Russian River Water Quality Summary
For the
Sonoma County Water Agency
2011 Temporary Urgency Change (TUC)

Prepared by

Sonoma County Water Agency

March 2012

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1.0 INTRODUCTION

On April 18, 2011, the Sonoma County Water Agency (Water Agency) petitioned the State Water Resources Control Board (SWRCB) to temporarily reduce minimum in-stream flows in the Russian River as required by the National Marine Fisheries Service's (NMFS) *Biological Opinion for Water Supply, Flood Control Operations, and Channel Maintenance conducted by the U.S. Army Corps of Engineers, the Sonoma County Water Agency, and the Mendocino County Russian River Flood Control and Water Conservation District in the Russian River Watershed* (Russian River Biological Opinion, NMFS 2008).

The Water Agency requested that the SWRCB make the following temporary changes to the Decision 1610 (D1610) in-stream flow requirements:

- From May 1 through October 15, 2011, instream flow requirements for the upper Russian River (from its confluence with the East Fork of the Russian River to its confluence with Dry Creek) be reduced from 185 cubic feet per second (cfs) to 125 cfs. The minimum instream flow requirement for the upper Russian River will be implemented as a 5-day running average of average daily stream flow measurements, with the stipulation that instantaneous stream flows will be no less than 110 cfs.

- From May 1 through October 15, 2010, in-stream flow requirements for the lower Russian River (downstream of its confluence with Dry Creek) be reduced from 125 cfs to 70 cfs with the understanding that the Water Agency will typically maintain approximately 85 cfs at the Hacienda Gauge as practicably feasible.

The SWRCB issued an Order (Order) approving the Water Agency's Temporary Urgency Change Petition (TUCP) on June 1, 2011. The Order included several terms and conditions, including requirements for the preparation of a water quality monitoring plan (Term 8). The Water Agency submitted a plan to meet the requirements of Term 8 on June 29, 2011. This report provides and summarizes all data collected during the 2011 water quality monitoring program as required by Term 9 of the Order.

2.0 2011 RUSSIAN RIVER FLOW SUMMARY

As described in the Order, the Water Agency requested temporary changes to D1610 in-stream flow requirements including reductions from 185 cfs to 125 cfs in the upper Russian River (from its confluence with the East Fork of the Russian River to its confluence with Dry Creek) and from 125 cfs to 70 cfs in the lower Russian River (downstream of its confluence with Dry Creek). The purpose of the 2011 Temporary Urgency Change (TUC) was to comply with the Biological Opinion which found that stream velocities under D1610 flows reduced the amount of available summer rearing habitat in the upper mainstem of the Russian River.

Inflow into Lake Pillsbury was sufficiently high enough to classify 2011 as a Normal year under D1610 and storage in Lake Mendocino, while below conditions experienced in 2010 was well above 2009 conditions. Despite the reduced Coyote Valley Dam releases authorized by the Order, flows were above D1610 minimum flows in some sections of the Russian River from tributary inflow due to a relatively wet spring. A mild demand season allowed stable releases from Lake Mendocino and minimized the need to release stored water. 2011 flows are shown in Figure 2-1.

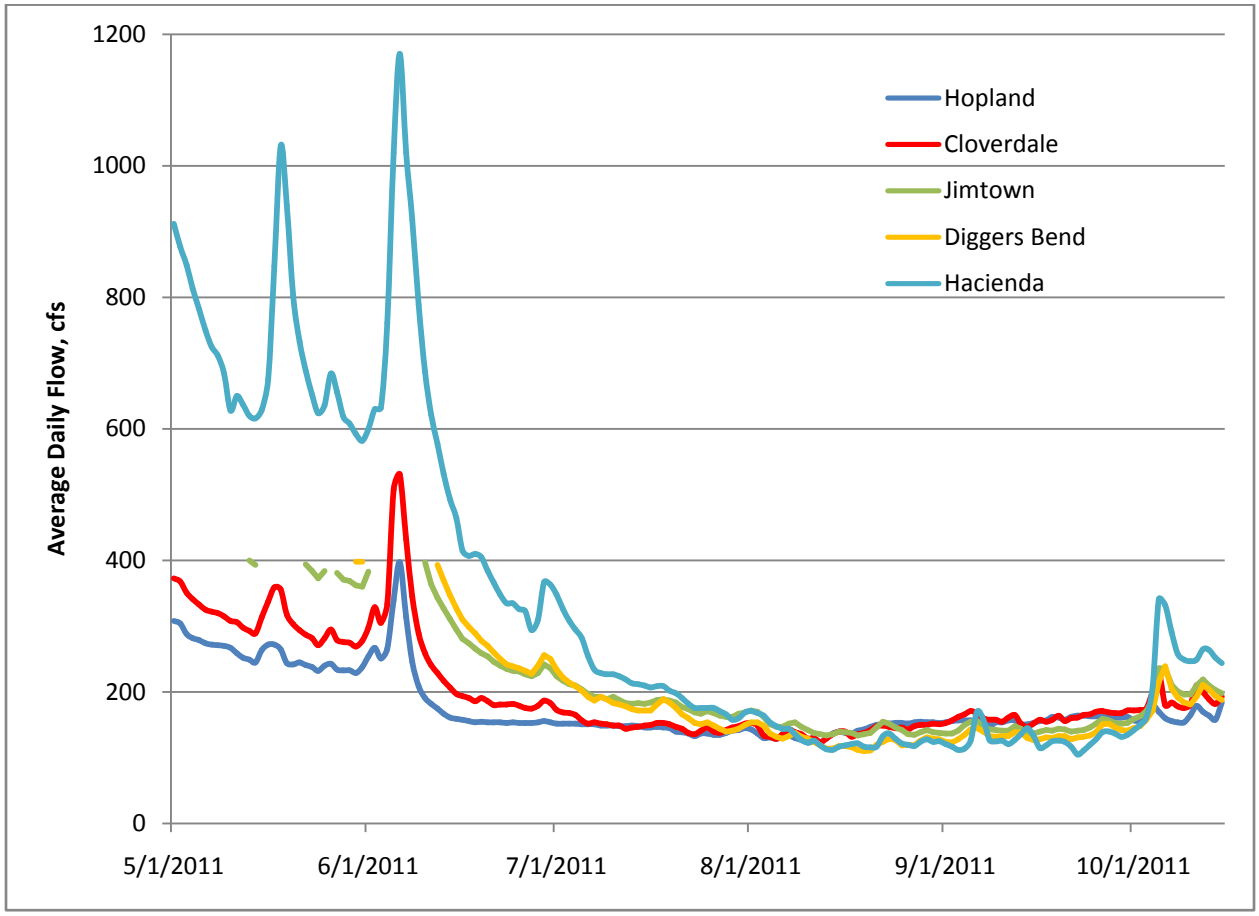

Figure 2-1. 2011 Average Daily Flows USGS Russian River gages (approved data), cubic feet per second (cfs)

In the section of the Russian River from Ukiah to the mouth of Dry Creek (upper Russian River) flows dropped below D1610 minimum flow, but remained above instantaneous flows authorized by the TUC Order. Figure 2-2 shows that flows in the upper Russian River above the Dry Creek confluence did not drop below 185 cfs until mid-June (Hopland) but remained under until early October.

Flows in the lower Russian River (downstream of the confluence with Dry Creek) dropped below D1610 minimum flow in mid August but remained higher than TUC minimum flows during the entire period of the Order (Figure 2-3). This was due to spring rains, tributary inflow, and relatively mild summer temperatures.

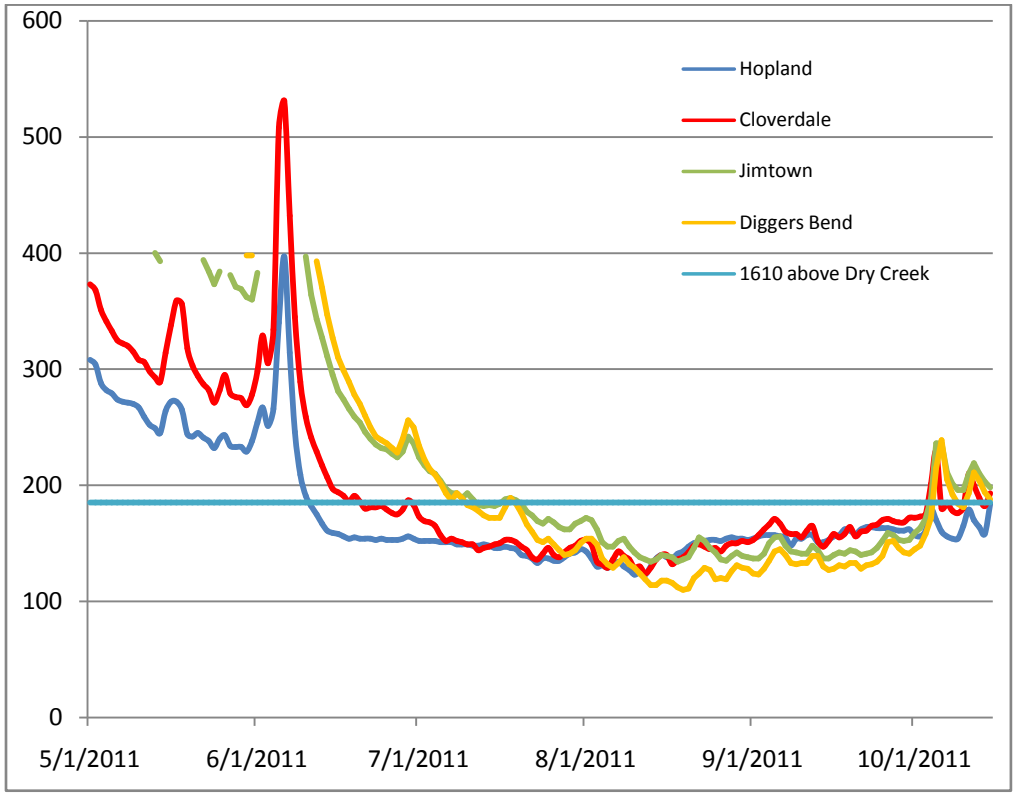

Figure 2-2. 2011 Average Daily Flows USGS gages above Dry Creek confluence (approved data), cfs

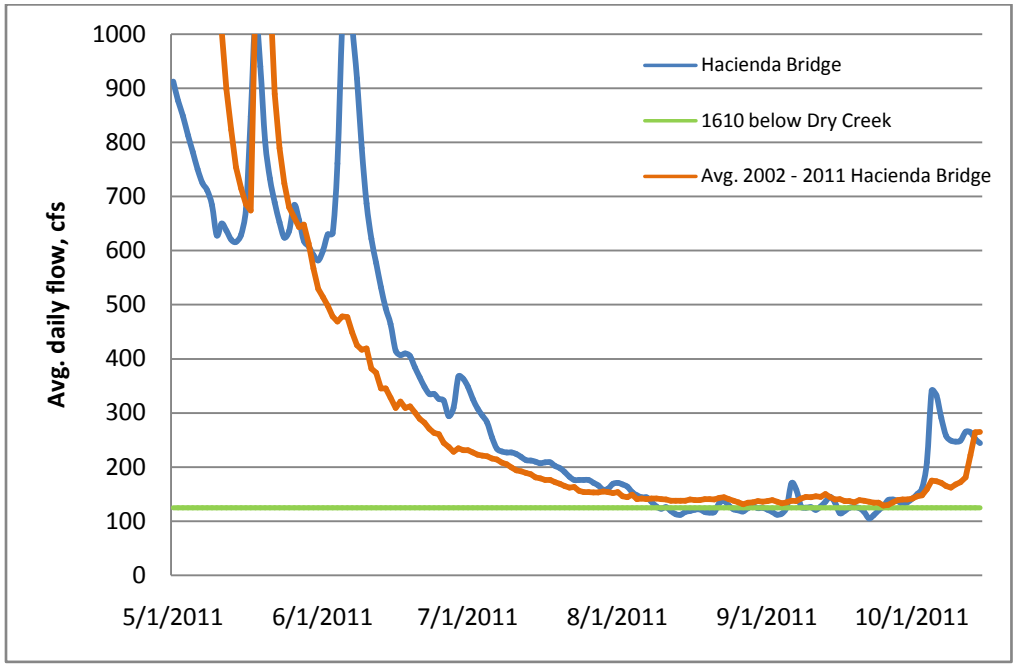

Figure 2-3. 2011 Average Daily Flows USGS gages below Dry Creek confluence (approved data), cfs

3.0 WATER QUALITY MONITORING

The collection of water quality data was conducted to supplement existing data to provide a more complete basis for analyzing spatial and temporal water quality trends due to Biological Opinion-stipulated changes in river flow and estuary management. The resulting data will help provide information to evaluate potential changes to water quality and availability of habitat for aquatic resources resulting from the proposed permanent changes to D1610 minimum in-stream flows that are mandated by the Biological Opinion. A complete analysis and evaluation of the water quality data is being conducted as part of the CEQA requirements associated with establishing permanent changes to D1610 and management of the estuary.

3.1 Mainstem Russian River Water Quality Monitoring

Several agencies conducted water quality monitoring in the mainstem of the Russian River during the term of the Order. From May 24th through October 4th, the NCRWQCB conducted weekly bacteriological sampling in cooperation with the Sonoma County Environmental Health Department at beaches that experience recreational activities involving the greatest body contact. To support the analysis and evaluation of water quality data needed for the CEQA requirements as noted above, the Water Agency conducted bi-weekly bacteriological, nutrient and algal mainstem sampling from May 19 through October 6.

The California Department of Public Health (CDPH) developed the "Draft Guidance for Fresh Water Beaches," which describes bacteria levels that, if exceeded, may require posted warning signs in order to protect public health. The CDPH draft guideline for single sample; total coliform is 10,000 most probable numbers (MPN) per 100 milliliters (ml), 400 MPN per 100 ml for fecal coliforms, 235 MPN per 100 ml for *e coli* and the MPN for Enterococcus is 61 per 100 ml. Exceedances of the draft guidance are highlighted in Table 3-1. However, it must be emphasized that these are draft guidelines, not adopted standards, and are therefore both subject to change (if it is determined that the guidelines are not accurate indicators) and are not currently enforceable. In addition, these draft guidelines were established for and are only applicable to fresh water beaches. Currently, there are no numeric guidelines that have been developed for estuarine areas. Additionally, the NCRWQCB Basin Plan includes numeric standards for fecal coliform relative to REC-1 beneficial use, this standard is also 400 MPN per 100 ml but is based upon 10% of the samples in a 30 day period. The EPA recommended criteria for Nutrients, Chlorophyll a, and Turbidity in Rivers and Streams in Aggregate Ecoregion III are used throughout with exceedances highlighted in Tables 3-2 to 3-10.

3.1.1 2011 Water Agency Mainstem Water Quality Sampling

Water samples were collected from the following nine (9) surface-water sites in the mainstem of the Russian River and as shown on Figure 3-1: Diggers Bend; Camp Rose; Memorial Beach; below Memorial Beach and above Dry Creek confluence; ~1,500 feet below Dry Creek confluence; Riverfront Park; ~150 feet below Water Agency RDS; ~1,300 feet below Mark West Creek confluence; Steelhead Beach.

All samples were analyzed for nutrients, chlorophyll *a*, standard bacterial indicators (total coliforms (multiple tube fermentation and colilert), *e. coli*, fecal coliform and enterococci), total and dissolved organic carbon, and total dissolved solids. Duplicate samples were taken at Steelhead Beach.

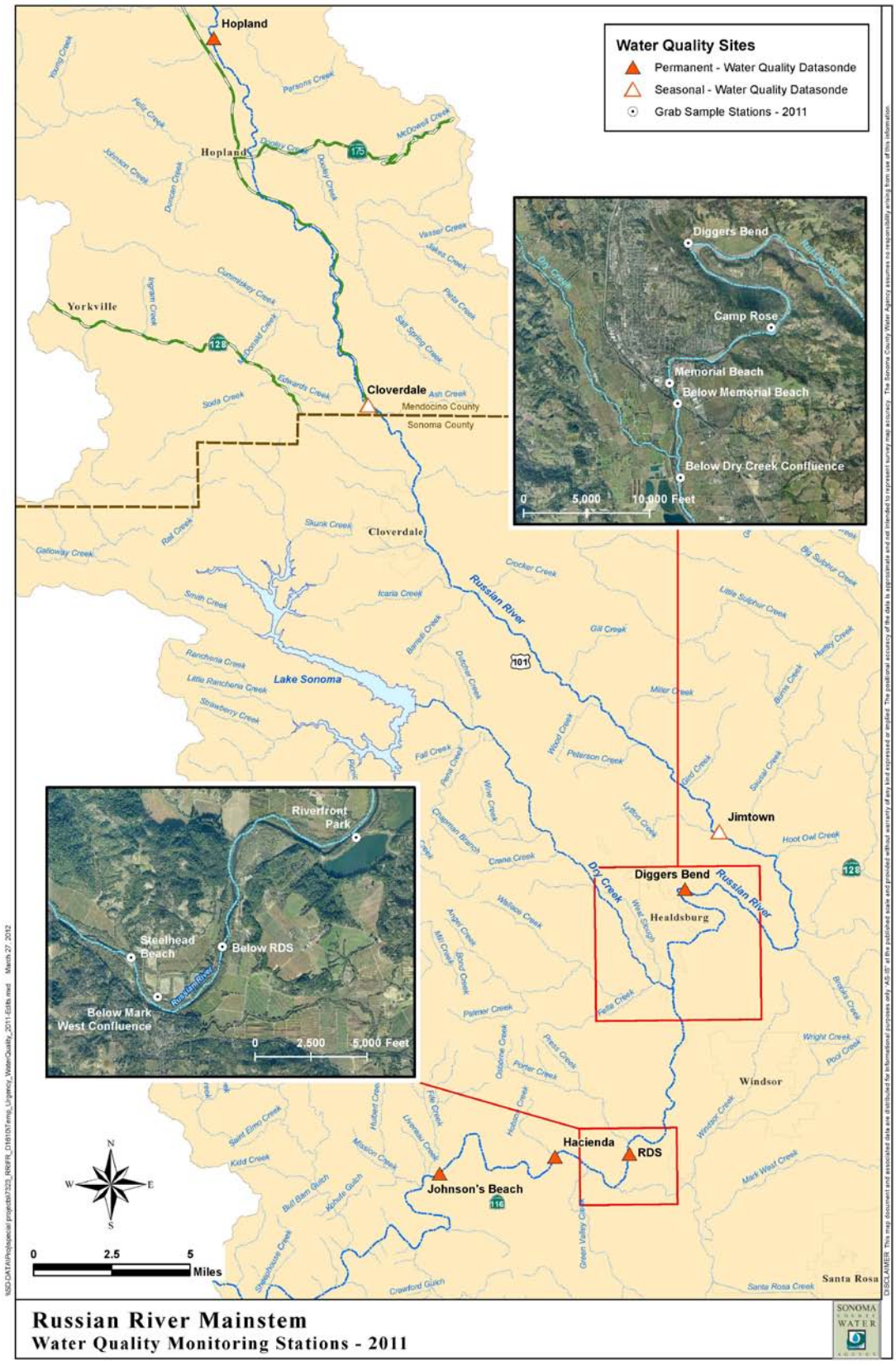

Figure 3-1. 2011 Water Agency Sample Site Locations

Bacteria analysis for the Water Agency was conducted by Alpha Laboratories in Ukiah, California. Total coliform was analyzed using multiple tube fermentation and Colilert to determine if there were significant differences between t he two methods. Fecal coliform and enterococci were analyzed by multiple tube fermentation and *e. coli* was analyzed by the Colilert method. Table 3-1 and Figures 3-3 through Figure 3-6 summarize the bacteria data collected during the term of the Order.

Based upon the CDPH guidance for fresh water beaches, Enterococcus exceedances varied throughout the term of the Order with exceedances being common at Steelhead Beach. Total coliform, fecal coliform and *e. coli* exceedances varied throughout the term of the Order but primarily at sites below the Dry Creek confluence. Total coliform results varied between multiple tube fermentation and colilert with no one analysis being dominate. Nutrient and algae results often exceeded the EPA criteria for Total Phosphorous and Total Nitrogen earlier in the season at most sites and then as the season progressed appear to concentrate below the Mark West confluence and at Steelhead Beach. See Tables 3-2 through 3-10.

Table 3-1. Bacteria concentrations for samples collected by the Water Agency. Highlighted values indicate those values exceeding the California Department of Public Health Draft Guidance for Fresh Water Beaches.

	Hacienda	Temperature	pH	Total Coliforms (multiple tube fermentation)	Total Coliforms (Colilert)	Fecal Coliform (multiple tube fermentation)	E. coli (Colilert)	Enterococci (multiple tube fermentation)
MDL**	Flow Rate			20	20	20	20	2.0
Date	(cfs)	°C	units	MPN/100mL	MPN/100mL	MPN/100mL	MPN/100mL	MPN/100mL
Digger's Bend*								
5/19/2011	940	15.0	7.76	1600	> 2400	240	93	- - - - -
6/2/2011	630	15.1	7.87	> 1600	1000	30	20	8.0
6/16/2011	415	19.4	7.76	170	1700	< 20	41	8.0
6/30/2011	363	19.7	7.86	500	1300	20	< 20	7.0
7/14/2011	212	21.1	7.65	260	1100	< 20	10	2.0
7/28/2011	166	21.7	7.90	210	3300	40	20	8.0
8/11/2011	126	20.7	7.27	330	1500	40	10	8.0
8/25/2011	122	21.4	7.58	1400	1800	< 20	10	23
9/8/2011	127	19.9	7.89	40	1500	< 20	10	26
9/22/2011	105	20.5	7.73	90	2100	< 20	< 20	33
10/6/2011	332	15.2	7.88	3500	2400	260	84	1600
Camp Rose*								
5/19/2011	940	16.5	7.75	1600	> 2400	130	100	46
6/2/2011	630	15.7	7.97	1600	1000	23	13	17
6/16/2011	415	20.2	7.96	220	130	20	31	80
6/30/2011	363	20.3	7.98	160	1300	20	< 20	7.0
7/14/2011	212	21.6	8.04	170	1200	20	20	4.0
7/28/2011	166	22.4	8.07	140	1800	< 20	10	2.0
8/11/2011	126	21.4	8.13	140	880	< 20	10	2.0
8/25/2011	122	21.6	7.95	260	1600	< 20	< 20	30
9/8/2011	127	20.6	7.90	170	1900	< 20	< 20	33
9/22/2011	105	20.7	7.82	170	1700	20	10	220
10/6/2011	332	16.0	7.94	9000	2200	400	63	500
CDPH Draft Guidance for Fresh Water Beaches - Single Sample Values:								
Beach posting is recommended when indicator organisms exceed any of the following levels:								
Total coliforms: 10,000 per 100 ml								
Fecal coliform: 400 per 100 ml								
Escherichia coli: 235 per 100 ml								
Enterococcus: 61 per 100 ml								
NCRWQCB Water Quality Standard for Water Contact Recreation (REC-1):								
Fecal Coliforms: Not more than ten percent of total samples during								
any 30-day period shall exceed 400/100mL								

Table 3-1 cont. Bacteria concentrations for samples collected by the Water Agency. Highlighted values indicate those values exceeding the California Department of Public Health Draft Guidance for Fresh Water Beaches.

