Chapter 7 Results of Groundwater Quality Trend Analysis

7.1 Background

The antidegradation analysis is based on Resolution 68-16, the Basin Plan, and the Recycled Water Policy. These documents are described in Section 1.2. The groundwater quality trend analysis presented herein uses data collected and analyzed as part of this project to address the requirements of the Recycled Water Policy and Resolution 68-16.

7.2 Constituents and Existing Water Quality

As discussed in Section 3, TDS and nitrate concentrations were compiled as part of this study. The average concentrations at each well from 2006-2010 were used to develop interpolated TDS and nitrate concentrations across the basin, as shown in Figure 3-5 and 3-6. To develop a statistic of basinwide TDS and nitrate concentrations, the interpolated concentrations were spatially averaged to develop a single TDS and a single nitrate concentration indicative of current conditions: 290 mg/L TDS and 1.3 mg/L nitrate (as N). These values are well below the Basin Plan's Water Quality Objectives of 500 mg/L TDS and 10 mg/L nitrate as N. The difference between the Water Quality Objective and the current water quality is the assimilative capacity of the basin: 210 mg/L TDS and 8.7 mg/L nitrate.

7.3 Projected Degradation in Water Quality

The analysis of potential degradation in water quality was performed based on the:

- Existing groundwater quality (see Section 7.2)
- Volumes of inflows and outflows as shown in the water budget (see Section 3.5)
- Concentrations of inflows and outflows
    - From land use/surface activities, based on loading model (see Section 6)
    - From surface water courses, based on:
        - The City of Santa Rosa's *NPDES Storm Water Permit Annual Report*, *2010-2011* (Santa Rosa, City of, 2011)
        - The City of Santa Rosa's *2010 Water Quality Report*(Santa Rosa, City of, 2011)

7.3.1 Projects

In addition to current activities in the basin, this analysis assumed full implementation of recycled water projects included in the higher estimate of 2035 use, as described in Section 4.1. The analysis assumed that the recycled water replaced other water supplies and did not result in an increase in the overall delivery of water. Additionally, implementation of recycled water projects was assumed to include adjustments in application of fertilizer reflecting the higher nitrogen concentration in recycled water as compared to the previous water source. Nitrogen levels in all sources of recycled water in the basin are low enough that, in some cases, existing users of recycled water show a need for additional nitrogen application, indicating that the recycled water does not have nitrogen in concentrations exceeding the needs of the irrigated crops or landscape.

7.3.2 Total Loading

Total loading and average basin concentration were estimated based on the volumes and concentrations discussed earlier in the report, as summarized in Table 7-1. These values were used in a Microsoft EXCEL spreadsheet to calculate the annual change in basin concentration over a 25-year time horizon based on the estimated volumes and concentrations of inflows and outflows.

Table 7-1: Estimated Volume and Concentration of Inflows and Outflows for Groundwater Quality Trend Analysis

Item	TDS	Nitrate	Basis
Initial Concentration (mg/L)	290	1.3	Calculated [a]
Initial Basin Volume (AF)	3,910,000	3,910,000	DWR, 2003
Surface Inflow Concentration (mg/L)	1,623	4.4	Calculated
Surface Inflow Volume (AFY)	14,435	14,435	DWR, 1987
Volume of Additional Recycled Water (AFY)	3,088	3,088	Recycled Water Goals
Marginal Change in Concentration due to Recycled Water Use (mg/L)	115	0**	Calculated [b]
Stream Recharge Concentration	150	1	Santa Rosa, 2011a,b
Stream Recharge Volume (AFY)	15,899	15,899	DWR, 1987
Pumping Outflow Concentration	Calculated [c]	Calculated [c]	Calculated [c]
Pumping Outflow Volume (AFY)	26,333	26,333	DWR, 1987
Subsurface Inflow/Outflow (AFY)	0	0	DWR, 1987

a. Calculations based on interpolation of available data from 2006-2010, excluding “environmental monitoring wells”, as discussed in Chapter 3.
b. Calculations based on the difference between the concentrations of TDS and nitrate in individual sources of recycled water and in the water supply being replaced. Marginal change in nitrate is assumed zero based on changes in application of fertilizers after conversion to recycled water.
c. Concentrations vary for each year based on the annual calculations estimating basin-wide concentrations.

