However, over the long-term, and on average, groundwater quality in the Riverside-A Management Zone is actually expected to continue improving under the various discharge scenarios evaluated in the WLAM.

B) Is the water quality degradation that may occur spatially-limited or temporally-limited?

Yes, any reduction in groundwater quality is expected to be both spatially and temporally-limited. Incidental recharge of recycled water affects only those areas of the Riverside-A Management Zone that are under the influence of the Santa Ana River. And, even then, only those segments of the Santa Ana River downstream from the actual discharge points. As such, the degradation is spatially-limited. Water quality in other areas of the Riverside-A Management Zone is not affected by the incidental recharge of recycled water.

And, as noted above, projected degradation associated with elevated TDS concentrations is only expected to occur under severe drought conditions. Any such degradation will be more than offset when normal (average) rainfall patterns return. Consequently, the incidental recharge of recycled water during dry hydrological conditions will only temporally degrade water quality in the Riverside-A Management Zone.

C) Will groundwater quality continue to meet the applicable water quality objective for TDS that is established in the Basin Plan?

Yes. Average annual TDS concentrations in the water percolating from the Santa Ana River to the Riverside-A Management Zone is expected to comply the TDS objective of 560 mg/L. Consequently, the permitted discharges will not cause or contribute to an exceedance of the water quality objective in the receiving water.

D) Will beneficial uses in the receiving water be unreasonably affected if discharge permits are issued with effluent limits similar to those assumed within the WLAM?

No. TDS concentrations in the Riverside-A Management Zone are expected to remain at or below the Secondary Maximum Contaminant Level (500 mg/L) recommended by U.S. EPA. Consequently, permitting incidental recharge of recycled water at volumes and concentrations presumed in the WLAM will not adversely affect beneficial uses in this groundwater basin.

E) Have the dischargers implemented Best Practicable Treatment or Control (BPTC) to reduce TDS concentrations where feasible?

Yes. Significant salt loads from industrial sources have been diverted out of the wastewater treatment plants and over to the SARI line. All of the POTWs have implemented programs to minimize the incremental salt loads that result from the wastewater treatment process itself. In particular, using UV for disinfection at RIX has significantly reduce the TDS loads that would otherwise occur as by-products of the more common chlorination and dechlorination process.

All of the POTWs continue to comply with existing effluent limits prohibiting average TDS concentrations in the recycled water from being more than 250 mg/L greater than the average TDS concentrations in the service area's source water. The incremental increase in TDS concentration in recycled water is due to i) changes in water supply quality, ii) widespread implementation of water conservation measures throughout the region, and iii) increased use of residential water softening systems.

The possibility of prolonged drought is the primary reason for allowing existing wastewater discharges to continue recharging the Riverside-A Management Zone. Such recharges extend the utility of existing water supplies and provide a buffer against interruption of imported water. In addition, it is important to recharge the effluent as high as possible in the watershed in order to better provide for the maximum possible opportunities for use and reuse in the Santa Ana region.

Trend data shows that ambient TIN concentration in the Riverside-A Management Zone is asymptotically approaching the average TIN concentration of the river water recharging the basin. If the trend continues, it is likely that the average TIN concentration in groundwater will be close to 5.6 mg/L when the next Ambient Water Quality Update for the 1996-215 period is prepared in 2016. Once that occurs, further degradation is not expected provided that POTWs continue to meet their current effluent limits for TIN shown in Table 8, below.

Table 8: TIN and TDS Effluent Limits for Discharges to the Riverside-A Management Zone[14]

NPDES Permit	Max. Discharge	TIN	TDS
City of Rialto	8.8 mgd (9,857 ac-ft/yr)	10 mg/L	490 mg/L
RIX Facility	31.8 mgd (35,621 ac-ft/yr)	10 mg/L	550 mg/L
City of Riverside *Landscape Irrigation*	<0.1 mgd (≈112 ac-ft/yr)	10 mg/L	650 mg/L

F) Will allowing lower water quality provide "Maximum Benefit" to the people of California?

Yes. Continued discharge of high quality effluent by RIX and Rialto enhances several beneficial uses in Reach 3 and 4 of the Santa Ana River, including: warm-water aquatic habitat (WARM), water recreation (REC1 & REC2), riparian habitat (WILD, RARE) and groundwater recharge (GWR). The latter is especially important given the need to protect water supplies during long drought periods like the one currently occurring.

In addition, recent analysis indicates that the on-going discharge of high quality effluent from RIX and Rialto probably helps to reduce the average TDS concentration in the base flow of the Santa Ana River where it recharges the Chino-South groundwater basin and the Orange County groundwater basin.[15]

The proposed allocation of assimilative capacity is consistent with California's Antidegradation Policy[16] and with the re-use goals set forth in the State Water Resources Control Board's Recycled Water Policy.[17] Imposing more stringent effluent limits would increase treatment costs without providing any concomitant benefit to human health or the environment.

[14] Effluent limits should continue to be expressed as volume-weighted annual averages.
[15] Wildermuth Environmental Inc. Investigation and Characterization of the Cause(s) of Recent Exceedances of the TDS Concentration Objective for Reach 3 of the Santa Ana River. February, 2015.
[16] SWRCB Res. No. 68-16; Administrative Procedures Update 90-004 (July 2, 1990); and Questions and Answers for SWRCB Res. No. 68-16 (Feb. 16, 1995).
[17] SWRCB Res. No. 2009-0011 (Feb. 3, 2011)