	Hacienda	Temperature	pH	Total Coliforms (multiple tube fermentation)	Total Coliforms (Colilert)	Fecal Coliform (multiple tube fermentation)	E. coli (Colilert)	Enterococci (multiple tube fermentation)
MDL**	Flow Rate			20	20	20	20	2.0
Date	(cfs)	°C	units	MPN/100mL	MPN/100mL	MPN/100mL	MPN/100mL	MPN/100mL
Healdsburg Memorial Beach*								
5/19/2011	940	16.6	8.06	1600	> 2400	110	57	33
6/2/2011	630	15.8	8.05	> 1600	1000	17.0	30	4.0
6/16/2011	415	20.4	8.06	170	1400	40	110	11
6/30/2011	363	20.9	7.89	1700	1500	40	30	50
7/14/2011	212	23.7	8.13	500	1100	40	10	900
7/28/2011	166	25.0	8.35	160	930	36	10	130
8/11/2011	126	23.8	7.34	210	1900	70	10	8.0
8/25/2011	122	23.7	8.05	110	1800	< 20	31	24
9/8/2011	127	21.5	7.85	840	1700	310	52	27
9/22/2011	105	22.0	7.86	300	1800	230	52	140
10/6/2011	332	16.4	8.03	1400	2400	110	150	70
Below Healdsburg Memorial Beach and above Dry Creek Confluence*								
5/19/2011	940	16.7	8.04	1600	2400	240	61	21
6/2/2011	630	16.4	8.09	280	1000	2.0	13	12
6/16/2011	415	20.7	8.11	700	1100	80	< 20	54
6/30/2011	363	21.7	7.86	700	1200	110	30	17
7/14/2011	212	23.9	8.23	190	960	< 20	< 20	1600
7/28/2011	166	24.4	8.26	110	690	< 20	10	40
8/11/2011	126	23.8	8.13	440	2500	40	10	7.0
8/25/2011	122	24.2	8.21	1400	1400	< 20	10	4.0
9/8/2011	127	22.2	8.02	600	1900	20	10	21
9/22/2011	105	22.2	7.99	600	1700	< 20	10	27
10/6/2011	332	17.8	7.99	2800	3000	210	180	170
Below Dry Creek Confluence*								
5/19/2011	940	15.0	7.79	500	2000	23	28	8.0
6/2/2011	630	16.8	7.89	> 1600	1000	30	17	120
6/16/2011	415	20.3	8.17	930	1700	< 20	< 20	70
6/30/2011	363	19.7	7.91	2200	1500	40	20	30
7/14/2011	212	22.0	8.11	300	640	80	10	32
7/28/2011	166	21.1	8.15	> 16000	8300	210	10	22
8/11/2011	126	21.2	7.70	700	1700	70	20	130
8/25/2011	122	22.1	8.11	1200	1400	20	20	140
9/8/2011	127	21.9	8.36	900	1200	70	41	48
9/22/2011	105	20.2	7.95	1400	1200	70	52	40
10/6/2011	332	16.1	7.80	2400	16000	300	310	220
Riverfront Park*								
5/19/2011	940	14.6	7.39	> 1600	2000	21	24	140
6/2/2011	630	14.7	8.19	> 1600	>2400	50	26	14
6/16/2011	415	19.5	7.96	1100	2400	40	41	21
6/30/2011	363	18.5	7.89	840	1600	70	52	13
7/14/2011	212	18.9	7.75	300	980	70	10	17
7/28/2011	166	19.7	7.74	330	2900	40	30	4.0
8/11/2011	126	19.0	7.70	380	2100	40	10	50
8/25/2011	122	19.8	7.67	1100	1700	20	31	220
9/8/2011	127	18.1	7.69	900	980	40	10	220
9/22/2011	105	19.0	7.67	800	3300	40	< 20	300
10/6/2011	332	15.1	7.70	2800	1700	170	41	900
CDPH Draft Guidance for Fresh Water Beaches - Single Sample Values:								
Beach posting is recommended when indicator organisms exceed any of the following levels:								
Total coliforms: 10,000 per 100 ml								
Fecal coliform: 400 per 100 ml								
Escherichia coli: 235 per 100 ml								
Enterococcus: 61 per 100 ml								
NCRWQCB Water Quality Standard for Water Contact Recreation (REC-1):								
Fecal Coliforms: Not more than ten percent of total samples during								
any 30-day period shall exceed 400/100mL								

Table 3-1 cont. Bacteria concentrations for samples collected by the Water Agency. Highlighted values indicate those values exceeding the California Department of Public Health Draft Guidance for Fresh Water Beaches.

	Hacienda	Temperature	pH	Total Coliforms (multiple tube fermentation)	Total Coliforms (Colilert)	Fecal Coliform (multiple tube fermentation)	E. coli (Colilert)	Enterococci (multiple tube fermentation)
MDL**	Flow Rate			20	20	20	20	2.0
Date	(cfs)	°C	units	MPN/100mL	MPN/100mL	MPN/100mL	MPN/100mL	MPN/100mL
Below RDS above Mark West Confluence*								
5/19/2011	940	15.8	7.08	1600	> 2400	30	12	1600
6/2/2011	630	15.0	8.19	> 1600	1700	17	14	11
6/16/2011	415	21.1	8.10	500	1000	130	10	17
6/30/2011	363	19.0	7.96	400	1300	80	10	22
7/14/2011	212	21.0	7.86	3000	1400	40	20	11
7/28/2011	166	21.9	7.89	110	1400	20	< 20	80
8/11/2011	126	21.6	8.18	950	1000	40	< 20	23
8/25/2011	122	21.9	8.29	500	770	< 20	10	500
9/8/2011	127	20.3	8.13	600	830	40	10	26
9/22/2011	105	19.9	7.96	170	460	< 20	< 20	130
10/6/2011	332	15.7	7.94	> 16000	1900	540	72	280
Below Mark West Creek Confluence*								
5/19/2011	940	16.3	7.60	> 1600	2400	110	31	50
6/2/2011	630	15.1	8.16	> 1600	1000	30	28	13
6/16/2011	415	21.6	8.05	160	< 20	< 20	< 20	17
6/30/2011	363	19.3	7.97	> 16000	2600	220	74	17
7/14/2011	212	21.4	7.97	170	910	< 20	< 20	14
7/28/2011	166	23.6	8.25	300	1300	20	< 20	34
8/11/2011	126	21.6	8.29	460	880	40	< 20	13
8/25/2011	122	21.8	8.39	90	1000	20	10	70
9/8/2011	127	20.2	8.21	80	1200	< 20	< 20	60
9/22/2011	105	19.8	8.00	80	1000	40	10	170
10/6/2011	332	15.9	7.80	> 16000	9600	16000	820	> 1600
Steelhead Beach*								
5/19/2011	940	15.6	8.26	> 1600	2000	70	88	500
6/2/2011	630	15.1	8.19	1600	1000	170	38	50
6/16/2011	415	22.3	8.11	260	1000	40	31	130
6/30/2011	363	19.6	7.94	> 16000	3800	130	97	30
7/14/2011	212	21.8	8.01	300	990	20	< 20	22
7/28/2011	166	22.8	8.45	330	1300	< 20	< 20	240
8/11/2011	126	21.8	8.21	120	810	60	20	500
8/25/2011	122	22.0	8.39	520	830	70	< 20	300
9/8/2011	127	20.0	7.74	700	1100	500	41	170
9/22/2011	105	20.2	8.02	260	860	70	10	110
10/6/2011	332	16.1	7.82	> 16000	9600	> 16000	1000	> 1600
Steelhead Beach Duplicate Sample*								
5/19/2011	940	15.6	8.26	> 1600	2400	110	84	79
6/2/2011	630	15.1	8.19	> 1600	1000	50	31	220
6/16/2011	415	22.3	8.11	840	1000	170	20	27
6/30/2011	363	19.6	7.94	> 16000	4000	300	63	8.0
7/14/2011	212	21.8	8.01	81	990	40	20	40
7/28/2011	166	22.8	8.45	700	960	40	< 20	22
8/11/2011	126	21.8	8.21	430	1000	230	< 20	80
8/25/2011	122	22.0	8.39	700	700	20	< 20	80
9/8/2011	127	20.0	7.74	700	1000	500	41	900
9/22/2011	105	20.2	8.02	500	800	70	< 20	170
10/6/2011	332	16.1	7.82	> 16000	10000	> 16000	990	> 1600
CDPH Draft Guidance for Fresh Water Beaches - Single Sample Values:								
Beach posting is recommended when indicator organisms exceed any of the following levels:								
Total coliforms: 10,000 per 100 ml								
Fecal coliform: 400 per 100 ml								
Escherichia coli: 235 per 100 ml								
Enterococcus: 61 per 100 ml								
NCRWQCB Water Quality Standard for Water Contact Recreation (REC-1):								
Fecal Coliforms: Not more than ten percent of total samples during								
any 30-day period shall exceed 400/100mL								

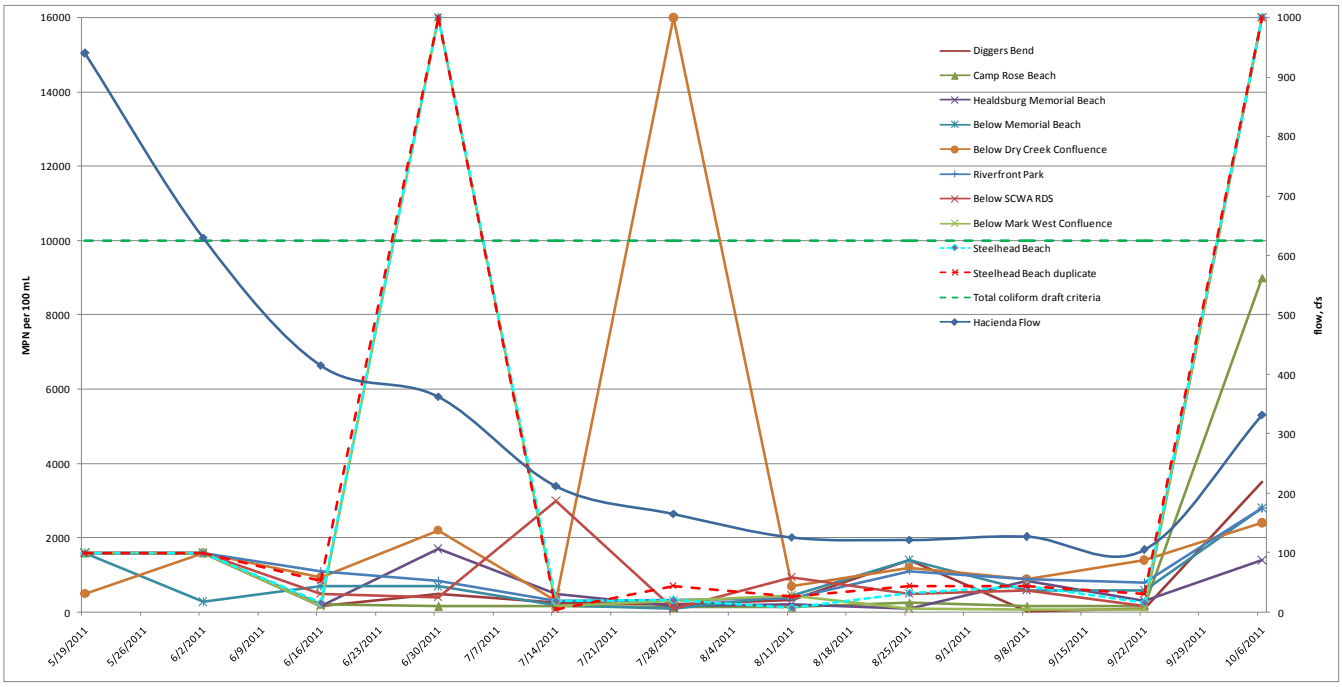

Figure 3-2. Water Agency Bacteria Sample Results for Total Coliform by Multiple Tube Fermentation

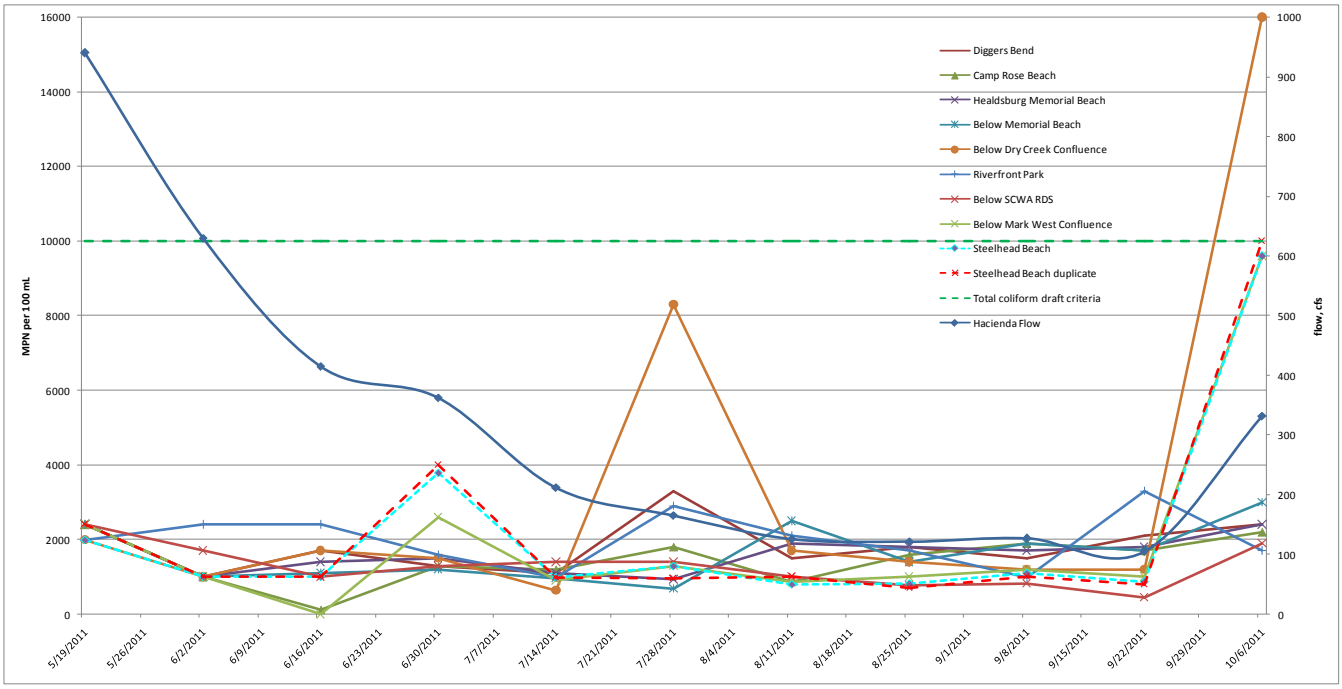

Figure 3-3. Water Agency Bacteria Sample Results for Total Coliform by Colilert Method

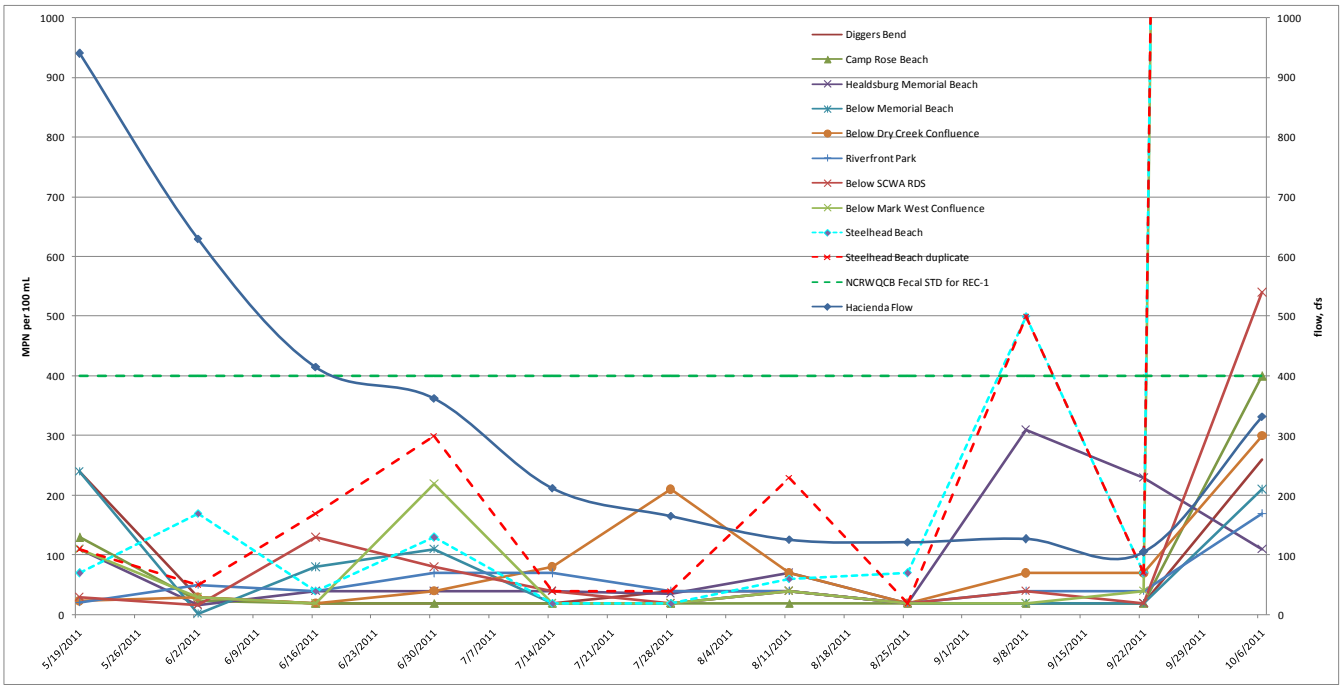

Figure 3-4. Water Agency Bacteria Sample Results for Fecal coliform by Multiple Tube Fermentation

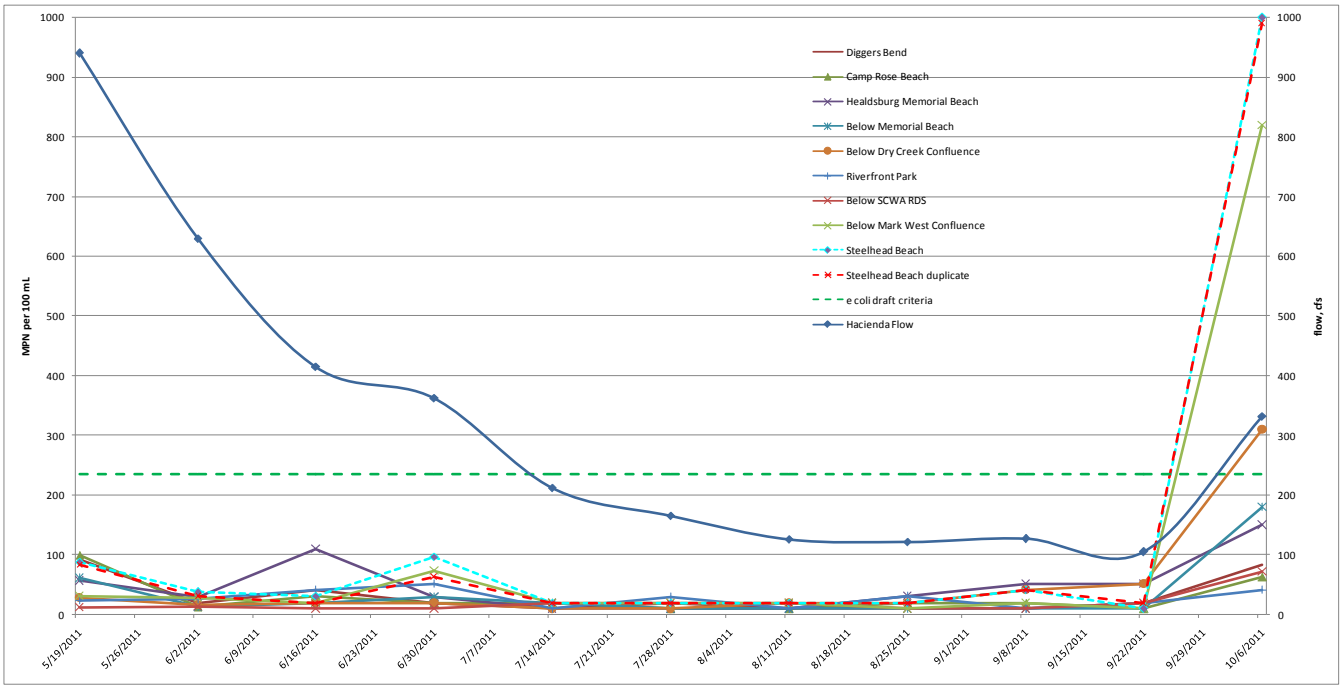

Figure 3-5. Water Agency Bacteria Sample Results for *e. coli* by Colilert Method

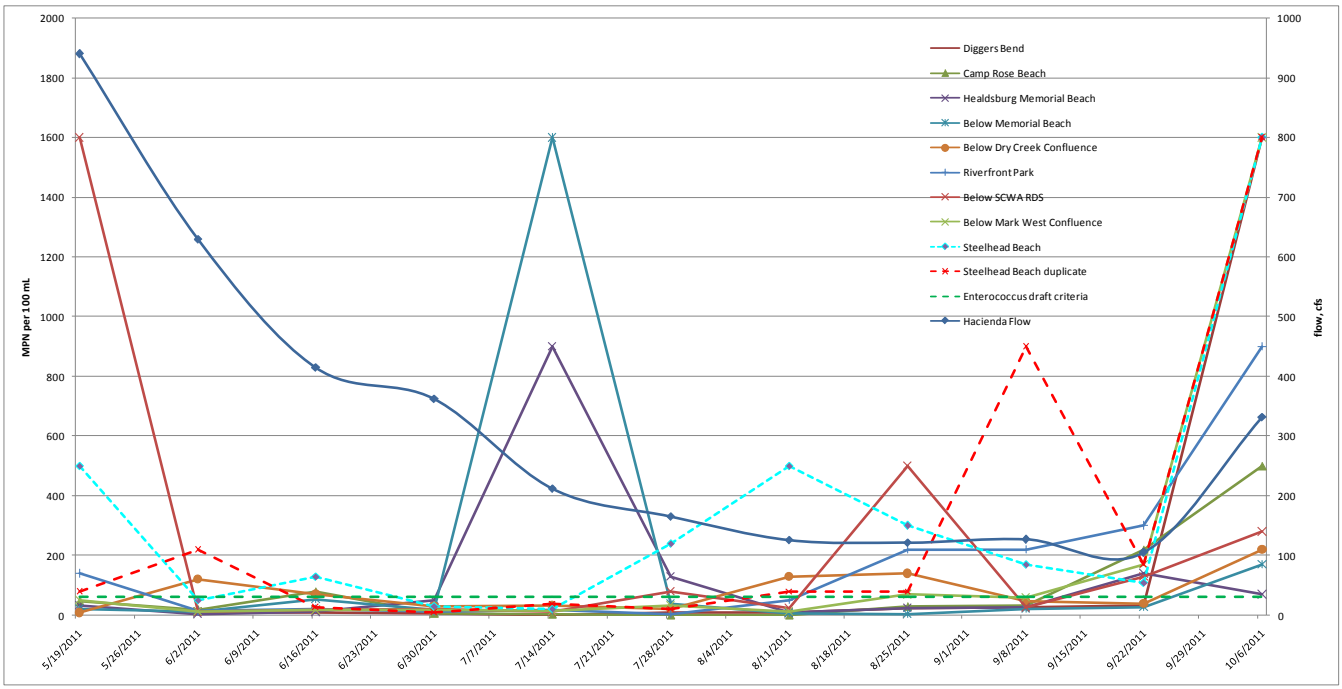

Figure 3-6. Water Agency Bacteria Sample Results for Enterococcus by Multiple Tube Fermentation

Table 3-2. 2011 Water Agency Nutrient Sample Results for Diggers Bend. Highlighted values indicate those values exceeding the recommended EPA criteria based on Aggregate Ecoregion III.