7.3.3 Groundwater Quality

The results of the loading analysis predict an increase in concentrations for both TDS and nitrate over the 25-year time horizon based on the conservative assumptions in this analysis. TDS is projected to increase from 290 mg/L to 360 mg/L. Nitrate (as N) is projected to increase from 1.3 mg/L to 1.7 mg/L. These values are both below the Basin Plan Objectives: 500 mg/L for TDS and 10 mg/L for nitrate. The estimated increases in concentrations include current land uses and practices, as well as implementation of recycled water at the Higher Estimate as described in Chapter 4. Future land uses, based on current trends of urbanization (less loading per urban acre than rural farmstead acre) and agricultural conversion (less loading from vineyards and orchards than pasture) are anticipated to result in lower salt and nutrient loads per acre than current land uses, so the current land use results in more conservative findings.

No additional storm water recharge to groundwater or new BMPs to control nitrogen or salt loading are assumed in the analysis. Figures 7-1 and 7-2 present the projected changes in TDS and nitrate concentrations with projected recycled water use as described in Table 4-1. For comparison, the dashed line on the figures shows the projected changes in TDS and nitrate with no additional recycled water usage beyond current levels. The estimated annual loading, inflows and outflows with associated concentrations, and basin-wide concentrations are shown in Tables 7-2 and 7-3 for TDS and nitrate (as N), respectively.