Digger's Bend*	Hacienda	Temperature	pH	Total Kjeldahl Nitrogen	Total Nitrogen	Total Organic Nitrogen	Ammonia as N	Ammonia as N Unionized	Total Dissolved Solids	Nitrate as N	Nitrite as N	Dissolved Organic Carbon	Total Organic Carbon	Total Orthophosphate	Phosphorus, Total	Chlorophyll-a
MDL**	Flow Rate			0.10		0.200	0.10	0.00010		.050	0.010	0.0400	0.0400	0.020	0.020	0.000050
Date	cfs	°C	units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
5/19/2011	940	15.0	7.76	0.24	0.55	0.245	< 0.10	< 0.00010	150	0.3	< 0.010	1.09	1.37	0.029	0.025	0.0031
6/2/2011	630	15.1	7.87	0.18	0.33	< 0.200	< 0.10	0.00067	160	0.16	< 0.010	1.17	1.47	0.038	0.030	0.0011
6/16/2011	415	19.4	7.76	0.24	0.35	< 0.200	< 0.10	0.0014	150	0.11	< 0.010	1.01	1.27	0.068	0.024	0.0014
6/30/2011	363	19.7	7.86	0.32	0.60	0.280	< 0.10	0.00094	180	0.28	< 0.010	1.07	1.44	0.056	0.040	0.00095
7/14/2011	212	21.1	7.65	0.24	0.41	0.210	< 0.10	0.00063	170	0.16	< 0.010	0.777	1.15	< 0.020	< 0.020	0.0017
7/28/2011	166	21.7	7.90	0.14	0.26	< 0.200	< 0.10	< 0.00010	180	0.12	< 0.010	1.10	1.55	0.036	< 0.020	0.00085
8/11/2011	126	20.7	7.27	0.32	0.43	0.245	< 0.10	0.00053	170	0.12	< 0.010	1.26	1.84	< 0.020	< 0.020	0.00039
8/25/2011	122	21.4	7.58	0.18	0.29	< 0.200	< 0.10	0.00056	150	0.12	< 0.010	1.29	1.80	< 0.020	< 0.020	0.00041
9/8/2011	127	19.9	7.89	0.18	0.29	< 0.200	< 0.10	0.0020	160	0.12	< 0.010	1.31	1.76	0.020	< 0.020	0.00065
9/22/2011	105	20.5	7.73	0.21	0.33	< 0.200	< 0.10	0.00030	150	0.12	< 0.010	1.28	1.83	0.033	< 0.020	0.00036
10/6/2011	332	15.2	7.88	0.24	0.39	0.245	< 0.10	< 0.00010	130	0.14	< 0.010	1.69	2.22	0.049	0.021	0.00078
* results are preliminary and subject to final revision.																
** Method Detection Limit																
Recommended EPA Criteria based on Aggregate Ecoregion III:																
Total Phosporus: 0.02188 mg/L (21.88 ug/L)																
Total Nitrogen: 0.38 mg/L																
Chlorophyll *a*: 0.00178 mg/L (1.78 ug/L)																

Table 3-3. 2011 Water Agency Nutrient Sample Results for Camp Rose. Highlighted values indicate those values exceeding the recommended EPA criteria based on Aggregate Ecoregion III.

Camp Rose*	Hacienda	Temperature	pH	Total Kjeldahl Nitrogen	Total Nitrogen	Total Organic Nitrogen	Ammonia as N	Ammonia as N Unionized	Total Dissolved Solids	Nitrate as N	Nitrite as N	Dissolved Organic Carbon	Total Organic Carbon	Total Orthophosphate	Phosphorus, Total	Chlorophyll-a
MDL**	Flow Rate			0.10		0.200	0.10	0.00010		.050	0.010	0.0400	0.0400	0.020	0.020	0.000050
Date	cfs	°C	units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
5/19/2011	940	16.5	7.75	0.24	0.54	0.245	< 0.10	< 0.00010	140	0.29	< 0.010	1.11	1.35	0.025	0.022	0.0030
6/2/2011	630	15.7	7.97	0.18	0.32	< 0.200	< 0.10	0.0018	140	0.15	< 0.010	1.18	1.42	0.038	0.028	0.0014
6/16/2011	415	20.2	7.96	0.21	0.22	< 0.200	< 0.10	0.0023	160	0.10	< 0.010	0.996	1.30	0.049	0.026	0.0011
6/30/2011	363	20.3	7.98	0.24	0.52	< 0.200	0.14	0.0049	170	0.28	< 0.010	1.09	1.38	0.036	0.042	0.00095
7/14/2011	212	21.6	8.04	0.24	0.40	0.210	< 0.10	0.0016	170	0.15	< 0.010	0.834	1.11	< 0.020	< 0.020	0.0013
7/28/2011	166	22.4	8.07	0.14	0.26	< 0.200	< 0.10	< 0.00010	150	0.12	< 0.010	1.28	1.46	< 0.020	< 0.020	0.00064
8/11/2011	126	21.4	8.13	0.18	0.29	< 0.200	< 0.10	0.0018	170	0.12	< 0.010	1.31	1.79	< 0.020	< 0.020	0.00019
8/25/2011	122	21.6	7.95	0.10	0.22	< 0.200	< 0.10	0.0028	150	0.12	< 0.010	1.34	1.69	< 0.020	< 0.020	0.00041
9/8/2011	127	20.6	7.90	0.18	0.29	< 0.200	< 0.10	< 0.00010	200	0.12	< 0.010	1.31	1.72	< 0.020	< 0.020	0.00037
9/22/2011	105	20.7	7.82	0.24	0.36	< 0.200	< 0.10	0.0018	150	0.12	< 0.010	1.27	1.75	< 0.020	< 0.020	0.00060
10/6/2011	332	16.0	7.94	0.18	0.30	< 0.200	< 0.10	0.0016	130	0.13	< 0.010	2.00	2.18	0.029	< 0.020	0.00029

* results are preliminary and subject to final revision.
** Method Detection Limit

Recommended EPA Criteria based on Aggregate Ecoregion III:
Total Phosporus: 0.02188 mg/L (21.88 ug/L)
Total Nitrogen: 0.38 mg/L
Chlorophyll *a* : 0.00178 mg/L (1.78 ug/L)

Table 3-4. 2011 Water Agency Nutrient Sample Results for Memorial Beach. Highlighted values indicate those values exceeding the recommended EPA criteria based on Aggregate Ecoregion III.

Memorial Beach*	Hacienda	Temperature	pH	Total Kjeldahl Nitrogen	Total Nitrogen	Total Organic Nitrogen	Ammonia as N	Ammonia as N Unionized	Total Dissolved Solids	Nitrate as N	Nitrite as N	Dissolved Organic Carbon	Total Organic Carbon	Total Orthophosphate	Phosphorus, Total	Chlorophyll-a
MDL**	Flow Rate			0.10		0.200	0.10	0.00010		.050	0.010	0.0400	0.0400	0.020	0.020	0.000050
Date	cfs	°C	units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
5/19/2011	940	16.6	8.06	0.24	0.52	0.245	< 0.10	< 0.00010	130	0.27	< 0.010	1.10	1.36	< 0.020	0.020	0.0017
6/2/2011	630	15.8	8.05	0.18	0.33	< 0.200	0.14	0.0043	150	0.16	< 0.010	1.13	1.38	0.042	0.030	0.0015
6/16/2011	415	20.4	8.06	0.24	0.38	0.245	< 0.10	< 0.00010	160	0.14	< 0.010	1.03	1.27	0.045	0.022	0.00079
6/30/2011	363	20.9	7.89	0.24	0.50	< 0.200	< 0.10	0.0022	170	0.26	< 0.010	1.11	1.43	0.056	0.030	0.00038
7/14/2011	212	23.7	8.13	0.21	0.33	< 0.200	< 0.10	0.0022	180	0.12	< 0.010	1.02	1.45	< 0.020	< 0.020	0.0024
7/28/2011	166	25.0	8.35	0.21	0.21	< 0.200	< 0.10	0.0076	170	< .050	< 0.010	1.33	1.74	< 0.020	< 0.020	0.00032
8/11/2011	126	23.8	7.34	0.21	0.21	< 0.200	< 0.10	0.00038	180	< .050	< 0.010	1.40	1.93	< 0.020	< 0.020	0.00019
8/25/2011	122	23.7	8.05	0.18	0.29	< 0.200	< 0.10	0.0020	160	0.12	< 0.010	1.26	1.62	< 0.020	< 0.020	0.0013
9/8/2011	127	21.5	7.85	0.18	0.29	< 0.200	< 0.10	0.0011	160	0.12	< 0.010	1.23	1.60	0.020	0.021	0.00084
9/22/2011	105	22.0	7.86	0.18	0.18	< 0.200	< 0.10	0.0011	150	< .050	< 0.010	1.23	1.63	0.021	< 0.020	0.00048
10/6/2011	332	16.4	8.03	0.21	0.33	< 0.200	0.14	0.0040	150	0.12	< 0.010	1.69	1.91	0.029	< 0.020	0.00020

* results are preliminary and subject to final revision.
** Method Detection Limit

Recommended EPA Criteria based on Aggregate Ecoregion III:
Total Phosporus: 0.02188 mg/L (21.88 ug/L)
Total Nitrogen: 0.38 mg/L
Chlorophyll *a* : 0.00178 mg/L (1.78 ug/L)

Table 3-5. 2011 Water Agency Nutrient Sample Results for Below Healdsburg Dam. Highlighted values indicate those values exceeding the recommended EPA criteria based on Aggregate Ecoregion III.

Below Healdsburg Dam*	Hacienda	Temperature	pH	Total Kjeldahl Nitrogen	Total Nitrogen	Total Organic Nitrogen	Ammonia as N	Ammonia as N Unionized	Total Dissolved Solids	Nitrate as N	Nitrite as N	Dissolved Organic Carbon	Total Organic Carbon	Total Orthophosphate	Phosphorus, Total	Chlorophyll-a
MDL**	Flow Rate			0.10		0.200	0.10	0.00010		.050	0.010	0.0400	0.0400	0.020	0.020	0.000050
Date	cfs	°C	units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
5/19/2011	940	16.7	8.04	0.24	0.51	0.210	< 0.10	0.0011	160	0.27	< 0.010	1.14	1.37	0.029	0.024	0.0023
6/2/2011	630	16.4	8.09	0.18	0.33	< 0.200	0.10	0.0035	160	0.15	< 0.010	1.12	1.40	0.049	0.036	0.00079
6/16/2011	415	20.7	8.11	0.21	0.32	< 0.200	< 0.10	0.0018	160	0.11	< 0.010	1.02	1.25	0.056	0.031	0.00045
6/30/2011	363	21.7	7.86	0.29	0.55	< 0.200	0.10	0.0034	170	0.26	< 0.010	1.09	1.49	0.048	0.024	0.00066
7/14/2011	212	23.9	8.23	0.21	0.34	< 0.200	< 0.10	0.0028	180	0.13	< 0.010	0.945	1.33	< 0.020	< 0.020	0.00078
7/28/2011	166	24.4	8.26	0.21	0.21	< 0.200	< 0.10	0.0059	160	< .05	< 0.010	1.32	1.67	< 0.020	< 0.020	0.00032
8/11/2011	126	23.8	8.13	0.18	0.29	< 0.200	< 0.10	< 0.00010	170	0.12	< 0.010	1.31	1.81	< 0.020	< 0.020	0.00058
8/25/2011	122	24.2	8.21	0.18	0.18	< 0.200	< 0.10	0.0055	150	< .05	< 0.010	1.27	1.60	< 0.020	< 0.020	0.00020
9/8/2011	127	22.2	8.02	0.14	0.26	< 0.200	< 0.10	0.0031	180	0.12	< 0.010	1.27	1.59	0.027	< 0.020	0.0010
9/22/2011	105	22.2	7.99	0.14	0.26	< 0.200	< 0.10	0.0029	160	0.12	< 0.010	1.25	1.67	< 0.020	< 0.020	0.00024
10/6/2011	332	17.8	7.99	0.14	0.26	< 0.200	< 0.10	0.0011	130	0.12	< 0.010	1.55	1.87	0.025	< 0.020	0.00058

* results are preliminary and subject to final revision.

** Method Detection Limit

Recommended EPA Criteria based on Aggregate Ecoregion III:

Total Phosporus: 0.02188 mg/L (21.88 ug/L)

Total Nitrogen: 0.38 mg/L

Chlorophyll *a*: 0.00178 mg/L (1.78 ug/L)

Table 3-6. 2011 Water Agency Nutrient Sample Results for Below Dry Creek Confluence. Highlighted values indicate those values exceeding the recommended EPA criteria based on Aggregate Ecoregion III.

Below Dry Creek Conf.*	Hacienda	Temperature	pH	Total Kjeldahl Nitrogen	Total Nitrogen	Total Organic Nitrogen	Ammonia as N	Ammonia as N Unionized	Total Dissolved Solids	Nitrate as N	Nitrite as N	Dissolved Organic Carbon	Total Organic Carbon	Total Orthophosphate	Phosphorus, Total	Chlorophyll-a
MDL**	Flow Rate			0.10		0.200	0.10	0.00010		.050	0.010	0.0400	0.0400	0.020	0.020	0.000050
Date	cfs	°C	units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
5/19/2011	940	15.0	7.79	0.32	0.49	0.315	< 0.10	< 0.00010	120	0.17	< 0.010	1.47	1.80	0.040	< 0.020	0.0039
6/2/2011	630	16.8	7.89	0.18	0.28	< 0.200	< 0.10	0.00016	130	0.10	< 0.010	1.08	1.38	< 0.020	0.026	0.00049
6/16/2011	415	20.3	8.17	0.24	0.30	< 0.200	< 0.10	0.0037	110	0.051	< 0.010	1.08	1.35	0.033	0.026	0.00091
6/30/2011	363	19.7	7.91	0.21	0.42	< 0.200	0.10	0.0032	140	0.21	< 0.010	1.08	1.55	0.036	0.026	0.0017
7/14/2011	212	22.0	8.11	0.21	0.36	< 0.200	< 0.10	0.0019	140	0.15	< 0.010	0.938	1.29	< 0.020	0.030	0.00059
7/28/2011	166	21.1	8.15	0.21	0.33	0.210	< 0.10	< 0.00010	160	0.12	< 0.010	1.19	1.51	0.13	< 0.020	0.0014
8/11/2011	126	21.2	7.70	0.14	0.26	< 0.200	< 0.10	0.00070	120	0.12	< 0.010	1.15	1.59	< 0.020	< 0.020	0.0020
8/25/2011	122	22.1	8.11	0.18	0.31	< 0.200	0.14	0.0079	120	0.13	< 0.010	1.16	1.49	< 0.020	< 0.020	0.00030
9/8/2011	127	21.9	8.36	0.28	0.41	0.280	< 0.10	< 0.00010	130	0.13	< 0.010	1.21	1.52	0.023	< 0.020	0.00084
9/22/2011	105	20.2	7.95	0.18	0.31	< 0.200	< 0.10	0.0011	120	0.14	< 0.010	1.18	1.58	0.033	< 0.020	0.00072
10/6/2011	332	16.1	7.80	0.21	0.35	< 0.200	0.10	0.0018	110	0.14	< 0.010	1.51	1.83	0.065	< 0.020	0.00029

* results are preliminary and subject to final revision.

** Method Detection Limit

Recommended EPA Criteria based on Aggregate Ecoregion III:

Total Phosporus: 0.02188 mg/L (21.88 ug/L)

Total Nitrogen: 0.38 mg/L

Chlorophyll *a*: 0.00178 mg/L (1.78 ug/L)

Table 3-7. 2011 Water Agency Nutrient Sample Results for Riverfront Park. Highlighted values indicate those values exceeding the recommended EPA criteria based on Aggregate Ecoregion III.

Riverfront Park*	Hacienda	Temperature	pH	Total Kjeldahl Nitrogen	Total Nitrogen	Total Organic Nitrogen	Ammonia as N	Ammonia as N Unionized	Total Dissolved Solids	Nitrate as N	Nitrite as N	Dissolved Organic Carbon	Total Organic Carbon	Total Orthophosphate	Phosphorus, Total	Chlorophyll-a
MDL**	Flow Rate					0.200	0.10	0.00010		.050	0.010	0.0400	0.0400	0.020	0.020	0.000050
Date	cfs	°C	units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
5/19/2011	940	14.6	7.39	0.21	0.46	0.210	< 0.10	< 0.00010	150	0.24	< 0.010	1.11	1.43	0.025	0.028	0.0025
6/2/2011	630	14.7	8.19	0.18	0.31	< 0.200	< 0.10	< 0.00010	140	0.14	< 0.010	1.08	1.43	0.026	0.020	0.00088
6/16/2011	415	19.5	7.96	0.21	0.30	< 0.200	< 0.10	0.0023	130	0.093	< 0.010	0.980	1.50	0.033	< 0.020	0.0012
6/30/2011	363	18.5	7.89	0.32	0.56	0.245	< 0.10	0.0019	160	0.24	< 0.010	1.03	1.34	0.032	0.029	0.00095
7/14/2011	212	18.9	7.75	0.18	0.33	< 0.200	< 0.10	0.00068	160	0.16	< 0.010	0.798	1.15	0.023	0.021	0.0014
7/28/2011	166	19.7	7.74	0.21	0.33	< 0.200	< 0.10	0.0014	160	0.12	< 0.010	1.07	1.48	< 0.020	< 0.020	0.00085
8/11/2011	126	19.0	7.70	0.21	0.33	< 0.200	0.10	0.0018	150	0.12	< 0.010	1.05	1.54	0.028	< 0.020	0.00068
8/25/2011	122	19.8	7.67	0.18	0.29	< 0.200	0.10	0.0019	130	0.12	< 0.010	1.02	1.53	< 0.020	0.020	0.00081
9/8/2011	127	18.1	7.69	0.18	0.30	< 0.200	< 0.10	0.0011	140	0.12	< 0.010	1.16	1.53	0.027	< 0.020	0.00093
9/22/2011	105	19.0	7.67	0.18	0.31	< 0.200	< 0.10	< 0.00010	150	0.13	< 0.010	1.08	1.62	0.029	< 0.020	0.00072
10/6/2011	332	15.1	7.70	0.18	0.31	< 0.200	0.10	0.0014	140	0.14	< 0.010	1.32	1.67	0.037	0.020	0.00039

* results are preliminary and subject to final revision.
** Method Detection Limit

Recommended EPA Criteria based on Aggregate Ecoregion III:
Total Phosporus: 0.02188 mg/L (21.88 ug/L)
Total Nitrogen: 0.38 mg/L
Chlorophyll *a*: 0.00178 mg/L (1.78 ug/L)

Table 3-8. 2011 Water Agency Nutrient Sample Results for Below Water Agency RDS. Highlighted values indicate those values exceeding the recommended EPA criteria based on Aggregate Ecoregion III.

Below RDS*	Hacienda	Temperature	pH	Total Kjeldahl Nitrogen	Total Nitrogen	Total Organic Nitrogen	Ammonia as N	Ammonia as N Unionized	Total Dissolved Solids	Nitrate as N	Nitrite as N	Dissolved Organic Carbon	Total Organic Carbon	Total Orthophosphate	Phosphorus, Total	Chlorophyll-a
MDL**	Flow Rate			0.10		0.200	0.10	0.00010		.050	0.010	0.0400	0.0400	0.020	0.020	0.000050
Date	cfs	°C	units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
5/19/2011	940	15.8	7.08	0.28	0.51	0.280	< 0.10	< 0.00010	140	0.23	< 0.010	1.15	1.41	0.040	<0.020	0.0027
6/2/2011	630	15.0	8.19	0.18	0.34	< 0.200	< 0.10	< 0.00010	150	0.16	< 0.010	1.15	1.40	0.038	0.071	0.0015
6/16/2011	415	21.1	8.10	0.24	0.33	0.210	< 0.10	0.0017	140	0.089	< 0.010	1.01	1.32	0.041	0.023	0.00091
6/30/2011	363	19.0	7.96	0.38	0.62	0.245	0.14	0.0044	170	0.23	< 0.010	1.11	1.35	0.067	0.024	0.00066
7/14/2011	212	21.0	7.86	0.35	0.48	0.315	< 0.10	0.0010	150	0.13	< 0.010	1.18	1.16	<0.020	<0.020	0.0012
7/28/2011	166	21.9	7.89	0.21	0.33	0.210	< 0.10	< 0.00010	180	0.12	< 0.010	1.12	1.50	0.025	<0.020	0.00042
8/11/2011	126	21.6	8.18	0.18	0.18	< 0.200	< 0.10	0.00060	160	< 0.050	< 0.010	1.10	1.77	<0.020	<0.020	0.00058
8/25/2011	122	21.9	8.29	0.18	0.29	< 0.200	< 0.10	0.0058	130	0.12	< 0.010	1.33	1.52	<0.020	<0.020	0.00030
9/8/2011	127	20.3	8.13	0.21	0.33	< 0.200	0.10	0.0051	150	0.12	< 0.010	1.19	1.54	0.023	<0.020	0.00047
9/22/2011	105	19.9	7.96	0.10	0.22	< 0.200	0.14	0.0047	140	0.12	< 0.010	1.33	1.57	<0.020	<0.020	0.00036
10/6/2011	332	15.7	7.94	0.42	0.55	0.315	0.10	0.0025	130	0.13	< 0.010	1.29	1.74	0.033	<0.020	<0.000050

* results are preliminary and subject to final revision.
** Method Detection Limit

Recommended EPA Criteria based on Aggregate Ecoregion III:
Total Phosporus: 0.02188 mg/L (21.88 ug/L)
Total Nitrogen: 0.38 mg/L
Chlorophyll *a*: 0.00178 mg/L (1.78 ug/L)

Table 3-9. 2011 Water Agency Nutrient Sample Results for Below Mark West Creek Confluence. Highlighted values indicate those values exceeding the recommended EPA criteria based on Aggregate Ecoregion III.

Below Mark West Confl.*	Hacienda	Temperature	pH	Total Kjeldahl Nitrogen	Total Nitrogen	Total Organic Nitrogen	Ammonia as N	Ammonia as N Unionized	Total Dissolved Solids	Nitrate as N	Nitrite as N	Dissolved Organic Carbon	Total Organic Carbon	Total Orthophosphate	Phosphorus, Total	Chlorophyll-a
MDL**	Flow Rate					0.200	0.10	0.00010		.050	0.010	0.0400	0.0400	0.020	0.020	0.000050
Date	cfs	°C	units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
5/19/2011	940	16.3	7.60	0.49	0.72	0.490	< 0.10	< 0.00010	140	0.23	< 0.010	1.15	1.46	0.095	0.021	0.0027
6/2/2011	630	15.1	8.16	0.21	0.36	0.210	< 0.10	< 0.00010	140	0.15	< 0.010	1.19	1.43	0.049	0.035	0.0011
6/16/2011	415	21.6	8.05	0.18	0.28	< 0.200	< 0.10	0.012	150	0.10	< 0.010	1.23	1.58	0.11	0.046	.00091
6/30/2011	363	19.3	7.97	0.35	0.58	0.245	0.10	0.0034	150	0.23	< 0.010	1.53	2.00	0.18	0.060	0.00095
7/14/2011	212	21.4	7.97	0.28	0.43	0.245	< 0.10	0.0013	170	0.15	< 0.010	1.10	1.60	0.10	0.052	0.0017
7/28/2011	166	23.6	8.25	0.18	0.29	< 0.200	< 0.10	0.0029	180	0.12	< 0.010	1.42	1.78	0.082	0.041	0.0012
8/11/2011	126	21.6	8.29	0.24	0.36	0.210	< 0.10	0.0034	150	0.12	< 0.010	1.34	1.68	0.050	0.025	0.0016
8/25/2011	122	21.8	8.39	0.18	0.29	< 0.200	< 0.10	0.0071	110	0.12	< 0.010	1.23	1.67	< 0.020	0.029	0.00051
9/8/2011	127	20.2	8.21	0.18	0.29	< 0.200	0.10	0.0061	160	0.12	< 0.010	1.28	1.58	0.035	< 0.020	0.00047
9/22/2011	105	19.8	8.00	0.14	0.14	< 0.200	< 0.10	0.0013	140	< 0.050	< 0.010	1.19	1.56	0.037	< 0.020	0.00036
10/6/2011	332	15.9	7.80	0.42	0.58	0.210	0.21	0.0036	150	0.16	< 0.010	2.17	2.79	0.15	0.067	0.00058

* results are preliminary and subject to final revision.
** Method Detection Limit

Recommended EPA Criteria based on Aggregate Ecoregion III:
Total Phosporus: 0.02188 mg/L (21.88 ug/L)
Total Nitrogen: 0.38 mg/L
Chlorophyll *a*: 0.00178 mg/L (1.78 ug/L)

Table 3-10. 2011 Water Agency Nutrient Sample Results for Steelhead Beach. Highlighted values indicate those values exceeding the recommended EPA criteria based on Aggregate Ecoregion III.

Steelhead Beach*	Hacienda	Temperature	pH	Total Kjeldahl Nitrogen	Total Nitrogen	Total Organic Nitrogen	Ammonia as N	Ammonia as N Unionized	Total Dissolved Solids	Nitrate as N	Nitrite as N	Dissolved Organic Carbon	Total Organic Carbon	Total Orthophosphate	Phosphorus, Total	Chlorophyll-a
MDL**	Flow Rate			0.10		0.200	0.10	0.00010		.050	0.010	0.0400	0.0400	0.020	0.020	0.000050
Date	cfs	°C	units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
5/19/2011	940	15.6	8.26	0.28	0.52	0.280	< 0.10	< 0.00010	140	0.24	< 0.010	1.46	1.92	0.11	0.055	0.0026
5/19/2011	Dup	15.6	8.26	0.28	0.52	0.280	< 0.10	< 0.00010	140	0.24	< 0.010	1.46	1.95	0.13	0.052	0.0024
6/2/2011	630	15.1	8.19	0.21	0.34	0.210	< 0.10	< 0.00010	160	0.13	< 0.010	1.48	1.87	0.12	0.054	0.0013
6/2/2011	Dup	15.1	8.19	0.21	0.34	0.210	< 0.10	< 0.00010	160	0.13	< 0.010	1.49	1.89	0.12	0.057	0.0023
6/16/2011	415	22.3	8.11	0.24	1.0	< 0.200	0.18	0.0097	150	0.078	< 0.010	1.33	1.76	0.15	0.061	0.0011
6/16/2011	Dup	22.3	8.11	0.24	1.0	< 0.200	0.14	0.0075	160	0.077	< 0.010	1.37	1.77	0.15	0.061	0.00079
6/30/2011	363	19.6	7.94	0.38	0.62	0.350	< 0.10	0.0011	160	0.23	< 0.010	1.74	2.32	0.12	0.060	0.0011
6/30/2011	Dup	19.6	7.94	0.32	0.54	< 0.200	0.14	0.0045	160	0.23	< 0.010	1.75	2.37	0.12	0.061	0.00095
7/14/2011	212	21.8	8.01	0.28	0.42	0.245	< 0.10	0.0015	160	0.14	< 0.010	1.08	1.50	0.058	0.042	0.0015
7/14/2011	Dup	21.8	8.01	0.24	0.38	0.210	< 0.10	0.0015	160	0.14	< 0.010	1.10	1.55	0.058	0.044	0.0018
7/28/2011	166	22.8	8.45	0.18	0.18	< 0.200	0.10	0.012	180	< 0.050	< 0.010	1.35	1.64	0.093	0.037	0.00096
7/28/2011	Dup	22.8	8.45	0.21	0.33	< 0.200	< 0.10	0.0082	120	0.12	< 0.010	1.33	1.62	0.097	0.037	0.00096
8/11/2011	126	21.8	8.21	0.32	0.43	< 0.200	0.21	0.014	150	0.12	< 0.010	1.42	1.76	0.073	0.031	0.0016
8/11/2011	Dup	21.8	8.21	0.18	0.29	< 0.200	< 0.10	0.047	160	0.12	< 0.010	1.35	1.71	0.073	0.030	0.0012
8/25/2011	122	22.0	8.39	0.21	0.21	< 0.200	< 0.10	0.0036	140	< 0.050	< 0.010	1.23	1.73	< 0.020	0.022	0.00081
8/25/2011	Dup	22.0	8.39	0.14	0.14	< 0.200	< 0.10	0.0071	140	< 0.050	< 0.010	1.27	1.73	0.027	0.020	0.0012
9/8/2011	127	20.0	7.74	0.21	0.33	< 0.200	0.14	0.0029	190	0.12	< 0.010	1.24	1.55	0.039	0.022	0.00047
9/8/2011	Dup	20.0	7.74	0.24	0.37	0.245	< 0.10	< 0.00010	170	0.12	< 0.010	1.26	1.57	0.039	0.023	0.00056
9/22/2011	105	20.2	8.02	0.21	0.21	0.210	< 0.10	< 0.00010	140	< 0.050	< 0.010	1.17	1.58	0.033	< 0.020	0.00060
9/22/2011	Dup	20.2	8.02	0.18	0.29	< 0.200	< 0.10	0.0080	140	0.12	< 0.010	1.18	1.56	0.029	< 0.020	0.00036
10/6/2011	332	16.1	7.82	0.60	0.76	0.245	0.35	0.0063	130	0.16	< 0.010	2.35	2.99	0.16	0.076	0.000098
10/6/2011	Dup	16.1	7.82	0.63	0.80	0.313	0.32	0.0057	150	0.16	< 0.010	2.25	3.01	0.16	0.073	0.00068

* results are preliminary and subject to final revision.
** Method Detection Limit

Recommended EPA Criteria based on Aggregate Ecoregion III:
Total Phosporus: 0.02188 mg/L (21.88 ug/L)
Total Nitrogen: 0.38 mg/L
Chlorophyll *a*: 0.00178 mg/L (1.78 ug/L)

3.1.2 2011 Seasonal Bacterial Sampling (Beach Sampling)

The NCRWQCB, in cooperation with the Sonoma County Environmental Health Department (DEH) conducts seasonal bacteriological sampling at Russian River beaches which experience the greatest body contact recreation.

The NCRWQCB seasonal sampling locations consist of: Camp Rose Beach; Healdsburg Veterans Memorial Beach; Steelhead Beach; Forestville Access Beach; Johnson's Beach; and Monte Rio Beach. Bacteriological samples were collected weekly beginning in June and continuing into early October. The samples were analyzed using the Colilert quantitray MPN method for total coliform and e. *coli* and the Enterolert quantitray method for Enterococcus. Results from the sampling program (median of three samples) are reported by the NCRWQCB and the DEH at their respective websites and on the DEH Beach Sampling Hotline. The 2011 seasonal results are shown in Table 3-11 and Figures 3-7 through Figure 3-9.

Comparing the Water Agency enterococcus results and the NCRWQCB results for the Steelhead Beach sample site it appears that the multiple tube fermentation analysis results in significantly higher values over those resulting from the enterolert method. However, this may be in part because the NCRWQCB results are the median of three samples. The analysis resulting from the 2011 beach sampling program and prior years are being evaluated as part of the CEQA requirements associated with establishing permanent changes to D1610.

Table 3-11. Sonoma County Seasonal Beach Results collected by the NCRWQCB. Highlighted values indicate those values exceeding the California Department of Public Health Draft Guidance for Fresh Water Beaches.

	Alexander Valley			Camp Rose Beach			Healdsburg Veterans			Steelhead Beach			Forestville Access			Johnson's Beach			Monte Rio Beach		
	T. coli	*e. coli*	Entero.	T. coli	*e. coli*	Entero.	T. coli	*e. coli*	Entero.	T. coli	*e. coli*	Entero.	T. coli	*e. coli*	Entero.	T. coli	*e. coli*	Entero.	T. coli	*e. coli*	Entero.
24-May-11	7,701	<10	10	4,106	20	<10	3,654	<10	<10	2,382	10	<10	1,989	10	<10	1,918	<10	<10	3,448	10	<10
31-May-11	8,164	20	<10	5,475	20	<10	3,448	20	20	2,310	30	10	2,247	10	10	1,724	20	20	1,553	10	10
7-Jun-11	9,208	75	31	5,794	63	31	5,794	86	30	4,106	146	41	3,448	146	20	3,076	75	30	3,448	85	31
14-Jun-11	3,654	10	10	1,725	20	<10	1,723	20	10	1,036	30	10	1,401	<10	<10	620	<10	10	638	<10	<10
21-Jun-11	2,481	20	10	1,793	<10	<10	1,553	30	20	1,126	10	<10	1,236	<10	<10	1,515	20	41	2,613	20	<10
28-Jun-11	1,616	10	30	1,850	10	31	2,382	108	98	1,450	20	10	1,850	31	10	2,359	52	20	2,489	31	20
30-Jun-11							723	<10	10												
5-Jul-11	1,236	20	<10	1,670	10	<10	959	31	10	1,376	31	10	1,464	20	<10	1,376	20	10	2,613	20	10
12-Jul-11	1,076	<10	10	1,607	10	<10	880	30	10	676	<10	10	960	10	<10	2,187	10	<10	2,143	10	10
19-Jul-11	749	10	<10	2,014	10	<10	1,112	10	10	703	<10	10	771	10	<10	1,376	31	<10	2,755	<10	10
26-Jul-11	1,607	10	10	2,064	10	10	744	31	10	798	<10	10	1,137	<10	<10	1,553	20	10	4,352	<10	10
2-Aug-11	1,187	20	10	1,467	10	<10	613	20	10	855	20	30	959	31	10	712	10	10	1,314	31	<10
9-Aug-11	1,785	<10	<10	1,989	<10	10	1,483	20	<10	908	41	41	1,039	10	10	767	20	10	1,046	<10	<10
16-Aug-11	2,495	<10	31	2,187	30	20	3,076	10	<10	703	10	20	878	10	41	991	<10	<10	1,439	<10	<10
23-Aug-11	1,918	<10	51	1,860	<10	41	1,515	10	10	884	20	51	754	<10	52	861	20	10	2,723	20	146
25-Aug-11																			1,770	34	<10
30-Aug-11	1,989	<10	10	2,046	<10	<10	1,162	10	<10	379	10	<10	813	<10	<10	1,354	<10	<10	1,376	<10	<10
6-Sep-11	1,497	10	<10	24,196	<10	<10	1,607	20	<10	529	10	<10	813	<10	<10	1,119	10	<10	1,092	10	<10
8-Sep-11				2,909	<10	20															
13-Sep-11	602	10	<10	933	31	<10	1,178	20	<10	228	<10	<10	339	<10	<10	785	20	<10	862	10	<10
20-Sep-11	884	10	68.9	1,935	10	54.2	1,333	10	38.4	243	10	27.2	*	*	25.6	695	10	31.3	404	10	10.8
22-Sep-11	1,106	<10	60										305	10	24.3						
27-Sep-11	1,036	<10	26.5	1,246	<10	31.5	1,354	30	20.3	275	10	15.8	487	<10	21.1	908	<10	14.8	1,017	52	80.9
29-Sep-11																					14.6
4-Oct-11	1,259	74	20	1,100	63	20	4,352	435	110	1,246	20	20	1,223	231	20	1,071	63	10	1,467	75	10
6-Oct-11							10,462	880	960												
11-Oct-11							1,046	97	<10												

Single Sample Values

Beach posting is recommended when indicator organisms exceed any of the following levels:

Total coliforms: 10,000 per 100 ml

e coli: 235 per 100 ml

Enterococcus: 61 per 100 ml

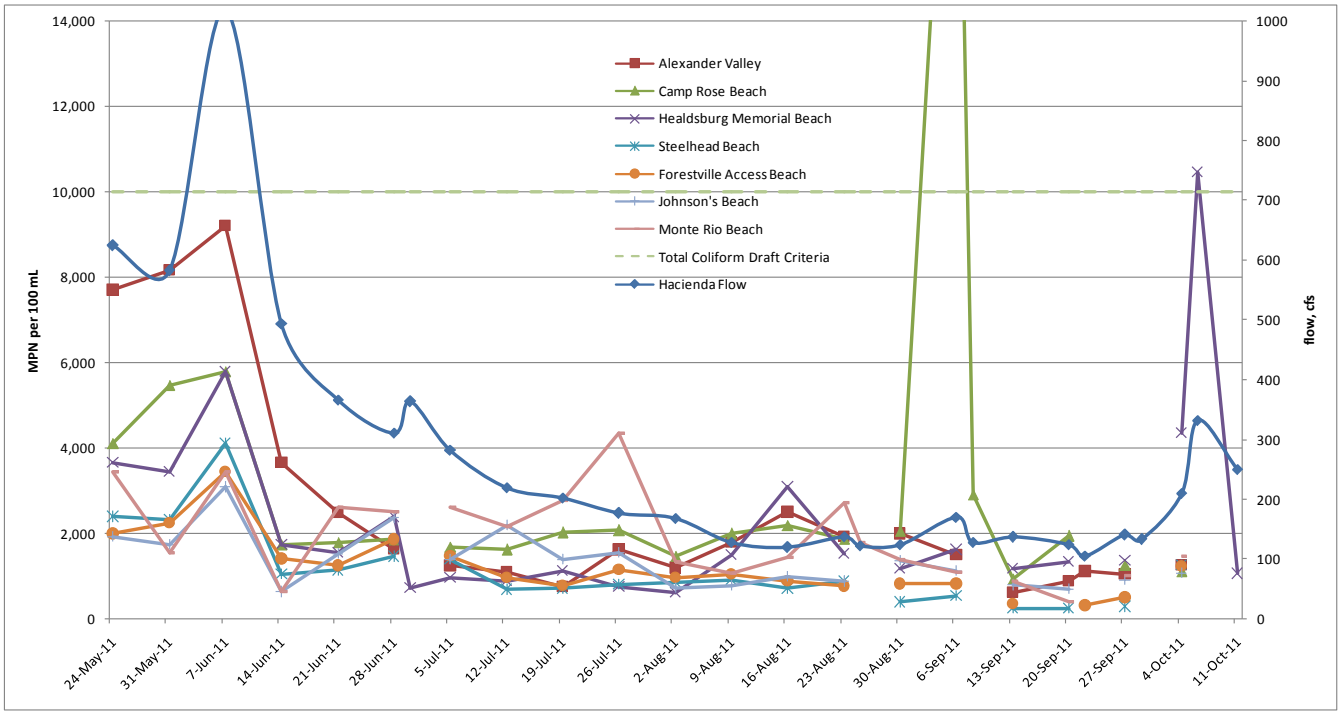

Figure 3-7. Sonoma County Beach Bacteria Sample Results for Total Coliform

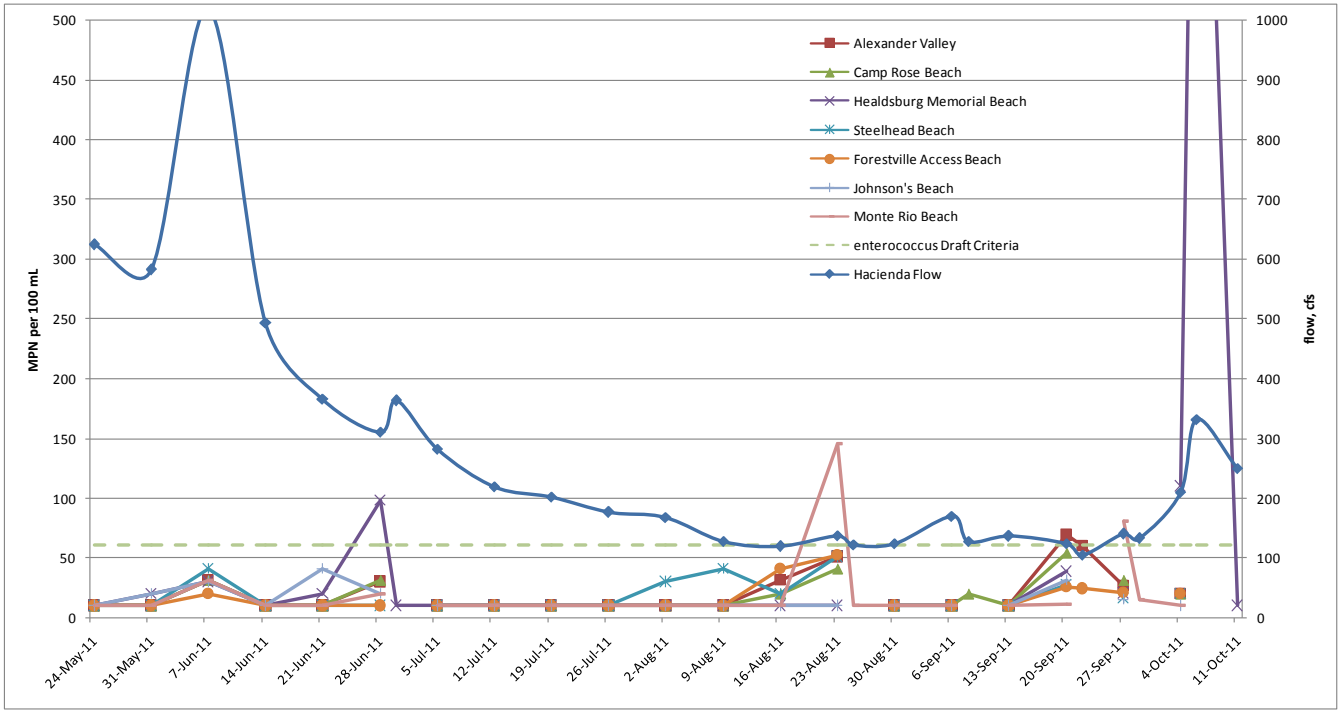

Figure 3-8 - Sonoma County Beach Pathogen Sample Results for Enterococcus

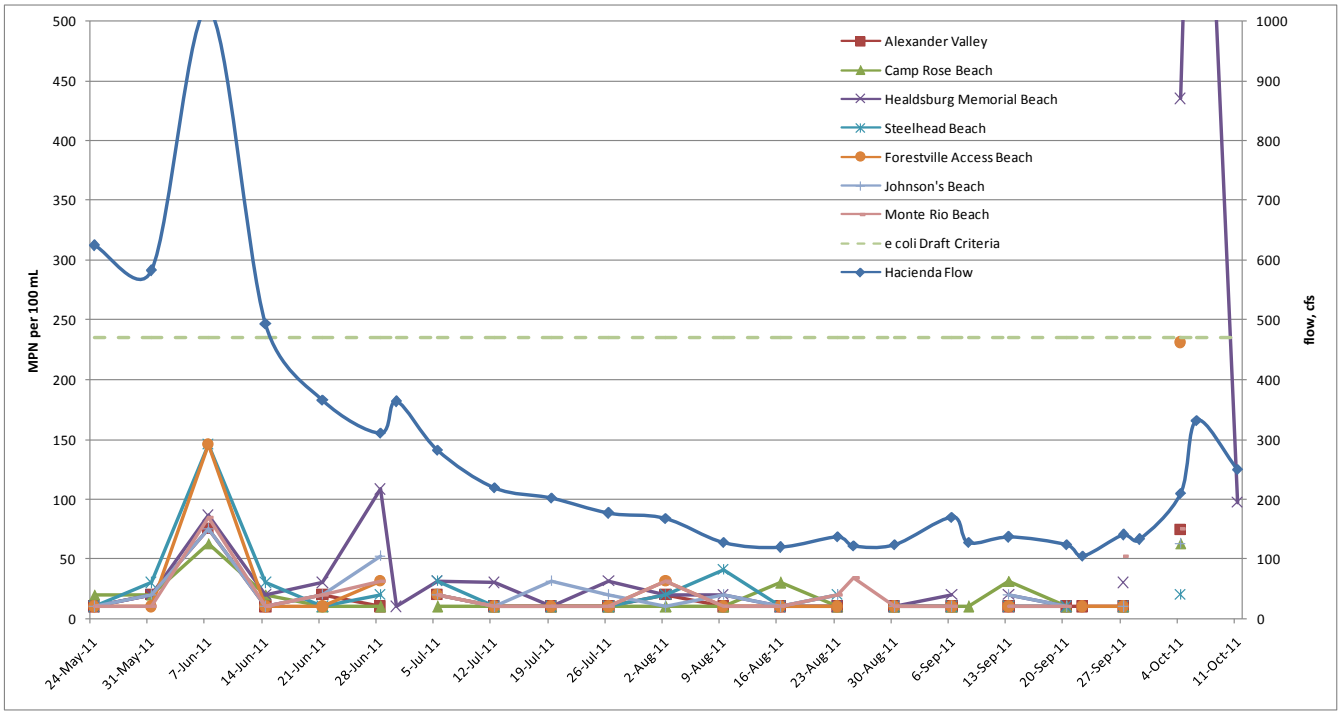

Figure 3-9. Sonoma County Beach Pathogen Sample Results for *e coli*

3.2 Russian River Estuary Water Quality Monitoring

Although flows in the lower Russian River did not reach allowable minimum flows as noted in the Order and flows in the lower Russian River (downstream of the confluence with Dry Creek) were higher than D1610 minimum flows during the entire Order as discussed in Section 2, water quality monitoring continued to be conducted in the lower, middle, and upper reaches of the Russian River Estuary and the upper extent of inundation and backwatering during lagoon formation, between the mouth of the river at Jenner and Monte Rio, including in two tributaries. Water Agency staff collected data to establish baseline information on water quality in the Estuary to gain a better understanding of the longitudinal and vertical water quality profile during the ebb and flow of the tide, and to track changes to the water quality profile that may occur during periods of barrier beach closure and reopening.

Saline water is denser than freshwater and a salinity "wedge" forms as freshwater outflow passes over the denser tidal inflow. During the lagoon management period (May 15 to October 15), the lower and middle reaches of the Estuary up to Sheephouse Creek are predominantly saline environments with a thin freshwater layer that flows over the denser saltwater. The upper reach of the Estuary transitions to a predominantly freshwater environment, which is periodically underlain by a denser, saltwater layer that migrates upstream to Duncans Mills during summer low flow conditions and barrier beach closure. Additionally, river flows, tides, topography, and wind action affect the amount of mixing of the water column at various longitudinal and vertical positions within the Estuary.

In 2011, the Estuary did not experience any closures during the lagoon management period, however there were several periods of perched conditions. Perched conditions occur when a barrier beach is incompletely formed and a small outlet channel remains allowing water levels to rise while still

providing outflow from the river. Perched conditions occurred for a period of 8 days from 22 September to 29 September, 5 days from 4 October to 8 October, and 5 days from 10 October to 14 October. During this time the Agency was able to monitor the partial development of a freshwater lagoon system as freshwater inflows increased the surface layer.

The Water Agency submits an annual report to the National Marine Fisheries Service and California Department of Fish and Game, documenting the status updates of the Water Agency's efforts in implementing the Biological Opinion. The water quality monitoring data for 2011 is currently being compiled and will be discussed in the "Russian River Biological Opinion Status and Data Report Year 2011-12" due to be released in June, 2012. The annual report will be available on the Water Agency's website: http://www.scwa.ca.gov/bo-annual-report/. As with the other datasets, the estuary data will be evaluated as part of the CEQA requirements associated with revised minimum flows in the mainstem. The grab sample sites are shown in Figure 3-10, the results are summarized in Tables 3-12 through 3-17 and the entire dataset can be found as noted, in the 2011-2012 Russian River Biological Opinion Status and Data Report. Highlighted values indicate those values exceeding California Department of Public Health Draft Guidance for Fresh Water Beaches for Indicator Bacteria, NCRWQCB Basin Plan standards for fecal coliforms for water contact recreation, and EPA recommended criteria for Nutrients, Chlorophyll a, and Turbidity in Rivers and Streams in Aggregate Ecoregion III. However, it must be emphasized that unlike the NCRWQCB fecal coliform standard, the draft CDPH guidelines and EPA criteria are not adopted standards, and are therefore both subject to change (if it is determined that the guidelines or criteria are not accurate indicators) and are not currently enforceable. In addition, these draft guidelines and criteria were established for and are only applicable to fresh water beaches and freshwater portions of the estuary. Currently, there are no numeric guidelines or criteria that have been established specifically for estuaries.