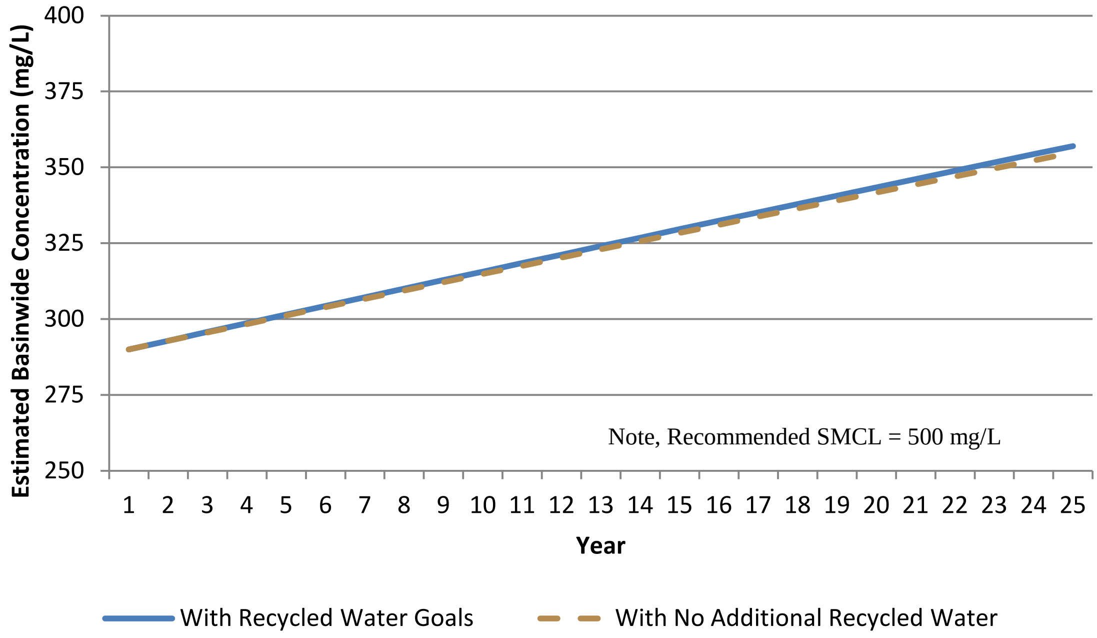

Figure 7-1: Projected Basin-wide TDS Concentrations

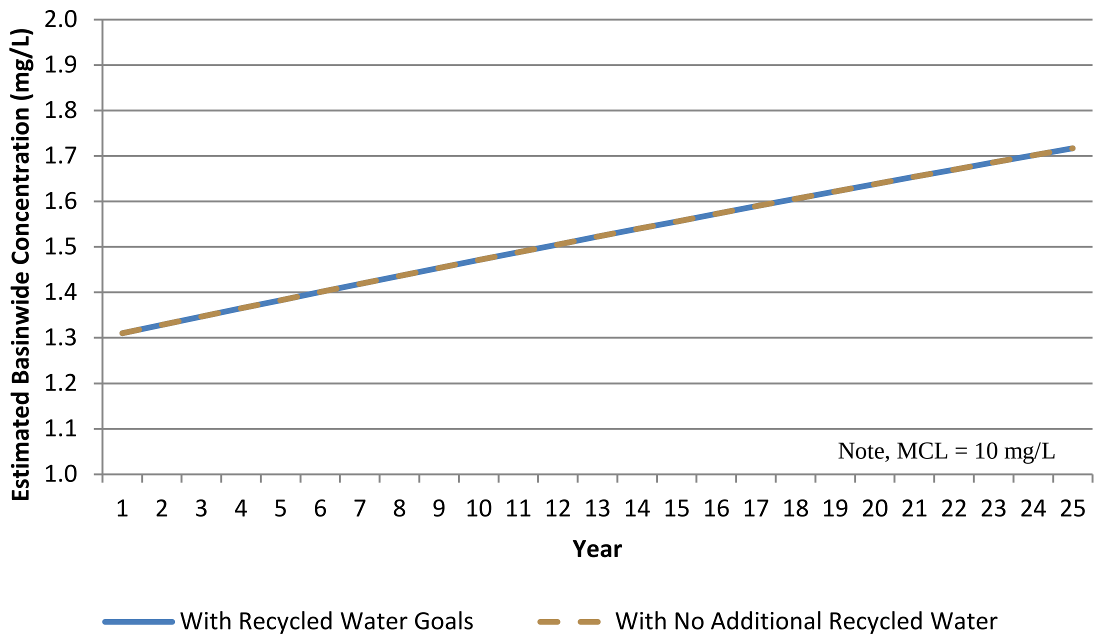

Figure 7-2: Projected Basin-wide Nitrate (as N) Concentrations

Table 7-2: Groundwater Quality Trend Analysis, TDS

Year	Basin Conditions			Inflows															Outflows		
							Impact of Additional Recycled Water Use														
	Initial Concentration (mg/L)	Basin Groundwater Volume (AF)	Basin Mass (tons)	Surface Inflow Concentration (mg/L)	Surface Inflow Volume (AF)	Surface Inflow Mass (tons)	Marginal Change in Concentration, Windsor (mg/L)	Volume, Windsor (AF)	Mass, Windsor (tons)	Marginal Change in Concentration, SCWA (mg/L)	Volume, SCWA (AF)	Mass, SCWA (tons)	Marginal Change in Concentration, Santa Rosa and Rohnert Park (mg/L)	Volume, Santa Rosa and Rohnert Park (AF)	Mass, Santa Rosa and Rohnert Park (tons)	Stream Recharge Concentration (mg/L)	Stream Recharge Volume (AF)	Stream Recharge Mass (tons)	Groundwater Pumping Concentration (mg/L)	Groundwater Pumping Volume (AF)	Groundwater Pumping Mass (tons)
1	290	3,910,000	1,541,751	1,201	14,435	23,577	140	685	130	122	21	4	108	2,381	350	150	15,899	3,243	290	26,333	10,383
2	293	3,914,002	1,558,671	1,206	14,435	23,668	140	685	130	122	21	4	108	2,381	350	150	15,899	3,243	293	26,333	10,486
3	296	3,918,003	1,575,579	1,211	14,435	23,759	140	685	130	122	21	4	108	2,381	350	150	15,899	3,243	296	26,333	10,589
4	299	3,922,005	1,592,475	1,215	14,435	23,850	140	685	130	122	21	4	108	2,381	350	150	15,899	3,243	299	26,333	10,692
5	301	3,926,007	1,609,360	1,220	14,435	23,941	140	685	130	122	21	4	108	2,381	350	150	15,899	3,243	301	26,333	10,794
6	304	3,930,008	1,626,232	1,224	14,435	24,031	140	685	130	122	21	4	108	2,381	350	150	15,899	3,243	304	26,333	10,896
7	307	3,934,010	1,643,093	1,229	14,435	24,121	140	685	130	122	21	4	108	2,381	350	150	15,899	3,243	307	26,333	10,998
8	310	3,938,011	1,659,942	1,234	14,435	24,211	140	685	130	122	21	4	108	2,381	350	150	15,899	3,243	310	26,333	11,100