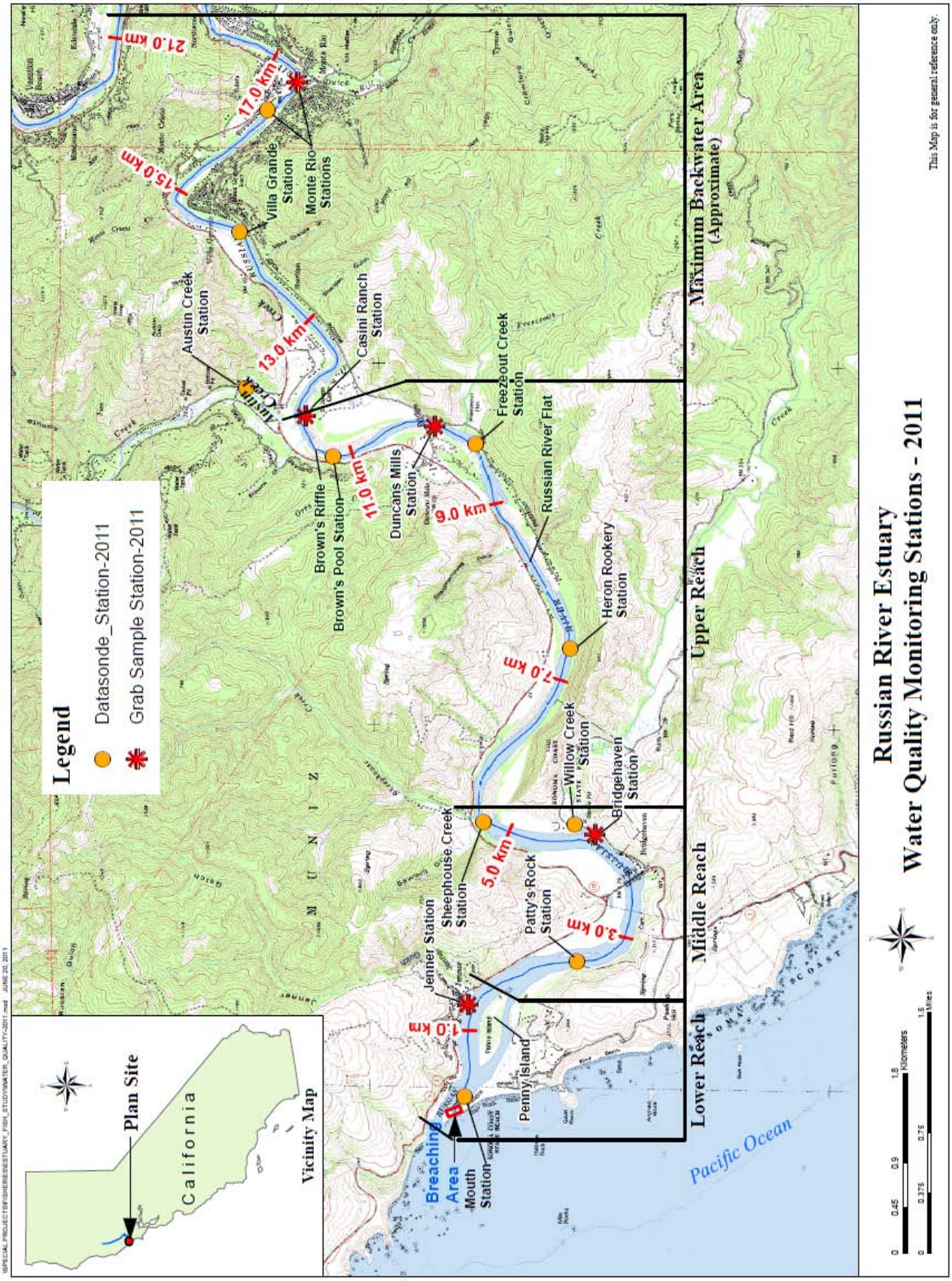

Figure 3-10. 2011 Estuary Sample Sites.

Table 3-12. 2011 Monte Rio Station Grab Sample Results.

Monte Rio*	Temperature	Total Organic Nitrogen	Ammonia as N	Ammonia as N Unionized	Nitrate as N (NO_3)	Nitrite as N	Total Kjeldahl Nitrogen	Total Nitrogen	Phosphorus, Total	Turbidity	Chlorophyll-a	Total Coliforms (multiple tube fermentation)	Total Coliforms (Colilert)	Fecal Coliforms (multiple tube fermentation)	E. coli (Colilert)	Enterococcus (multiple tube fermentation)	Hacienda	
MDL**		0.200	0.10	0.00010	0.030	0.020	0.10		0.020	0.020	0.000050	20	20	20	20	2.0	Flow Rate	Estuary
Date	°C	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	NTU	mg/L	MPN	MPN	MPN	MPN	MPN	(cfs)	Condition
5/17/2011	14	ND	ND	0.0013	0.22	ND	0.21	**0.43**	**0.041**	**2.7**	**0.0045**	900.0	2400	50.0	73	**140**	767	open
5/31/2011	17.1	0.21	ND	ND	0.11	ND	0.21	0.32	**0.071**	**2.4**	0.0014	240.0	1600	30.0	6.2	13	545	open
6/14/2011	21.2	0.231	ND	0.00085	ND	ND	0.24	0.24	**0.054**	**3.7**	**0.0073**	220	1700	40	63	8.0	468	open
6/28/2011	21.5	0.21	0.14	0.0059	0.19	ND	0.35	**0.54**	**0.048**	1.9	**0.0045**	1100	2500	20	31	**80**	303	open
7/12/2011	22.7	0.245	ND	0.0016	0.12	ND	0.28	**0.40**	**0.053**	**2.6**	**0.0059**	140	2000	20	20	11	219	open
7/26/2011	22.8	ND	0.10	0.0047	ND	ND	0.21	0.21	**0.033**	**2.6**	**0.0019**	210	2500	20	ND	4.0	180	open
8/9/2011	22.3	ND	ND	0.0024	ND	ND	0.18	0.18	**0.029**	1.6	0.0013	520	1300	40	10	27	132	open
8/23/2011	21.6	ND	ND	0.0018	0.12	ND	0.18	0.30	**0.043**	**2.9**	**0.0022**	500	2200	ND	10	8.0	144	open
9/6/2011	20.5	ND	ND	0.00088	0.12	ND	0.18	0.29	**0.033**	1.7	0.0017	260	1300	ND	ND	4.0	178	open
9/20/2011	20.4	ND	ND	0.00082	ND	ND	0.18	0.18	0.020	1.3	0.0014	2100	1400	ND	20	ND	129	open
9/29/2011	20.0	ND	ND	0.00052	0.12	ND	0.18	0.29	0.021	1.8	0.00039	2400	1900	80	31	30	137	perched
10/4/2011	18.1	ND	0.10	0.0017	0.12	ND	0.18	0.29	**0.028**	1.2	0.00050	1200	1400	20	63	50	219	perched
10/6/2011	16.2	0.280	ND	0.0012	0.14	ND	0.35	**0.49**	**0.099**	2.8	0.0014	**>16000**	**16000**	**1400**	150	13	350	perched

* results are preliminary and subject to final revision.
** Method Detection Limit

Recommended EPA Criteria based on Aggregate Ecoregion III:
Total Phosporus: 0.02188 mg/L (21.88 ug/L)
Total Nitrogen: 0.38 mg/L
Chlorophyll *a*: 0.00178 mg/L (1.78 ug/L)
Turbidity: 2.34 FTU/NTU

NCRWQCB Water Quality Standard for Water Contact Recreation (REC-1):
Fecal Coliforms: Not more than ten percent of total samples during any 30-day period shall exceed 400/100mL

CDPH Draft Guidance for Fresh Water Beaches - Single Sample Values:
Beach posting is recommended when indicator organisms exceed any of the following levels:
Total coliforms: 10,000 per 100 ml
Fecal coliform: 400 per 100 ml
Escherichia coli: 235 per 100 ml
Enterococcus: 61 per 100 ml

Table 3-13. 2011 Monte Rio Duplicate Station Grab Sample Results.

Monte Rio Duplicate*	Temperature	Total Organic Nitrogen	Ammonia as N	Ammonia as N Unionized	Nitrate as N (NO_3)	Nitrite as N	Total Kjeldahl Nitrogen	Total Nitrogen	Phosphorus, Total	Turbidity	Chlorophyll-a	Total Coliforms (multiple tube fermentation)	Total Coliforms (Colilert)	Fecal Coliforms (multiple tube fermentation)	E. coli (Colilert)	Enterococcus (multiple tube fermentation)	Hacienda	
MDL**		0.200	0.10	0.00010	0.030	0.020	0.10		0.020	0.020	0.000050	20	20	20	20	2.0	Flow Rate	Estuary
Date	°C	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	NTU	mg/L	MPN	MPN	MPN	MPN	MPN	(cfs)	Condition
5/17/2011	14.2	ND	ND	0.0013	0.22	ND	0.21	**0.43**	**0.038**	**2.7**	0.001	>1600	>2400	80.0	74	50	767	open
5/31/2011	17.1	0.21	ND	ND	0.11	ND	0.21	0.32	**0.069**	**2.5**	0.0013	140.0	2400	23.0	9.8	22	545	open
6/14/2011	21.2	0.28	ND	0.0021	ND	ND	0.32	0.32	**0.055**	**2.8**	**0.015**	1700	1400	ND	10	17	468	open
6/28/2011	21.5	ND	0.18	0.0076	0.19	ND	0.35	**0.54**	**0.049**	2	**0.0041**	1700	2200	ND	31	50	303	open
7/12/2011	22.7	ND	ND	0.0032	0.12	ND	0.21	0.33	**0.054**	**2.7**	**0.0063**	750	1700	40	ND	22	219	open
7/26/2011	22.8	ND	0.10	0.0047	ND	ND	0.24	0.24	**0.033**	2.3	**0.0018**	170	2500	ND	ND	4.0	180	open
8/9/2011	22.3	ND	ND	0.0012	0.12	ND	0.14	0.26	**0.039**	2.2	0.0013	170	1500	ND	10	22	132	open
8/23/2011	21.6	ND	ND	0.0018	0.13	ND	0.21	0.34	**0.040**	2.0	0.0014	900	2200	ND	10	8.0	144	open
9/6/2011	20.5	ND	ND	0.00088	0.12	ND	0.21	0.33	**0.033**	1.3	0.0013	5400	1900	ND	10	8.0	178	open
9/20/2011	20.4	0.753	ND	0.00082	0.12	ND	0.79	**0.91**	**0.022**	1.3	0.00094	170	1200	ND	20	7.0	129	open
9/29/2011	20.0	ND	ND	0.00052	0.12	ND	0.18	0.29	**0.022**	1.8	ND	300	1200	20	20	27	137	perched
10/4/2011	18.1	ND	ND	ND	0.12	ND	0.18	0.29	**0.025**	1.3	**0.0020**	2800	1500	ND	52	**70**	219	perched
10/6/2011	16.2	0.245	ND	0.0012	0.14	ND	0.32	**0.46**	**0.098**	3.0	0.0012	**>16000**	**24000**	**900**	170	**80**	350	perched

* results are preliminary and subject to final revision.
** Method Detection Limit

Recommended EPA Criteria based on Aggregate Ecoregion III:
Total Phosporus: 0.02188 mg/L (21.88 ug/L)
Total Nitrogen: 0.38 mg/L
Chlorophyll *a*: 0.00178 mg/L (1.78 ug/L)
Turbidity: 2.34 FTU/NTU

NCRWQCB Water Quality Standard for Water Contact Recreation (REC-1):
Fecal Coliforms: Not more than ten percent of total samples during any 30-day period shall exceed 400/100mL

CDPH Draft Guidance for Fresh Water Beaches - Single Sample Values:
Beach posting is recommended when indicator organisms exceed any of the following levels:
Total coliforms: 10,000 per 100 ml
Fecal coliform: 400 per 100 ml
Escherichia coli: 235 per 100 ml
Enterococcus: 61 per 100 ml

Table 3-14. 2011 Casini Ranch Station Grab Sample Results. This site may experience estuarine conditions.

Casini Ranch*	Temperature	Total Organic Nitrogen	Ammonia as N	Ammonia as N Unionized	Nitrate as N (NO_3)	Nitrite as N	Total Kjeldahl Nitrogen	Total Nitrogen	Phosphorus, Total	Turbidity	Chlorophyll-a	Total Coliforms (multiple tube fermentation)	Total Coliforms (Colilert)	Fecal Coliforms (multiple tube fermentation)	E. coli (Colilert)	Enterococcus (multiple tube fermentation)	Hacienda	
MDL**		0.200	0.10	0.00010	0.030	0.020	0.10		0.020	0.020	0.000050	20	20	20	20	2.0	Flow Rate	Estuary
Date	°C	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	NTU	mg/L	MPN	MPN	MPN	MPN	MPN	(cfs)	Condition
5/17/2011	15	ND	ND	0.00089	0.19	ND	0.21	**0.40**	**0.025**	**2.4**	**0.0026**	>1600	>2400	80.0	93	**280**	767	open
5/31/2011	17.6	0.21	ND	0.0013	0.11	ND	0.24	0.35	**0.044**	1.7	0.00088	300.0	1200	8.0	14	7.0	545	open
6/14/2011	21.8	0.21	ND	0.0028	ND	ND	0.24	0.24	**0.037**	1.5	**0.0023**	140	960	ND	ND	2.0	468	open
6/28/2011	21.2	0.25	0.14	0.0055	0.16	ND	0.39	**0.55**	**0.049**	1.8	**0.0042**	3500	1400	ND	ND	26	303	open
7/12/2011	23.2	ND	ND	0.0032	0.12	ND	0.24	0.36	**0.077**	1.3	0.0016	370	3400	70	20	7.0	219	open
7/26/2011	22.9	ND	0.10	0.0090	0.12	ND	0.24	0.36	**0.034**	1.3	0.0013	900	4400	40	ND	2.0	180	open
8/9/2011	22.4	ND	ND	0.0037	0.12	ND	0.21	0.33	**0.037**	1.3	0.00096	280	4600	ND	ND	4.0	132	open
8/23/2011	21.8	ND	ND	0.0023	0.12	ND	0.18	0.29	**0.040**	1.3	0.0013	500	1900	ND	20	4.0	144	open
9/6/2011	20.7	0.210	ND	0.0028	0.12	ND	0.28	**0.40**	**0.037**	**5.6**	0.0012	140	990	20	ND	2.0	178	open
9/20/2011	20.9	ND	0.10	0.0041	0.12	ND	0.24	0.37	0.021	1.2	0.00047	140	1100	40	ND	4.0	129	open
9/29/2011	21.0	ND	ND	0.0018	0.12	ND	0.24	0.37	**0.033**	1.1	0.00068	9000	1400	300	31	50	137	perched
10/4/2011	19.1	ND	0.14	0.0031	0.13	ND	0.24	**0.38**	**0.029**	1.3	0.00050	900	1700	80	52	**70**	219	perched
10/6/2011	17.0	ND	ND	0.0021	0.12	ND	0.21	0.34	**0.045**	1.3	0.00040	800	1000	40	41	22	350	perched

* results are preliminary and subject to final revision.
** Method Detection Limit

Recommended EPA Criteria based on Aggregate Ecoregion III:
Total Phosporus: 0.02188 mg/L (21.88 ug/L)
Total Nitrogen: 0.38 mg/L
Chlorophyll *a*: 0.00178 mg/L (1.78 ug/L)
Turbidity: 2.34 FTU/NTU

NCRWQCB Water Quality Standard for Water Contact Recreation (REC-1):
Fecal Coliforms: Not more than ten percent of total samples during any 30-day period shall exceed 400/100mL

CDPH Draft Guidance for Fresh Water Beaches - Single Sample Values:
Beach posting is recommended when indicator organisms exceed any of the following levels:
Total coliforms: 10,000 per 100 ml
Fecal coliform: 400 per 100 ml
Escherichia coli: 235 per 100 ml
Enterococcus: 61 per 100 ml

Table 3-15. 2011 Duncans Mills Station Grab Sample Results. This site may experience estuarine conditions.

Duncans Mills*	Temperature	Total Organic Nitrogen	Ammonia as N	Ammonia as N Unionized	Nitrate as N (NO_3)	Nitrite as N	Total Kjeldahl Nitrogen	Total Nitrogen	Phosphorus, Total	Turbidity	Chlorophyll-a	Total Coliforms (multiple tube fermentation)	Total Coliforms (Colilert)	Fecal Coliforms (multiple tube fermentation)	E. coli (Colilert)	Enterococcus (multiple tube fermentation)	Hacienda	
MDL**		0.200	0.10	0.00010	0.030	0.020	0.10		0.020	0.020	0.000050	20	20	20	20	2.0	Flow Rate	Estuary
Date	°C	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	NTU	mg/L	MPN	MPN	MPN	MPN	MPN	(cfs)	Condition
5/17/2011	14	ND	ND	0.0013	0.19	ND	0.21	**0.40**	**0.034**	2.0	**0.0029**	>1600	2000	240.0	120	**80**	767	open
5/31/2011	17.6	ND	ND	0.002	0.081	ND	0.18	0.26	**0.031**	1.8	0.0015	500.0	1700	30.0	7.5	2.0	545	open
6/14/2011	21.2	0.21	ND	0.004	ND	ND	0.24	0.24	**0.047**	1.9	**0.0036**	900	3500	ND	20	17	468	open
6/28/2011	21.0	ND	0.18	0.0071	0.16	ND	0.32	**0.48**	**0.043**	1.6	**0.0034**	2200	1100	300	74	**500**	303	open
7/12/2011	22.3	ND	ND	0.003	0.12	ND	0.24	0.37	**0.063**	1.2	0.00098	900	7200	70	41	ND	219	open
7/26/2011	22.0	ND	0.10	0.0055	0.12	ND	0.24	0.36	**0.038**	1.3	0.0013	220	**10000**	ND	ND	2.0	180	open
8/9/2011	21.3	ND	ND	0.0034	0.16	ND	0.21	0.37	**0.031**	1.4	0.0011	170	**>24000**	40	10	ND	132	open
8/23/2011	21.8	0.210	ND	0.0014	0.14	ND	0.24	**0.38**	**0.039**	1.3	0.00051	300	5200	20	10	**240**	144	open
9/6/2011	20.2	ND	ND	0.0026	0.13	ND	0.18	0.30	**0.032**	**4.2**	0.00074	240	1400	50	10	ND	178	open
9/20/2011	20.8	ND	ND	0.0011	0.14	ND	0.18	0.31	**0.025**	1.1	0.00071	110	1000	ND	ND	7.0	129	open
9/29/2011	20.3	ND	ND	0.00082	0.12	ND	0.21	0.33	**0.027**	1.4	0.000098	900	2200	80	74	**130**	137	perched
10/4/2011	18.5	0.210	0.10	0.0023	0.14	ND	0.32	**0.46**	**0.024**	1.4	0.00070	900	1500	70	84	**70**	219	perched
10/6/2011	16.8	0.210	ND	0.00083	0.12	ND	0.24	0.37	0.036	1.3	0.00040	1400	1000	210	20	**170**	350	perched

* results are preliminary and subject to final revision.
** Method Detection Limit

Recommended EPA Criteria based on Aggregate Ecoregion III:
Total Phosporus: 0.02188 mg/L (21.88 ug/L)
Total Nitrogen: 0.38 mg/L
Chlorophyll *a*: 0.00178 mg/L (1.78 ug/L)
Turbidity: 2.34 FTU/NTU

NCRWQCB Water Quality Standard for Water Contact Recreation (REC-1):
Fecal Coliforms: Not more than ten percent of total samples during any 30-day period shall exceed 400/100mL

CDPH Draft Guidance for Fresh Water Beaches - Single Sample Values:
Beach posting is recommended when indicator organisms exceed any of the following levels:
Total coliforms: 10,000 per 100 ml
Fecal coliform: 400 per 100 ml
Escherichia coli: 235 per 100 ml
Enterococcus: 61 per 100 ml

Table 3-16. 2011 Bridgehaven Station Grab Sample Results. Estuarine conditions exist at this site.

Bridgehaven*	Temperature	Total Organic Nitrogen	Ammonia as N	Ammonia as N Unionized	Nitrate as N (NO_3)	Nitrite as N	Total Kjeldahl Nitrogen	Total Nitrogen	Phosphorus, Total	Turbidity	Chlorophyll-a	Total Coliforms (multiple tube fermentation)	Total Coliforms (Colilert)	Fecal Coliforms (multiple tube fermentation)	E. coli (Colilert)	Enterococcus (multiple tube fermentation)	Hacienda	
MDL**		0.200	0.10	0.00010	0.030	0.020	0.10		0.020	0.020	0.000050	20	20	20	20	2.0	Flow Rate	Estuary
Date	°C	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	NTU	mg/L	MPN	MPN	MPN	MPN	MPN	(cfs)	Condition
5/17/2011	12	0.21	0.1	0.00064	0.12	ND	0.32	**0.43**	**0.2**	**16**	0.0004	>1600	>2400	**500.0**	**270**	33	767	open
5/31/2011	16.5	ND	ND	0.00093	ND	ND	0.18	0.22	**0.035**	1.4	0.00059	500.0	1400	70.0	5.2	2.0	545	open
6/14/2011	20.4	ND	ND	0.0023	ND	ND	0.21	0.21	**0.039**	2.1	0.00023	170	1500	20	ND	7.0	468	open
6/28/2011	19.7	0.215	0.1	0.0041	0.27	ND	0.32	**0.59**	**0.041**	2.3	0.00047	1700	**>24000**	40	20	30	303	open
7/12/2011	20.7	ND	0.1	0.01	0.13	ND	0.28	**0.41**	**0.065**	2.1	0.00059	140	**10000**	40	140	14	219	open
7/26/2011	21.0	0.280	0.10	0.0083	ND	ND	0.38	**0.38**	**0.042**	2.0	**0.0079**	140	**10000**	20	ND	ND	180	open
8/9/2011	19.5	ND	0.14	0.0043	ND	ND	0.14	0.14	**0.071**	**4.9**	**0.022**	320	**>24000**	ND	85	11	132	open
8/23/2011	17.4	ND	0.14	0.0017	0.63	ND	0.21	**0.84**	**0.060**	2.3	**0.0028**	840	**10000**	90	10	4.0	144	open
9/6/2011	17.8	0.350	0.14	0.0029	0.62	ND	0.49	**1.1**	**0.066**	**8.6**	**0.0031**	1400	**24000**	ND	20	17	178	open
9/20/2011	17.4	0.245	0.10	0.0016	0.63	ND	0.35	**0.48**	**0.057**	**8.0**	**0.0061**	450	**>24000**	ND	ND	8.0	129	open
9/29/2011	18.4	0.245	ND	0.0010	0.12	ND	0.32	**0.44**	**0.037**	2.1	0.00049	**>16000**	9600	**700**	74	**500**	137	perched
10/4/2011	16.3	0.350	0.14	0.00013	ND	ND	0.49	**0.49**	**0.067**	**8.4**	0.00070	**>16000**	**>24000**	**900**	**420**	**240**	219	perched
10/6/2011	14.4	0.385	ND	ND	0.13	ND	0.38	**0.51**	**0.077**	**5.5**	0.0015	**>16000**	9800	**390**	160	**240**	350	perched

* results are preliminary and subject to final revision.

** Method Detection Limit

Recommended EPA Criteria based on Aggregate Ecoregion III:

Total Phosporus: 0.02188 mg/L (21.88 ug/L)

Total Nitrogen: 0.38 mg/L

Chlorophyll *a*: 0.00178 mg/L (1.78 ug/L)

Turbidity: 2.34 FTU/NTU

NCRWQCB Water Quality Standard for Water Contact Recreation (REC-1):

Fecal Coliforms: Not more than ten percent of total samples during any 30-day period shall exceed 400/100mL

CDPH Draft Guidance for Fresh Water Beaches - Single Sample Values:

Beach posting is recommended when indicator organisms exceed any of the following levels:

Total coliforms: 10,000 per 100 ml

Fecal coliform: 400 per 100 ml

Escherichia coli: 235 per 100 ml

Enterococcus: 61 per 100 ml

Table 3-17. 2011 Jenner Boat Ramp Station Grab Sample Results. Estuarine conditions exist at this site.

Jenner Boat Ramp*	Temperature	Total Organic Nitrogen	Ammonia as N	Ammonia as N Unionized	Nitrate as N (NO_3)	Nitrite as N	Total Kjeldahl Nitrogen	Total Nitrogen	Phosphorus, Total	Turbidity	Chlorophyll-a	Total Coliforms (multiple tube fermentation)	Total Coliforms (Colilert)	Fecal Coliforms (multiple tube fermentation)	E. coli (Colilert)	Enterococcus (multiple tube fermentation)	Hacienda	
MDL**		0.200	0.10	0.00010	0.030	0.020	0.10		0.020	0.020	0.000050	20	20	20	20	2.0	Flow Rate	Estuary
Date	°C	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	NTU	mg/L	MPN	MPN	MPN	MPN	MPN	(cfs)	Condition
5/17/2011	14	ND	0.1	0.0021	0.19	ND	0.24	**0.43**	ND	1.6	0.001	900.0	2400	80.0	60	4.0	767	open
5/31/2011	16.0	ND	ND	0.0023	ND	ND	0.21	0.24	**0.029**	1.9	0.00059	110.0	>2400	23.0	16	4.0	545	open
6/14/2011	19.4	ND	0.14	0.0062	ND	ND	0.14	0.14	**0.048**	2.3	0.00057	300	8300	ND	20	2.0	468	open
6/28/2011	18.2	0.210	0.14	0.0057	0.67	ND	0.35	**1.00**	**0.043**	**4.4**	0.00057	**>16000**	**24000**	170	150	**170**	303	open
7/12/2011	18.8	0.406	ND	0.0071	0.15	ND	0.35	**0.50**	**0.068**	**3.3**	0.0016	340	**10000**	40	84	6.0	219	open
7/26/2011	19.1	ND	0.21	0.0093	1.2	ND	0.35	**0.47**	**0.048**	**2.9**	**0.0045**	170	**10000**	ND	ND	2.0	180	open
8/9/2011	16.7	0.385	ND	0.0020	ND	ND	0.46	**0.46**	**0.044**	**2.9**	**0.012**	1100	**>24000**	20	72	14	132	open
8/23/2011	15.9	ND	0.26	0.0046	1.3	ND	0.42	**1.7**	**0.052**	**2.6**	**0.0034**	170	8700	90	41	**170**	144	open
9/6/2011	16.5	0.210	0.14	0.0042	1.3	ND	0.35	**1.6**	**0.048**	**2.8**	**0.0021**	260	**10000**	40	52	4.0	178	open
9/20/2011	17.2	0.385	ND	ND	ND	ND	0.38	**0.38**	**0.031**	2.0	0.00047	170	**>24000**	ND	20	ND	129	open
9/29/2011	18.9	ND	ND	0.0021	ND	ND	0.24	0.24	**0.027**	1.7	0.0015	3000	9100	40	98	17	137	perched
10/4/2011	16.3	0.315	ND	0.00048	ND	ND	0.35	0.35	**0.039**	1.8	**0.0018**	2500	**24000**	40	41	50	219	perched
10/6/2011	15.7	0.245	ND	ND	0.14	ND	0.24	**0.39**	**0.041**	**7.5**	0.0011	**>16000**	**17000**	**1500**	**320**	**1600**	350	perched

* results are preliminary and subject to final revision.

** Method Detection Limit

Recommended EPA Criteria based on Aggregate Ecoregion III:

Total Phosporus: 0.02188 mg/L (21.88 ug/L)

Total Nitrogen: 0.38 mg/L

Chlorophyll *a*: 0.00178 mg/L (1.78 ug/L)

Turbidity: 2.34 FTU/NTU

NCRWQCB Water Quality Standard for Water Contact Recreation (REC-1):

Fecal Coliforms: Not more than ten percent of total samples during any 30-day period shall exceed 400/100mL

CDPH Draft Guidance for Fresh Water Beaches - Single Sample Values:

Beach posting is recommended when indicator organisms exceed any of the following levels:

Total coliforms: 10,000 per 100 ml

Fecal coliform: 400 per 100 ml

Escherichia coli: 235 per 100 ml

Enterococcus: 61 per 100 ml

4.0 ADDITIONAL MONITORING

4.1 Permanent Datasondes

In coordination with the USGS the Water Agency maintains five multi-parameter water quality sondes on the Russian River located at Russian River near Hopland, Russian River at Diggers Bend near Healdsburg and Russian River near Guerneville (aka Hacienda Bridge), the Water Agency's water supply facility at Mirabel (RDS), and Johnson's Beach. These five sondes are referred to as "permanent" because the Water Agency maintains them as part of its early warning detection system for use year-round. The sondes take real time readings of water pH, temperature, dissolved oxygen content (DO), specific conductivity, turbidity, and depth, every 15 minutes.

In addition to the permanent sondes, the Water Agency in cooperation with the USGS installed seasonal sondes with real-time telemetry at the USGS river gage station at Russian River near Cloverdale (north of Cloverdale at Commisky Station Road) and at the gage station at Russian River at Jimtown (Alexander Valley Road Bridge). These two additional sondes are included by the USGS on its "Real-time Data for California" website.

The data collected by the sondes described above are evaluated in Section 4.2 in response to the SWRCB request to evaluate whether and to what extent, the reduced flows authorized by the Order caused any impacts to water quality or availability of aquatic habitat for salmonids. In addition, the 2011 dataset and historical sonde data will be evaluated to support the Water Agency's future CEQA compliance documents.

4.2 Aquatic Habitat for Salmonids

4.2.1 Introduction

Altered flow regimes in rivers have the potential to change the environmental conditions experienced by salmonids occupying mainstem habitats. NMFS (2008) found that high summer time flows related to reservoir releases can increase velocities to the point that there is a reduction in the amount of optimal habitat available to summer rearing salmonids. However summer flows can be reduced to the point that water temperature could increase and dissolved oxygen (DO) could decrease, thereby degrading summer salmonid rearing habitat. In April of 2011 the Water Agency requested a Temporary Urgency Change Petition (TUCP) to meet the requirements in the Biological Opinion. The 2011 TUCP requested a change in minimum instream flow requirements under D1610 in order to improve salmonid rearing habitat in the Russian River as outlined in the Biological Opinion. These flow changes are also intended to provide a lower, closer-to-natural inflow to the estuary between late spring and early fall, thereby enhancing the potential for maintaining a seasonal freshwater lagoon that would likely support increased production of juvenile steelhead and salmon (NMFS 2008). In the State Water Resource Control Board's (SWRCB) Order the Water Agency was tasked with evaluating impacts to water quality and the availability of aquatic habitat for salmonids in the Russian River associated with reductions in minimum instream flows in the Order. The period covered by the Order is June 1 through October 15, 2011. This report summarizes Russian River flow, temperature, DO, and salmonid monitoring data in order to evaluate the potential effect of reducing minimum instream flows on salmonid habitat.

4.2.2 Life stages

Salmonids in the Russian River can be affected by flow, temperature, and DO changes at multiple life stages. The Russian River supports three species of salmonids, coho salmon, steelhead, and Chinook salmon (Martini-Lamb and Manning 2011). These species follow a similar life history where adults migrate from the ocean to the river and move upstream to spawn in the fall and winter. Females dig nests called redds in the stream substrate on riffles and pool tail crests. As eggs are deposited into the nest they are fertilized by males. The eggs are covered with gravel by the female and the eggs remain in the nest for 8-10 weeks before hatching. After hatching the larval fish, identified as alevins, remain in the gravel for another 4-10 weeks before emerging. After emerging these young salmonids are identified first as fry and then later as parr once they have undergone some freshwater growth. Parr rear for a few months (Chinook) to 2 years (steelhead) in freshwater before undergoing a physiological change identified as smoltification. At this stage, fish are identified as smolts, and are physiologically able to adapt to living in saltwater, and are ready for ocean entry (Quinn 2005). In the Russian River smolts move downstream to the ocean in the spring (Chase et al. 2005 and 2007, Obedzinski et al. 2006). Salmonids spend 1 to 4 years at sea before returning to the river to spawn as adults (Moyle 2002). Because all life stages of all three species of Russian River salmonids spend a period of time in the Russian River watershed, they must cope with the freshwater conditions they encounter including flow, temperature, and DO levels. While broadly all three species follow a similar life history, each species tends to spawn and rear in different locations and are present in the Russian River watershed at slightly different times; consequently, these subtle but important differences may expose each species to a different set of freshwater conditions.

Coho timing

Wild coho have become scarce in the Russian River and monitoring data relies mainly on fish released from the hatchery as part of the Russian River Coho Salmon Captive Broodstock Program (RRCSCBP). Data collected on the Water Agency's Mirabel inflatable dam video camera system in 2011 indicate that the adult coho salmon run may start in late October and continue through at least January (SCWA unpublished data). Spawning and rearing occurs in the tributaries to the Russian River (NMFS 2008). Downstream migrant trapping in tributaries of the Russian River indicate that the coho smolt out-migration starts before April and continues through mid-June (Obedzinski et al. 2006). Coho salmon have been detected as late as mid-July in the mainstem Russian River downstream migrant traps operated by the Water Agency (Martini-Lamb and Manning 2011). For coho, only the temperature and DO data relating to the adult and smolt life stages will be summarized for this report. Spawning and rearing take place in the tributaries which are outside of the spatial boundaries governed by the Order (Table 4-1).

Steelhead timing

Based on video monitoring at the Water Agency's Mirabel inflatable dam and returns to the Warm Springs Hatchery, adult steelhead return to the Russian River later than Chinook. Deflation of the inflatable dam and removal of the underwater video camera system preclude a precise measure of adult return timing or numbers; however, continuous video monitoring at the Inflatable dam during late fall through spring in 2006-2007, timing of returns to the hatchery, and data gathered from steelhead angler report cards (SCWA unpublished data, Jackson 2007) suggests that although very few adult steelhead may return as early September in some years, the vast majority of returns occur between January and

April. Additionally, during coho spawner surveys conducted by the University of California Cooperative Extension (UCCE), steelhead have been observed spawning in tributaries of the Russian River in January, but more often in February and March (Obedzinski 2012).

Many steelhead spawn and rear in the tributaries of the Russian River while some steelhead rear in the upper mainstem Russian River (NMFS 2008, Cook 2003). Cook (2003) found that summer rearing steelhead were distributed in the highest concentrations in the reach of the Russian River between Hopland and Cloverdale (Canyon Reach). Steelhead were also found in relatively high numbers (when compared to habitats downstream of Cloverdale) in the section of river between the Coyote Valley Dam and Hopland (Ukiah Reach), but at a lower density than in the Canyon Reach. The Canyon Reach is the highest gradient section of the mainstem Russian River and contains fast water habitats that include riffles and cascades (Cook 2003). Both the Canyon and Ukiah reaches have cooler water temperatures when compared to other mainstem reaches. The cool water found in the Canyon and Ukiah reaches is a direct result of releases made at the Coyote Valley Dam. Therefore, for steelhead parr, water temperature data will only be summarized at Hopland and Cloverdale because they are the only sites where water temperature data was collected that are within the section of the upper Russian River known to support summer rearing steelhead parr.

The steelhead smolt migration in the Russian River begins at least as early as March and continues through June, peaking between mid-March and mid-May (Martini-Lamb and Manning 2011). For Russian River steelhead, adult migratory, parr (rearing), and smolt life stages are present in the mainstem during the time period covered by the Order and only these life stages will be analyzed for the potential effect of altered temperature and DO levels related to the Order (Table 4-1).

Chinook timing

Based on video monitoring at the Water Agency's inflatable dam in Mirabel, adult Chinook are typically observed in the Russian River before coho and steelhead. Chinook enter the Russian River as early as September, but are typically not present in high numbers until mid-October. Generally the Chinook run peaks between mid-October and mid-November and is over in late December (Chase et al. 2005 and 2007, SCWA unpublished data). Chinook are mainstem spawners and deposit their eggs into the stream bed of the mainstem Russian River and in Dry Creek during the fall (Chase et al. 2005 and 2007, Cook 2003, Martini-Lamb and Manning 2011). Chinook offspring rear for approximately two to four months before out-migrating to sea in the spring. Based on downstream migrant trapping data the majority of the Chinook smolt out-migration appears to be complete by mid to late June (Chase et al. 2005 and 2007, Martini-Lamb and Manning 2011). The adult migratory and smolt life stages are present in the mainstem of the Russian River during the time period covered by the Order. Therefore, temperature and DO levels during the time period related to the Order will be analyzed for these Chinook life stages in this report (Table 4-1).

Table 4-1. The species and life stage of salmonids found in the Russian River watershed that will be analyzed for this report during the period covered by the Order (June 1, 2011 to October 15, 2011) and the justification for excluding certain life stages from the analysis. The Order only applies to the Mainstem Russian River and not its tributaries.

Species	Life stage	Summarized in report	Comments
Chinook	adult	x	September to late December
	spawning		Fall/winter
	egg		Winter/early spring
	alevin		Winter/early spring
	fry		Winter/early spring
	smolt	x	Spring/early summer
steelhead	adult	x	Fall/winter
	spawning		Winter/early spring
	egg		Winter/early spring
	alevin		Winter/early spring
	fry		Spring/early summer
	parr	x	spring/summer/fall/possibly winter
	smolt	x	Winter/early spring
coho	adult		Fall/winter
	spawning		spawns in tributaries
	egg		eggs deposited tributaries
	alevin		Alvin emerge in tributaries
	fry		freshwater rearing takes place in tributaries
	parr		freshwater rearing takes place in tributaries
	smolt	x	Spring/early summer

4.2.3 Methods

The Water Agency operated a downstream migrant trap and later an underwater camera system at the Mirabel inflatable dam approximately 4.8 river kilometers (rkm) upstream of Hacienda. Data from this monitoring site was used to determine what species and life stages were present in the Russian River during the Order. Physical habitat conditions (flow, water temperature, and DO) were collected at multiple sites (Hopland, Cloverdale, Jimtown, Diggers Bend and Hacienda) in the Russian River during the Order. These conditions were compared to findings in the literature that were used to construct temperature and DO criteria for Russian River salmonids during different life history phases. These criteria were used to assess potential impacts to salmonids related to temperature, and DO.

Temperature

Daily minimum and daily maximum water temperature were collected at 5 sites (Hopland, Cloverdale, Jimtown, Diggers Bend and Hacienda) on the Russian River and compared to temperature zones and limits that were constructed from a compilation of temperature data found in the literature. Salmonids have different temperature requirements depending on the species or life stage, therefore the temperature zones and upper limit used in this report differ by species and life stage.

Stream temperatures that restrict salmonids vary with species and possibly by geographical region. Critical temperatures that limit production and survival of salmonids vary widely in the literature. As a result, establishing a single set of criteria that describes the suitability of a particular stream's thermal regime to support salmonids is difficult. For example, Bell (1986) states that the upper lethal temperature of steelhead is 23.8 ˚C, while Nielsen et al. (1994) reported steelhead in the Eel River feeding at water temperatures of 24 ˚C. Further, growth of Chinook has been reported to be maximized at a temperature of 14.8 ˚C when food rations are maintained at 60 percent of satiation, but at 18.9 to 20.5˚F when fish were fed to satiation. Much of the literature analyzing the effects of temperature on fish is focused on determining "optimal" or lethal levels. However, even in natural environments, fish often spend the majority of their time exposed to "suboptimal" conditions. Depending on the elevated temperature, fish are able to survive, grow, and reproduce at temperatures above their theoretical "optimum." Brett (1956) developed a generalized concept of the effects of temperature on salmonids. He used four categories (zones) with five responses to relate the effects of temperature on growth and survival; the upper lethal limit where death occurs rapidly, zone of resistance where death can occur depending on the length of exposure, zone of tolerance where there is no mortality but no growth as well, and the zone of preference where growth occurs proportional to food availability, and optimal zone where growth occurs at all but starvation rations. Below the Zone of Preference growth is reduced by excessively cold temperatures. Sullivan et al. (2000) illustrated this concept graphically (Figure 4-1). It is within the Zone of Preference that fish spend the majority of their lives.

Chinook salmon and steelhead have similar temperature tolerances. In addition, they both spawn in the mainstem Russian River. Coho salmon generally have a lower tolerance for temperature and do not spawn in the mainstem Russian River. Therefore, criteria evaluating the effects of temperature on Chinook salmon and steelhead will be combined, while a separate set of criteria will be developed for Coho salmon. However, the time of year that they are present in the river differ.

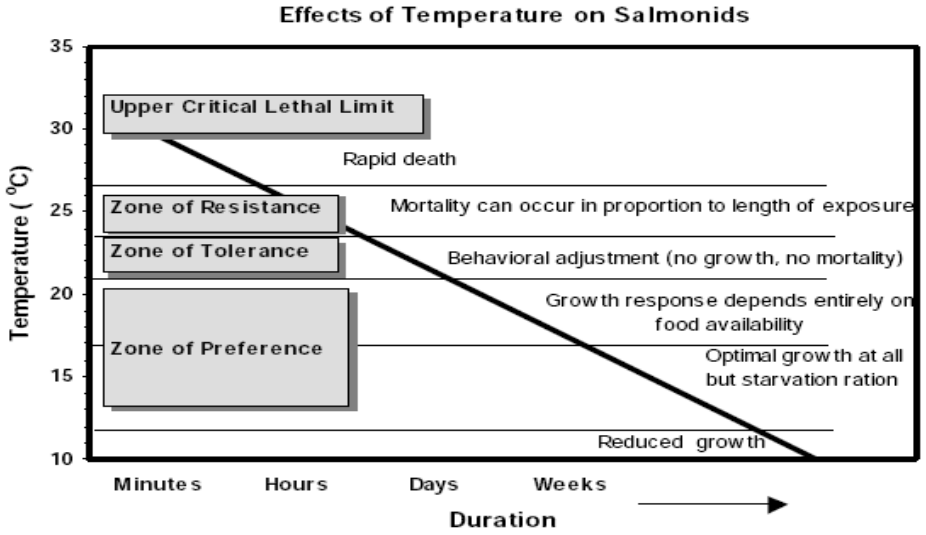

Figure 4-1. General environmental effects of temperature on salmonids in relation to duration and magnitude of temperature (from Sullivan et al. 2000, page 2-2).

Coho salmon

Bell (1986) gives the preferred range of temperatures for emigrating juvenile coho salmon as 7.2 to 16.7 ˚C. The Environmental Protection Agency (EPA 1977) developed the concept of the "Maximum Weekly Average Temperature" (MWAT). A MWAT is the highest temperature that an organism can survive over the long term and maintain a healthy population (the MWAT is based on a 7-day moving average, and is the warmest seven consecutive days recorded annually). The EPA determined that the MWAT for coho salmon was 17.7 ˚C. Welsh *et al.* (2001) compared the distribution of juvenile coho salmon in 21 tributaries in the Mattole River Basin with the maximum weekly maximum temperature (MWMT), defined as the highest average maximum temperature over a seven day period, and the MWAT. The warmest tributaries supporting coho salmon had a MWMT of 18 ˚C, and a MWAT of 16.7 ˚C. All tributaries that had a MWMT of less than 16.3 ˚C and a MWAT of less than 14.5 ˚C supported juvenile coho salmon.

The maximum sustained cruising (swimming) speed of under yearling coho salmon occurred at 20 ˚C; above this temperature, swimming speed decreased significantly (Griffiths and Alderice (1972) and Brett *et al.* (1958), cited by Bell (1986)). Growth of coho salmon fry was reported as high between 8.9 and 12.8 ˚C, but decreased (from 55 mg/day to 35 mg/day) when temperature was increased to 18.1˚C (Stein *et al.* 1972). Coho salmon growth apparently stops at temperatures above 20 ˚C (Bell 1973, cited by McMahon 1983). However, in a field study conducted in Washington, no differences in coho salmon growth rates were found between streams where the daily maximum water temperature exceeded 20 ˚C during July and August and other nearby streams of similar size (Bisson *et al.* 1988). Sullivan *et al.* (2000) concluded that setting an upper threshold for the 7-day maximum temperature at 16.5 ˚C would minimize growth loss for coho salmon. Thomas *et al.* (1986) examined the effects of fluctuating temperature on mortality, stress and energy reserves of juvenile coho salmon. Coho salmon held in a fluctuating environment of 6.5 to 20 ˚C had higher levels of plasma cortisol (which may indicate that the fish were under stress); however, the fish did not exhibit common signs of stress, such as flashing, gasping at the surface, or disorientation. Thomas *et al.* (1986) also reported that all test fish survived when daily temperature fluctuation ranged from 5.0 to 23 ˚C.

Holt *et al.* (1975) found that the percentage of coho salmon and steelhead dying after exposure to a bacterial infection increased with temperature from no mortality at a temperature of 9.4 ˚C to 100 percent mortality at a temperature of 20.6 ˚C. All control fish survived the maximum temperatures tested (23.3 ˚C).

Steelhead

The upper lethal water temperature for steelhead has been reported to be 23.8 ˚C (Bell 1986). Myrick and Cech (2000) reported that various strains of rainbow trout/steelhead can withstand temperatures near 26 ˚C for short periods of time. In the Eel River, juvenile steelhead were observed feeding in surface waters with ambient temperatures up to 24 ˚C (Nielsen *et al.* 1994). Optimal water temperatures for rearing steelhead have been reported to be 10 to 12.7 ˚C (Bell 1984) and 14.2 ˚C (Bovee 1978). Steelhead streams should have summer water temperatures between 10 and 15 ˚C, with maximum water temperatures below 20 ˚C (Barnhart 1986). Myrick and Cech (2000) reported a preferred temperature for wild Feather River steelhead of approximately 17 ˚C under both fed and food deprived conditions, even though the fish were collected from water with temperatures below 15 ˚C.

Myrick and Cech (2005) tested steelhead growth rates at three temperatures (11, 15 and 19 ˚C). Food consumption rates were the same at each temperature, however growth rate was higher at 19 ˚C suggesting improved food conversion efficiency at the higher temperature. Reese and Harvey (2002) found that the growth of and the size of the territory defended by dominant steelhead was reduced in the presence of juvenile pikeminnow at temperatures between 20.0-23 ˚C, but growth was not reduced when the two species were held in treatment water ranging between 15 and 18 ˚C. Werner et al. (2005) detected significant increases in the heat shock protein (hsp) 72 in wild steelhead parr collected in the Navarro River Watershed when the short- and long term daily average temperatures were 18 to 19 ˚C, and daily maximum temperatures were 20 to 22.5 ˚C. Although this study did not report on the ecological consequences of juvenile steelhead rearing at temperatures above 18 ˚C (e.g., reduced growth, survival, etc.), the presence of hsp indicate that the fish were undergoing a response to an outside stressor (temperature in this case), implying a physiological cost to the fish. Nielsen *et al.* (1994) reported an increase in agonistic behavior and a decrease in foraging as stream temperatures increased above 22 ˚C. Harvey et al. (2002) found steelhead in relatively high densities in some tributaries to the Eel River where MWATs ranged between 20-22 ˚C. Steelhead were not observed to move into thermally stratified pools at temperatures below 22 ˚C. Wurtsbaugh and Davis (1977) reported that for fish fed to satiation, an increase in temperature led to an increase in the maximum consumption rates. The high feeding rates decreased the negative effects of increased water temperatures, up to 22.5 ˚C for rainbow trout. Above 22.5 ˚C, feeding rates decreased, possibly due to temperature related stress.

Sullivan *et al.* (2000) concluded that setting an upper threshold for the 7-day maximum temperature at 20.9 ˚C would minimize growth loss for steelhead. Roelofs *et al.* (1993) classified water temperatures in the Eel River as: extremely stressful for steelhead above 26 ˚C, causing chronic physiological stress that jeopardizes survival at temperatures between 23 and 26 ˚C, and as having chronic effects at temperatures between 20 and 23 ˚C. A MWAT has not been calculated for steelhead.

Chinook salmon

The upper critical lethal limit for Chinook salmon has been variously reported to be 26 ˚C (Hansen 1999, cited in Myrick and Cech 2000), 25 ˚C (Brett 1952 and Bell 1986), and 23 ˚C (±1˚C) (Baker *et al.* 1995). Chinook salmon can tolerate brief exposure to temperatures of 28.8 ˚C when acclimated to a temperature 19 ˚C (Myrick and Cech 1999). The upper chronic thermal limit (temperature survived for at least 7 days) is similar to the upper lethal temperatures (24 to 25.1˚C) (Myrick and Cech 2000).

The preferred temperature range for Chinook salmon has been reported to range from 12 to 14 ˚C (Brett 1952) and 13.0 to 14.4 ˚C (Bell 1986). However, Myrick and Cech (2000) reviewed several studies analyzing the effects of temperature on growth of Chinook salmon, and found that growth was maximized at temperatures ranging between 15.3 and 20.5 ˚C, when food was not limiting. Brett et al. 1982 reported growth was maximized between 18.9 and 20.5 ˚C (when fed to satiation), depending on the stock used. Stauffer (1973) (modified by McLean 1979) developed a model for Chinook and coho salmon in a Washington State fish hatchery that predicts growth rate based on ration levels and water temperature. When ration levels were cut to 60 percent of satiation, maximum growth occurred at 14.8 ˚C, and theoretically, zero growth would occur at 21.4 ˚C. Rich (1987) reported maximum growth occurred at 15.3 ˚C, but water quality may have been a factor in the reducing growth in this study. Marine and Cech (2004) reported that Chinook smolts reared at fluctuating temperatures between 17

and 20.0 ˚C grew at rates similar to Chinook smolts reared at 13 to 16 ˚C, and that Chinook smolts survived and grew at temperatures up to 24 ˚C at ration levels found in the wild. However, the rate of growth decreased for fish reared at temperatures above 22 ˚C (Brett et al. 1982).