9	313	3,942,013	1,676,780	1,238	14,435	24,301	140	685	130	122	21	4	108	2,381	350	150	15,899	3,243	313	26,333	11,201
10	316	3,946,015	1,693,606	1,243	14,435	24,390	140	685	130	122	21	4	108	2,381	350	150	15,899	3,243	316	26,333	11,302
11	318	3,950,016	1,710,420	1,247	14,435	24,479	140	685	130	122	21	4	108	2,381	350	150	15,899	3,243	318	26,333	11,402
12	321	3,954,018	1,727,223	1,252	14,435	24,568	140	685	130	122	21	4	108	2,381	350	150	15,899	3,243	321	26,333	11,503
13	324	3,958,020	1,744,014	1,256	14,435	24,656	140	685	130	122	21	4	108	2,381	350	150	15,899	3,243	324	26,333	11,603
14	327	3,962,021	1,760,794	1,261	14,435	24,745	140	685	130	122	21	4	108	2,381	350	150	15,899	3,243	327	26,333	11,703
15	330	3,966,023	1,777,562	1,265	14,435	24,833	140	685	130	122	21	4	108	2,381	350	150	15,899	3,243	330	26,333	11,802
16	332	3,970,025	1,794,319	1,270	14,435	24,921	140	685	130	122	21	4	108	2,381	350	150	15,899	3,243	332	26,333	11,902
17	335	3,974,026	1,811,064	1,274	14,435	25,008	140	685	130	122	21	4	108	2,381	350	150	15,899	3,243	335	26,333	12,000
18	338	3,978,028	1,827,798	1,279	14,435	25,096	140	685	130	122	21	4	108	2,381	350	150	15,899	3,243	338	26,333	12,099
19	341	3,982,029	1,844,521	1,283	14,435	25,183	140	685	130	122	21	4	108	2,381	350	150	15,899	3,243	341	26,333	12,198
20	343	3,986,031	1,861,233	1,287	14,435	25,270	140	685	130	122	21	4	108	2,381	350	150	15,899	3,243	343	26,333	12,296
21	346	3,990,033	1,877,933	1,292	14,435	25,356	140	685	130	122	21	4	108	2,381	350	150	15,899	3,243	346	26,333	12,394
22	349	3,994,034	1,894,622	1,296	14,435	25,443	140	685	130	122	21	4	108	2,381	350	150	15,899	3,243	349	26,333	12,491
23	352	3,998,036	1,911,299	1,301	14,435	25,529	140	685	130	122	21	4	108	2,381	350	150	15,899	3,243	352	26,333	12,589
24	354	4,002,038	1,927,966	1,305	14,435	25,615	140	685	130	122	21	4	108	2,381	350	150	15,899	3,243	354	26,333	12,686
25	357	4,006,039	1,944,621	1,309	14,435	25,700	140	685	130	122	21	4	108	2,381	350	150	15,899	3,243	357	26,333	12,782

Table 7-3: Groundwater Quality Trend Analysis, Nitrate (as N)