Water temperatures above 21.1 ˚C have been reported to stop downstream migration of Chinook salmon smolts (Department of Water Resources (DWR) 1988 cited by NCRWQCB 2000). However, in the Russian River, Chinook salmon have been captured in downstream migrant traps (presumed migrating) at temperatures in excess of 21.9 ˚C (Chase et al. 2004). Chinook reared at temperatures greater than 17 ˚C had impaired hypoosmoregulatory capability (ability to adapt to seawater) compared to fish reared between 13 and 16 ˚C (Marine and Cech 2004). However, smolts reared at temperatures between 17 and 20 ˚C did not experience a statistically significant decrease in survival during acute seawater test compared to fish reared at 13 to 16 ˚C. Compared to smolts reared at cooler temperatures, smolts reared at warmer temperatures were more vulnerable to predation during test held at cooler temperatures ranging between 15.0 and 17 ˚C, but were not more vulnerable to predation when the test were held at temperatures ranging from 18 to 21 ˚C. Marine (1997) demonstrated that Chinook salmon can successfully smolt at temperatures up to 20.0 ˚C, however,they did exhibit some impaired patterns compared to fish reared at lower temperatures. Clarke and Shelbourn (1985) and Clarke et al. (1981) reported that optimal temperatures for smolting Chinook salmon range between 10.0 and 17.5 ˚C.

Fall Adult Chinook salmon reportedly migrate at temperatures ranging from 51.1 to 19.4 ˚C, with an optimal temperature of 12.2 ˚C (Bell 1991). Upstream migration by adult Chinook salmon in the San Joaquin River was halted when temperatures exceeded 21.1 ˚C, but resumed when temperatures declined below 17.8 ˚C (Hallock 1970, cited by Entrix (in DW Kelly and Associates and 1992)). However, Dunham (1968, cited by SWRCB 1988) reported that adult salmon migrated through the Klamath River at water temperatures as high as 24.4 ˚C. In the Russian River, adult Chinook salmon have been observed migrating past the Inflatable Dam at temperatures up to 21.8 ˚C, but relatively large numbers of adults are rarely observed at temperatures above 17 ˚C.

Assessing the potential impacts of temperature on adult salmonids is complicated by the fact that temperatures that have little or no impact on the adults may result in reduced survival of their subsequent embryos. Eggs from salmon held for a prolonged time period at 15.6 to 16.7 ˚C had a lower survival rate to hatching (70 percent) compared to eggs from salmon held at 12.8 to 15 ˚C (80 percent survival). Eggs incubated at temperatures above 16.7 ˚C experienced 100 percent mortality (Hinze 1959, cited by DW Kelly and Associates and 1992**)**. Since spawning success involves impacts to both adults and egg development, upstream migration and spawning are considered to be one life stage, and the temperature criteria will be based on the developing eggs, as opposed to impacts to adults which have a higher temperature tolerance.

Adult Chinook salmon begin to migrate upstream through the Russian River in earnest in October through November (low numbers of Chinook salmon have been counted at the Inflatable Dam in late August (≤ 9 annually) and September (0 to 176 annually). Entry into freshwater is based on a number of variables, including time of year, ocean conditions, streamflow, whether the river mouth is opened or closed, and possibly water temperature. Although Chinook salmon have been observed migrating past the Inflatable dam at temperatures ranging to 22.6 °C, approximately 91 percent of the adult Chinook

salmon have been observed at the fish counting station after the average daily temperature declined below 17.1 °C (SCWA unpublished data). Annually, between approximately 73 and 97 percent of the fish counted at the Inflatable dam pass after the average daily temperature declines below 15.6 °C.

Using information gathered from the literature water temperature criteria were constructed for coho, Steelhead, and Chinook. These criteria for each species were subdivided by the following life stages; downstream migrants (smolts), upstream migration and spawning (adults), and juvenile rearing (parr) (Table 4-2 through 4-4).

Table 4-2. Water Temperature Criteria and Life History Phase used to Assess Potential Impacts Related to coho salmon in the Russian River (upstream and downstream migrations).

Downstream migrants (March through June)	
Zone	**Temperature (˚C) criteria**
Zone of Preference – Optimal	< 15
Zone of Preference – Suitable	15 – 17.8
Zone of Tolerance	17.8– 20
Zone of Resistance	20 – 23.8
Upper Critical Lethal Limit	> 23.9
Upstream migration and spawning (November through January)	
Zone	**Temperature (˚C) criteria**
Zone of Preference – Optimal	<12.2
Zone of Preference – Suitable	12.2 – 15.6
Zone of Tolerance	15.6 – 16.9
Zone of Resistance	16.9 – 21.1
Upper Critical Lethal Limit	> 23.9
Juvenile Rearing (June through September)	
Zone	**Temperature (˚C) criteria**
Zone of Preference –Optimal	< 15
Zone of Preference – Suitable	15– 17.8
Zone of Tolerance	17.8 – 20
Zone of Resistance	20 – 23.8
Upper Critical Lethal Limit	> 23.9

Table 4-3. Water Temperature Criteria and Life History Phase used to Assess Potential Impacts Related to steelhead in the Russian River.

Downstream migrants (March through May)	
Zone	**Temperature (˚C) criteria**
Zone of Preference – Optimal	< 17.5
Zone of Preference – Suitable	17.5 – 18.9
Zone of Tolerance	18.9 – 21.1
Zone of Resistance	21.1 – 23.8
Upper Critical Lethal Limit	> 23.9
Upstream migration and spawning (December through March)	
Zone	**Temperature (˚C) criteria**
Zone of Preference – Optimal	<12.2
Zone of Preference – Suitable	12.2 – 15.5
Zone of Tolerance	15.5 – 16.9
Zone of Resistance	16.9 – 21.1
Upper Critical Lethal Limit (adults)	> 23.9
Juvenile Rearing (June through September)	
Zone	**Temperature (˚C) criteria**
Zone of Preference –Optimal	< 15.5
Zone of Preference – Suitable	15.5 – 20
Zone of Tolerance	20 – 21.9
Zone of Resistance	21.9 – 23.8
Upper Critical Lethal Limit	> 23.9

Table 4-4. Water Temperature Criteria and Life History Phase used to Assess Potential Impacts Related to Chinook salmon in the Russian River.

Downstream migrants (March through June)	
Zone	**Temperature (˚C) criteria**
Zone of Preference – Optimal	< 17.5
Zone of Preference – Suitable	17.5 – 18.9
Zone of Tolerance	18.9 – 21.1
Zone of Resistance	21.1 – 23.8
Upper Critical Lethal Limit	> 23.9
Upstream migration and spawning (October through December)	
Zone	**Temperature (˚C) criteria**
Zone of Preference – Optimal	<12.2
Zone of Preference – Suitable	12.2 – 15.5
Zone of Tolerance	15.5 – 16.9
Zone of Resistance	16.9 – 21.1
Upper Critical Lethal Limit (adults)	> 23.9

Dissolved Oxygen

Defining DO criteria for fish is complicated by the interaction between temperature and DO. Temperature strongly influences an organism's metabolism which in turn increases or decreases the DO

demand placed on that organism. For example, Raleigh et al. (1986) summarized several studies on DO-requirements for salmonids and concluded that DO levels of 8 mg/l were optimal at temperatures between 7 and 10 ˚C, but at temperatures above 10 ˚C optimal DO levels were >12.0 mg/l. Bjornn and Reiser (1991) summarized several studies and concluded that food conversion was impaired at DO concentrations less than 5.0 mg/L and that salmonids were not impaired when DO concentrations exceeded 8 mg/L. Depending on temperature, the lower lethal limit for DO is around 3.0 mg/l (Raleigh et al. 1984).

Table 4-5. Dissolved oxygen criteria used to assess conditions for salmonids in Dry Creek and the Russian River.

DO range (mg/L)	Descriptive rating
≤3.0	Lower Lethal Limit
3.1 to <5.0	Zone Resistance
5.0 to < 8.0	Zone Tolerance
8.0 to <12.0	Zone of Preference – Suitable
≥12.0	Zone of Preference – Optimal

4.2.4 Results

Flow

The spring of 2011 had normal rain fall, but flows in the Russian River were effectively reduced in some sections by implementing the flow regimes outlined in the Order. In portions of the upper Russian River near Hopland flows were generally below D1610 minimum (185 cfs), but above the minimum flows authorized by the 2011 Order (Figure 4-2). While the flow of 125 cfs at Healdsburg was not realized during the period the Order was in effect in 2011, flows lower than D1610 minimums were implemented. Flows in the lower Russian River (downstream of the confluence with Dry Creek) were higher than D1610 minimum flows during the entire Order with the exception of a 28-day period spanning portions of August and September (Figure 4-3). Flows during the spring were above D1610 minimums due to rainfall and tributary input.

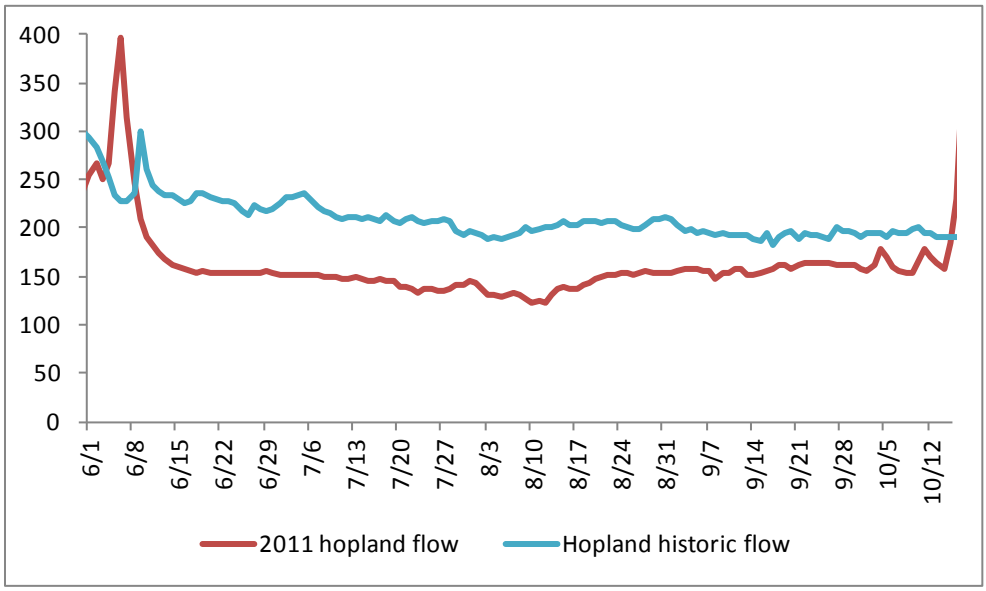

Figure 4-2. The 2011 Hopland average daily flow shown with the Historic flow at Hopland for normal water years (2002, 2003, 2005, 2006)

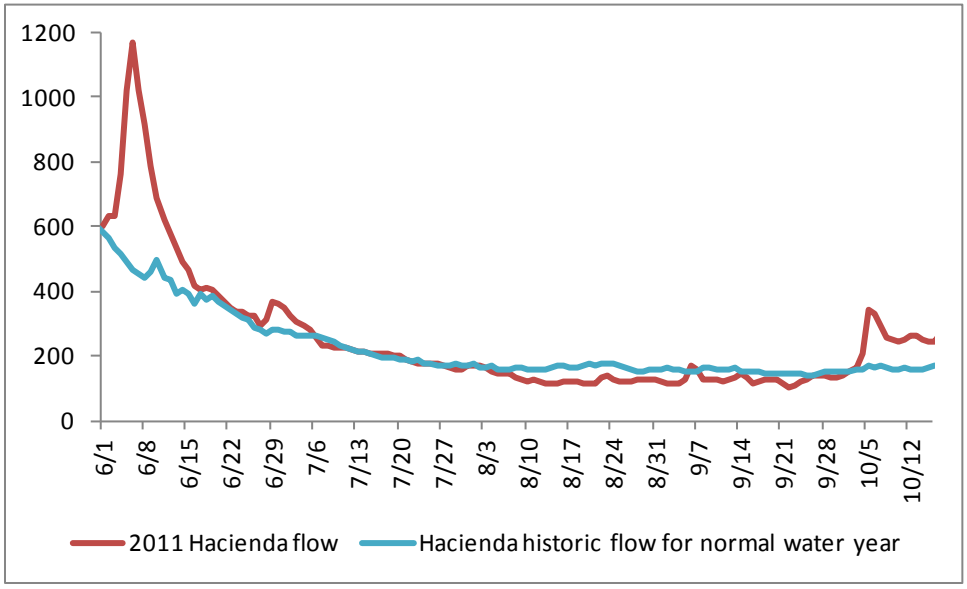

Figure 4-3. The 2011 Hacienda average daily flow shown with the Hacienda flow at Hopland for normal water years (the average flow for years (2002, 2003, 2005, 2006)

Temperature

In the upper Russian River near Hopland, water temperatures remained cooler in the fall than during many other years. During August the daily maximum water temperatures in the upper Russian River diverged from the historic water temperatures from normal water years (2002, 2003, 2005, 2006). On October 6, 2011, this difference became the most apparent and the maximum daily water temperature was 4.1 °C cooler than the historic water temperature for normal water years (the average of the 2002, 2003, 2005, 2006 maximum daily water temperatures for that day) (Figure 4-4). It is important to note that both the ambient air temperature was similar or slightly warmer in 2011 than in normal water years and that flows were less in 2011 than in normal water years (Figure 4-5 and Figure 4-6). The divergence in water temperature in the fall at Hacienda from normal water years is likely due to the cold water pool (the portion of the lake below the thermocline) in Lake Mendocino being depleted under D1610 releases, but being preserved under the flow regime outlined in the Order. The preservation of the coldwater pool may also rely on carry over storage from the previous year as well as the degree of lake mixing which is likely wind driven. Flow is not the only factor in determining water temperature. Ambient air temperature is likely an important factor in determining mainstem Russian River water temperatures. However, preserving the cold water pool into the fall likely provides adult Chinook, as well as summer rearing steelhead, with cooler temperatures in the upper reaches of the mainstem Russian River.

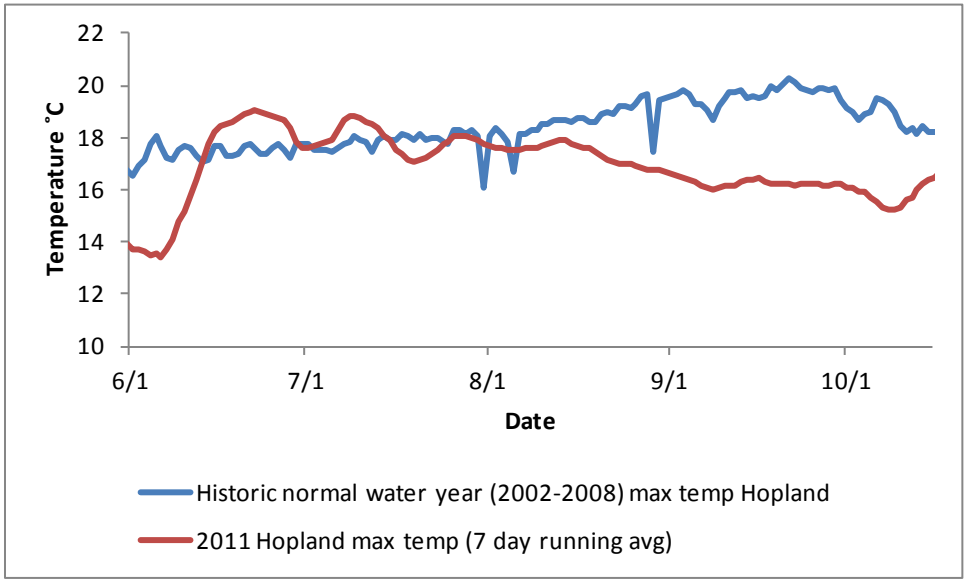

Figure 4-4. The 7-day running average of the daily maximum water temperature in 2011 at Hopland and the historic daily maximum water temperature (the average of the daily maximum water temperature from Decision 1610 normal water years (2002, 2003, 2005, 2006)

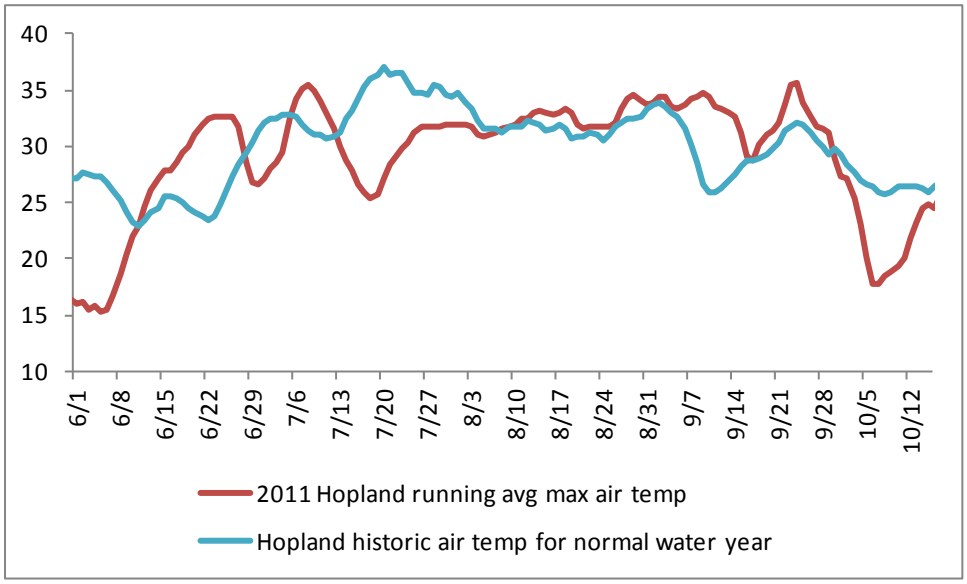

Figure 4-5. The 7-day running average of the daily maximum air temperature in 2011 at hopland and the historic daily maximum air temperature (the average of the daily maximum air temperature from Decision 1610 normal water years (2002, 2003, 2005, 2006).

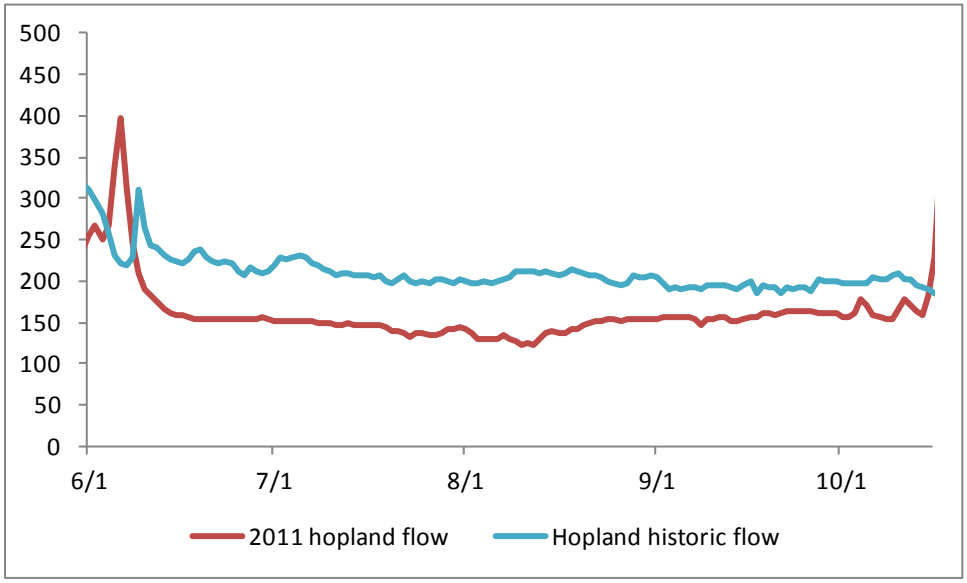

Figure 4-6. The Hacienda flow in 2011 shown with the average flow from normal water years (2002, 2003, 2005, 2006).

In the lower river, 2011 water temperatures were generally similar to normal water years and showed less divergence from normal water years than did Hopland (Figure 4-7). It is important to note that while flow was lower in 2011 than in normal water years, water temperatures were similar between these two groups (Figures 4-8 and 4-9). During the smolt outmigration season there was a large increase in water temperature at Hacienda that took place between June 6, 2011 and July 6, 2011 where daily maximum water temperatures rose from 15.4 °C to 25.5 °C. This temperature increase was not caused by flows dropping below D1610 minimums (125 cfs at hacienda). In fact daily average discharge at Hacienda remained above 255 cfs during this 31 day time period. The temperature increase seen at Hacienda during this time was likely caused by increasing air temperatures (figure 4-9). Daily maximum water temperatures at Hacienda tracked ambient air temperature closely during the spring, but there was some divergence in the fall (Figure 4-9). Daily maximum water temperatures at Hacienda are on average 4.9 °C warmer than at Hopland and follow this trend closely throughout most of the Order (Figure 4-10).

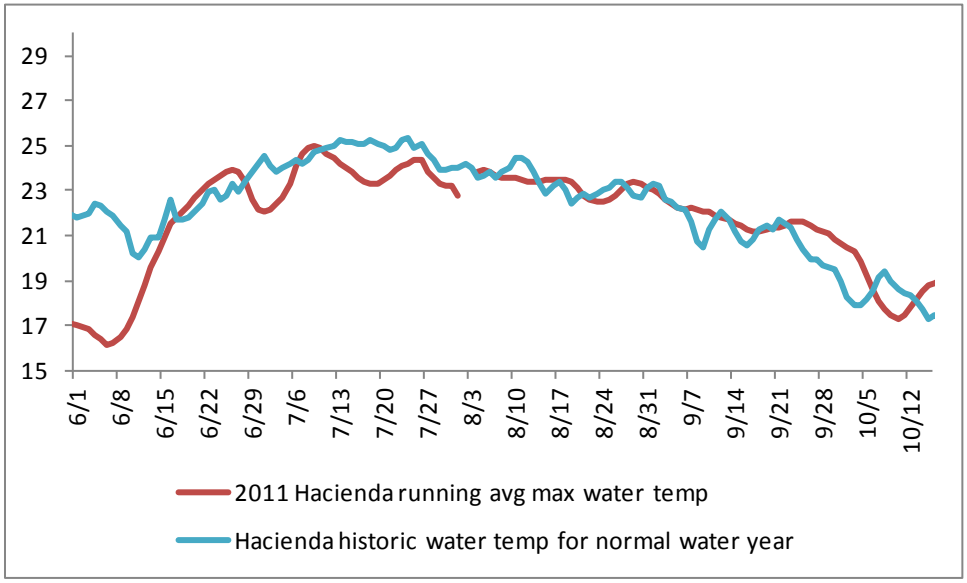

Figure 4-7. The 7 day running average of the daily maximum water temperature in 2011 at Hacienda and the historic daily maximum water temperature (the average of the daily maximum water temperature from Decision 1610 normal water years (2002, 2003, 2005, 2006)

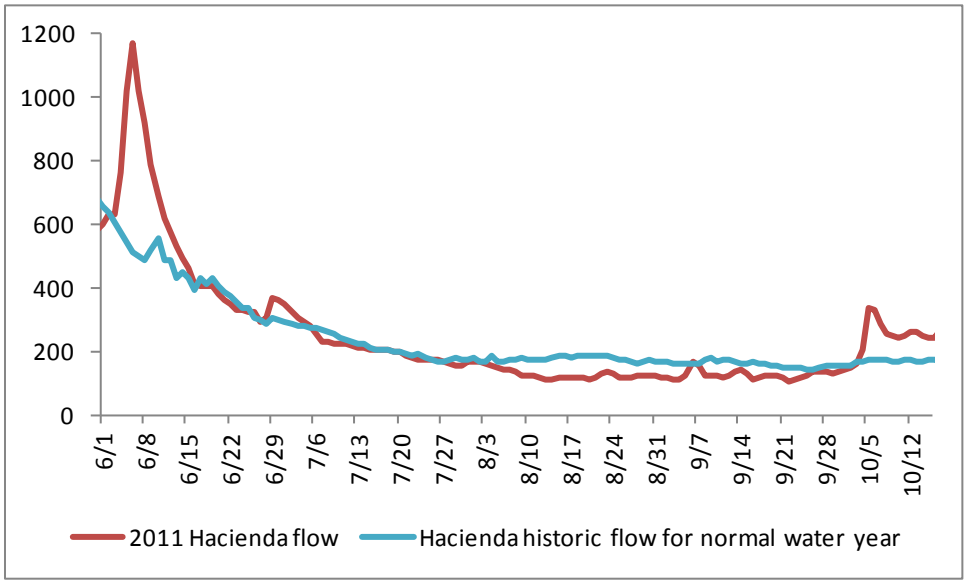

Figure 4-8. The daily discharge (cfs) at Hacienda in 2011 and the average daily discharge for normal water years from Decision 1610 (2002, 2003, 2005, 2006).