Year	Basin Conditions			Inflows															Outflow		
							Impact of Additional Recycled Water Use														
	Initial Concentration (mg/L)	Basin Groundwater Volume (AF)	Basin Mass (tons)	Surface Inflow Concentration (mg/L)	Surface Inflow Volume (AF)	Surface Inflow Mass (tons)	Marginal Change in Concentration, Windsor (mg/L)	Volume, Windsor (AF)	Mass, Windsor (tons)	Marginal Change in Concentration, SCWA (mg/L)	Volume, SCWA (AF)	Mass, SCWA (tons)	Marginal Change in Concentration, Santa Rosa and Rohnert Park (mg/L)	Volume, Santa Rosa and Rohnert Park (AF)	Mass, Santa Rosa and Rohnert Park (tons)	Stream Recharge Concentration (mg/L)	Stream Recharge Volume (AF)	Stream Recharge Mass (tons)	Groundwater Pumping Concentration (mg/L)	Groundwater Pumping Volume (AF)	Groundwater Pumping Mass (tons)
1	1.3	3,910,000	6,964	6.6	14,435	130	0	685	0	0	21	0	0	2,381	0	1.0	15,899	**22**	1.3	26,333	47
2	1.3	3,914,002	7,070	6.7	14,435	131	0	685	0	0	21	0	0	2,381	0	1.0	15,899	22	1.3	26,333	48
3	1.3	3,918,003	7,174	6.7	14,435	131	0	685	0	0	21	0	0	2,381	0	1.0	15,899	22	1.3	26,333	48
4	1.4	3,922,005	7,278	6.7	14,435	131	0	685	0	0	21	0	0	2,381	0	1.0	15,899	22	1.4	26,333	49
5	1.4	3,926,007	7,382	6.7	14,435	131	0	685	0	0	21	0	0	2,381	0	1.0	15,899	22	1.4	26,333	50
6	1.4	3,930,008	7,485	6.7	14,435	131	0	685	0	0	21	0	0	2,381	0	1.0	15,899	22	1.4	26,333	50
7	1.4	3,934,010	7,588	6.7	14,435	131	0	685	0	0	21	0	0	2,381	0	1.0	15,899	22	1.4	26,333	51
8	1.4	3,938,011	7,690	6.7	14,435	131	0	685	0	0	21	0	0	2,381	0	1.0	15,899	22	1.4	26,333	51
9	1.5	3,942,013	7,791	6.7	14,435	132	0	685	0	0	21	0	0	2,381	0	1.0	15,899	22	1.5	26,333	52
10	1.5	3,946,015	7,893	6.7	14,435	132	0	685	0	0	21	0	0	2,381	0	1.0	15,899	22	1.5	26,333	53
11	1.5	3,950,016	7,993	6.7	14,435	132	0	685	0	0	21	0	0	2,381	0	1.0	15,899	22	1.5	26,333	53
12	1.5	3,954,018	8,093	6.7	14,435	132	0	685	0	0	21	0	0	2,381	0	1.0	15,899	22	1.5	26,333	54
13	1.5	3,958,020	8,193	6.7	14,435	132	0	685	0	0	21	0	0	2,381	0	1.0	15,899	22	1.5	26,333	55
14	1.5	3,962,021	8,292	6.7	14,435	132	0	685	0	0	21	0	0	2,381	0	1.0	15,899	22	1.5	26,333	55
15	1.6	3,966,023	8,391	6.7	14,435	132	0	685	0	0	21	0	0	2,381	0	1.0	15,899	22	1.6	26,333	56
16	1.6	3,970,025	8,489	6.7	14,435	132	0	685	0	0	21	0	0	2,381	0	1.0	15,899	22	1.6	26,333	56
17	1.6	3,974,026	8,587	6.8	14,435	133	0	685	0	0	21	0	0	2,381	0	1.0	15,899	22	1.6	26,333	57
18	1.6	3,978,028	8,684	6.8	14,435	133	0	685	0	0	21	0	0	2,381	0	1.0	15,899	22	1.6	26,333	57
19	1.6	3,982,029	8,781	6.8	14,435	133	0	685	0	0	21	0	0	2,381	0	1.0	15,899	22	1.6	26,333	58
20	1.6	3,986,031	8,877	6.8	14,435	133	0	685	0	0	21	0	0	2,381	0	1.0	15,899	22	1.6	26,333	59
21	1.7	3,990,033	8,973	6.8	14,435	133	0	685	0	0	21	0	0	2,381	0	1.0	15,899	22	1.7	26,333	59
22	1.7	3,994,034	9,069	6.8	14,435	133	0	685	0	0	21	0	0	2,381	0	1.0	15,899	22	1.7	26,333	60
23	1.7	3,998,036	9,164	6.8	14,435	133	0	685	0	0	21	0	0	2,381	0	1.0	15,899	22	1.7	26,333	60
24	1.7	4,002,038	9,258	6.8	14,435	133	0	685	0	0	21	0	0	2,381	0	1.0	15,899	22	1.7	26,333	61
25	1.7	4,006,039	9,352	6.8	14,435	134	0	685	0	0	21	0	0	2,381	0	1.0	15,899	22	1.7	26,333	61