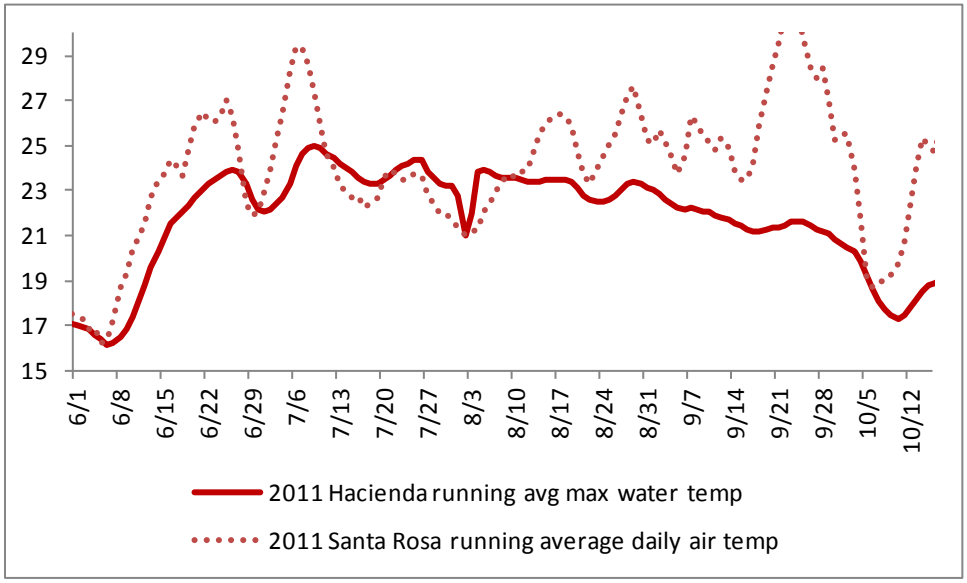

Figure 4-9. The 7-day running average of the daily maximum water temperature in 2011 at Hacienda and the 7 day running average of the daily maximum air temperature in 2011 measured at Santa Rosa.

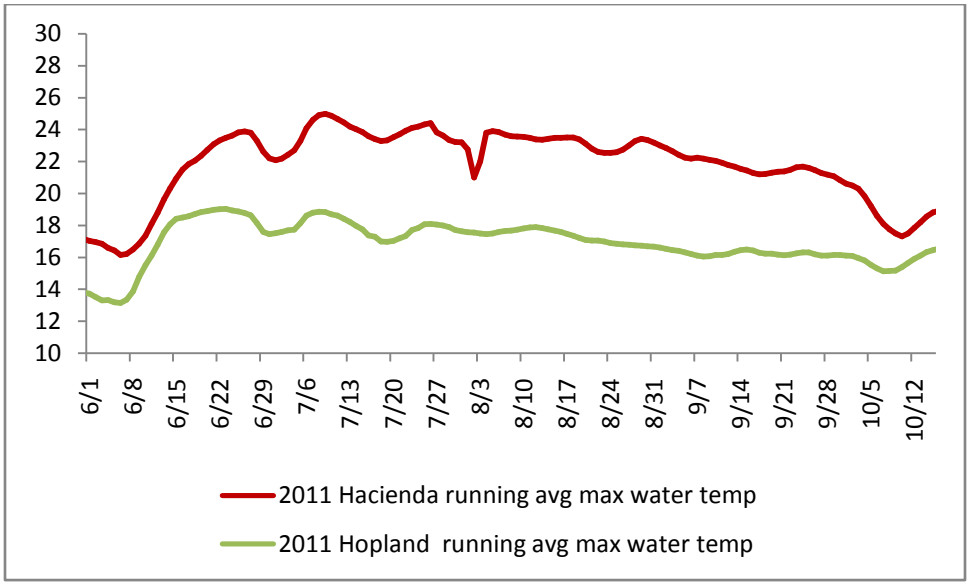

Figure 4-10. The 7-day running average of the daily maximum water temperature in 2011 at Hacienda and at Hopland.

Coho

Coho smolts were migrating through the mainstem Russian River during the beginning portion of the Order. Based on downstream migrant trapping at Mirabel in 2011, coho smolts were present in the mainstem Russian River until at least June 22. At Mirabel, 53 hatchery coho smolts, representing 8.6 % of the season total catch were captured after the Order went into effect on June 1, 2011. During this time 5 wild coho smolts were also captured.

In the section of river that coho smolts would be encountered (downstream of Maacama Creek) water temperatures were collected at Diggers Bend and Hacienda during the coho smolt migration. From June 1 to June 22, 2011, daily water temperatures ranged from a low of 14.3 °C to a high of 26.1 °C at Diggers Bend. At Hacienda Water temperatures ranged from 14.4°C to 24.8 °C. During the period of the Order where coho smolts were detected at Hacienda water temperatures at Hacienda and Diggers Bend were generally in the suitable temperature zone; however, water temperatures did enter the zones of tolerance and resistance near the end of the coho outmigration season. It is important to note that most (91.4%) of the coho smolts captured at Mirabel were captured before the Order went into effect. Only the tail of the run was present in the Russian River during the Order (Figure 4-11). Furthermore nearly all coho spawning habitat in the Russian River is in tributaries in the lower river (downstream of Healdsburg) and in Dry Creek. The only upper river tributary that is known to presently support coho is Redwood Creek a tributary to Maacama Creek. Therefore most of the coho produced in the Russian River basin do not encounter the water temperatures at Diggers Bend.

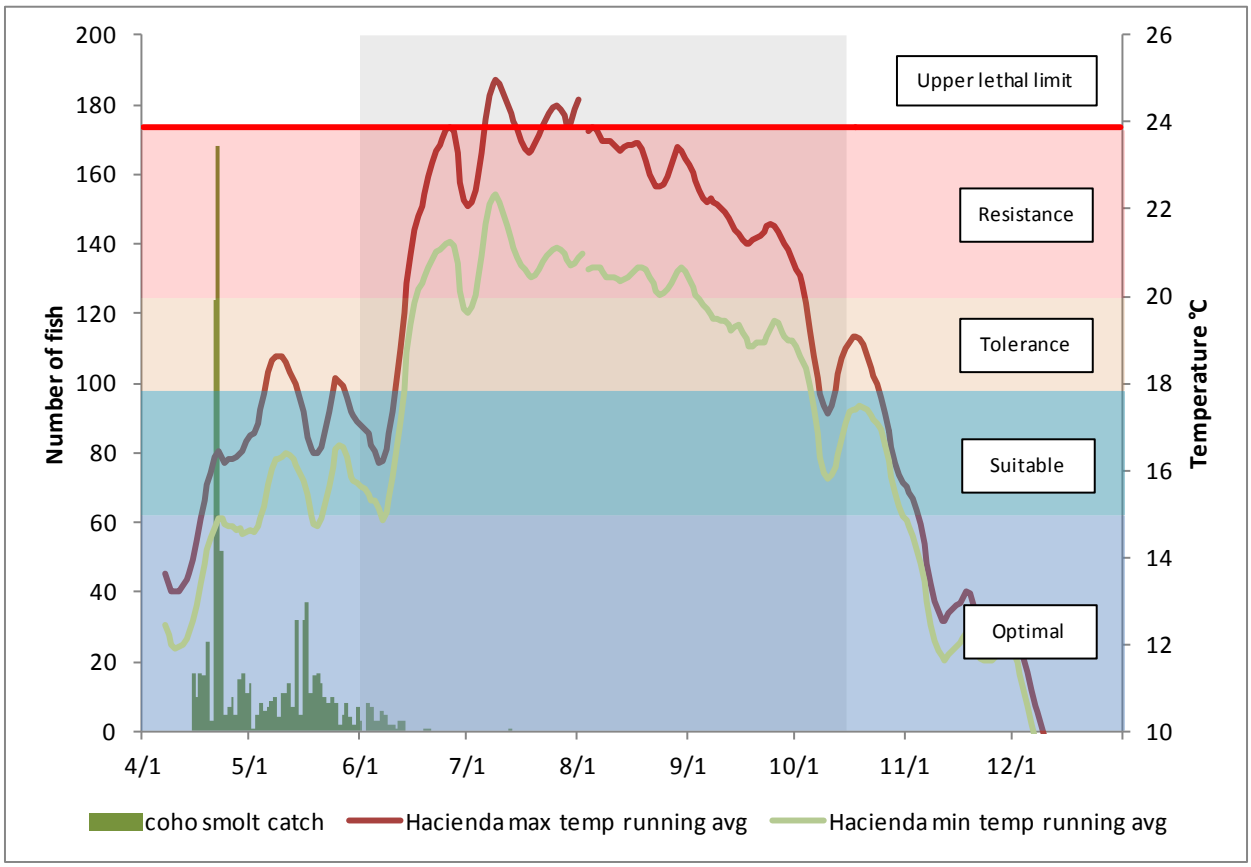

Figure 4-11. The number of coho smolts captured at Mirabel shown with the maximum and minimum daily water temperature 7-day running averages collected at Hacienda. Also shown are the temperature zones of optimal (<15 °C), suitable (15-17.8 °C), tolerance 17.8-20 °C), resistance (20-23.8 °C), and the upper critical lethal limit (>23.9 °C) for coho smolts. The period of the Order (June 1, 2011 to October 15, 2011) is shaded in grey.

Steelhead

Few adult steelhead were found in the Russian River during the time period that the Order was in effect. The first adult steelhead of the 2011 video monitoring season was observed on September 29. A total of 21 adult steelhead were estimated to have passed the Inflatable dam during the 2011 Order (SCWA unpublished data). Water temperatures at Hacienda, ranged from 15.0 °C to 22.1 °C during the period of the Order when adult steelhead were observed at the inflatable dam. During this time, water temperatures at Hacienda were in the zones of tolerance and resistance for adult steelhead (Figure 4-12). However it is important to note that steelhead adults voluntarily leave the ocean and enter the Russian River, and that the bulk of the adult steelhead migration occurs from December through April when water temperatures are much cooler (Chase 2005, Jackson 2007, SCWA unpublished data)

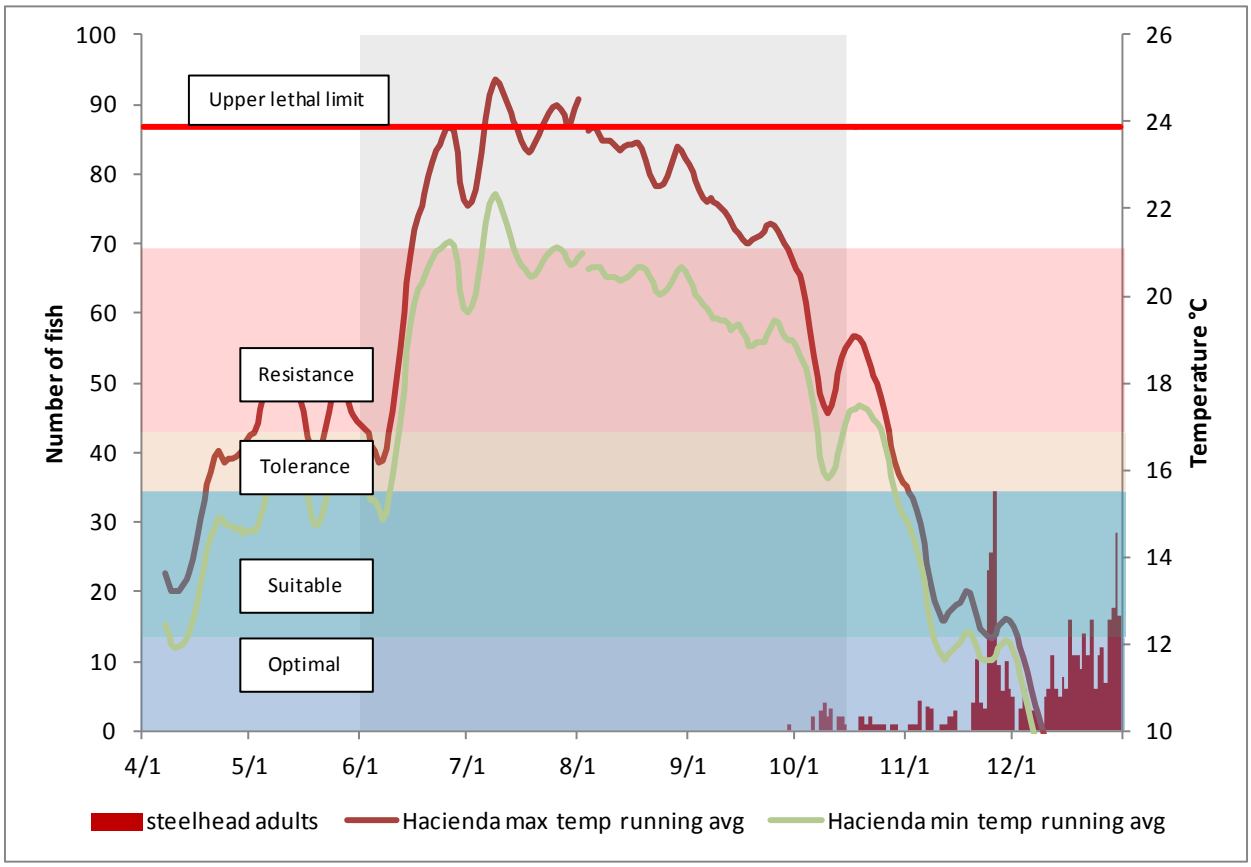

Figure 4-12. The number of steelhead adults observed on the Mirabel camera system shown with the daily maximum and minimum water temperature 7-day running averages collected at Hacienda. Also shown are the temperature zones of optimal (<12.2 °C), suitable (12.2-15.5 °C), tolerance (15.5-16.9 °C), resistance (16.9-21.1 °C), and the upper critical lethal limit (>23.9 °C) for steelhead adults . The period of the Order is shaded in grey.

In reaches that are considered steelhead rearing habitat, Ukiah to Cloverdale, water temperatures were often favorable for juvenile steelhead. During the time period that the Order was in effect, daily water temperatures measured at the USGS gauge (11462500) near Hopland ranged from 11.8 °C to 19.7 °C. At Hopland, the daily maximum and minimum water temperatures were generally in the optimal and suitable temperature zones (Figure 4-13). At Cloverdale, daily maximum water temperatures were generally in the zone of tolerance or suitability with only a few days in the zone of resistance while daily

minimum water temperatures were typically in the suitable temperature zone. It is important to note that the Cloverdale gauge is at the downstream limit of the reaches considered to be steelhead habitat and that water temperatures are gradually cooler as one moves upstream from Cloverdale towards Hopland. Water temperatures remained below the upper critical lethal limit at Hopland and Cloverdale (Figures 4-13 and 4-14).

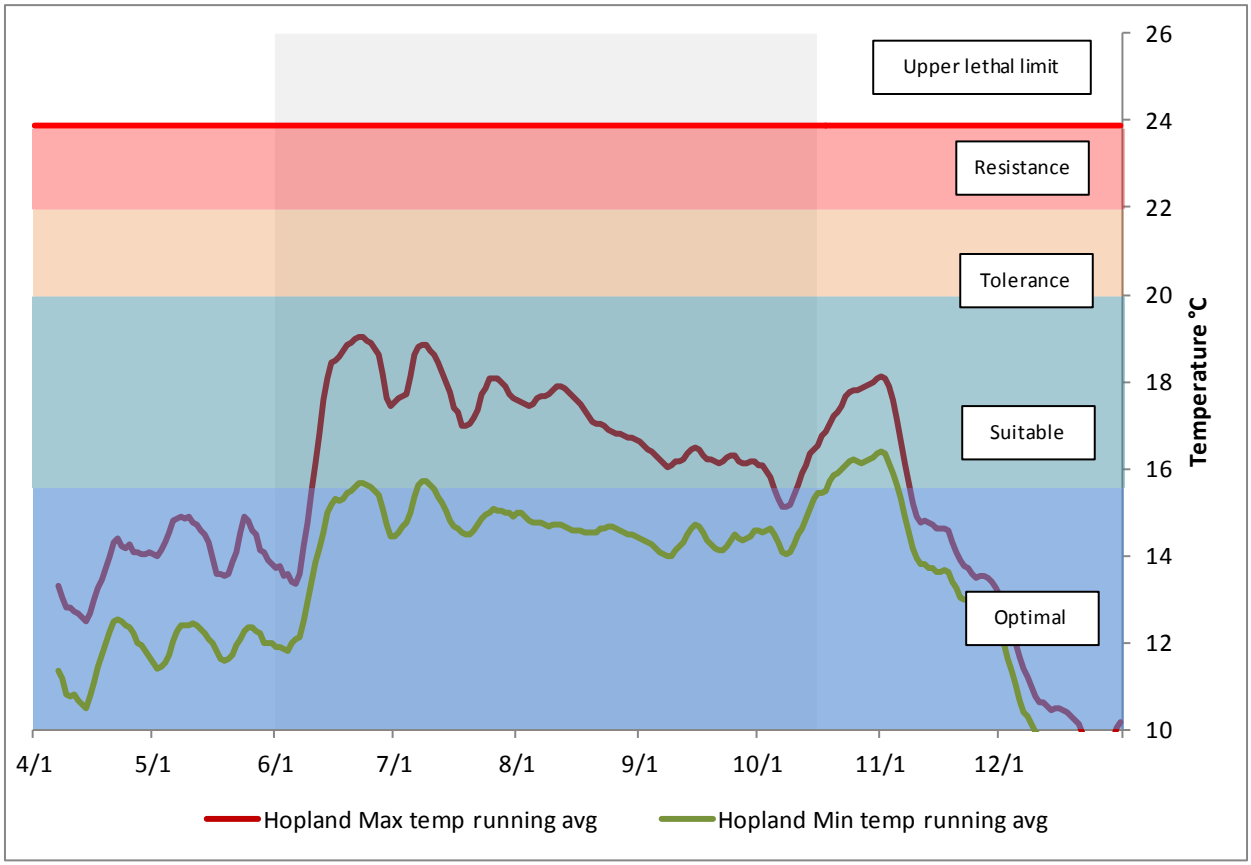

Figure 4-13. The maximum daily water temperature 7-day running average collected at Hopland shown with the temperature zones of optimal (>15.5 °C), suitable (15.5-20 °C), tolerance (20-21.1 °C), resistance (21.9-23.8 °C), and the upper critical lethal limit (>23.9 °C) for steelhead parr. The period of the Order is shaded in grey.

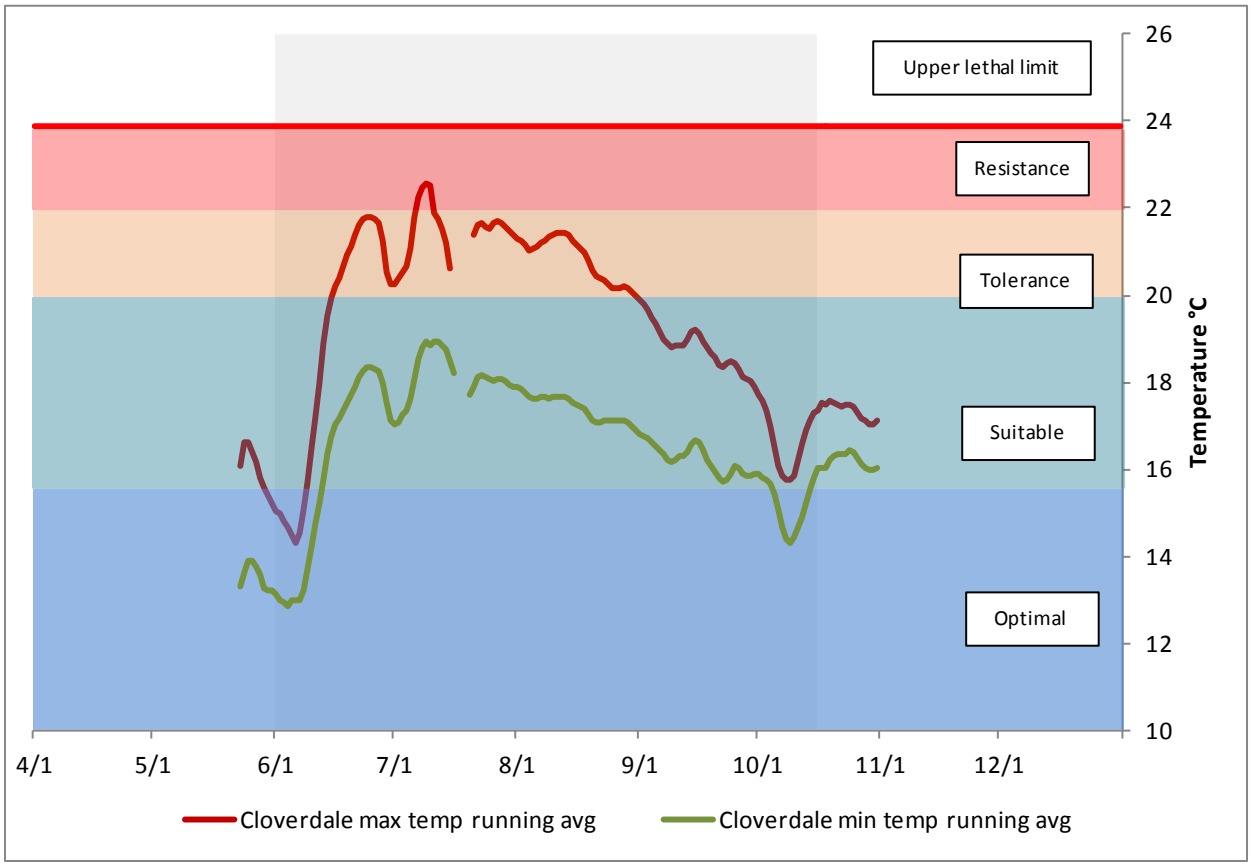

Figure 4-14. The maximum daily water temperature 7-day running average collected at Cloverdale shown with the temperature zones of optimal (>15.5 °C), suitable (15.5-20 °C), tolerance (20-21.1 °C), resistance (21.9-23.8 °C), and the upper critical lethal limit (>23.9 °C) for steelhead parr. The period of the Order is shaded in grey.

Steelhead smolts were present in the Russian River during the time period that the Order was in effect, although probably in low numbers. During 2011, 17 wild steelhead smolts were captured between June 1 and June 16 at Mirabel. The water temperatures at Hacienda ranged from 14.5 °C to 16.7 °C. During the portion of the Order where steelhead smolts were captured at Mirabel Water temperatures at Hacienda were generally in the optimal and suitable zones (Figure 4-15). Hopland, Jimtown, Cloverdale, and Diggers Bend are several miles upstream of the Water Agency's Mirabel trap site. Based on water temperatures it is likely that steelhead would emigrate from these sites earlier in the year. It is likely that many of the steelhead smolts detected in the Water Agency's trap at Mirabel had emigrated from Dry Creek where the water temperatures are much cooler.

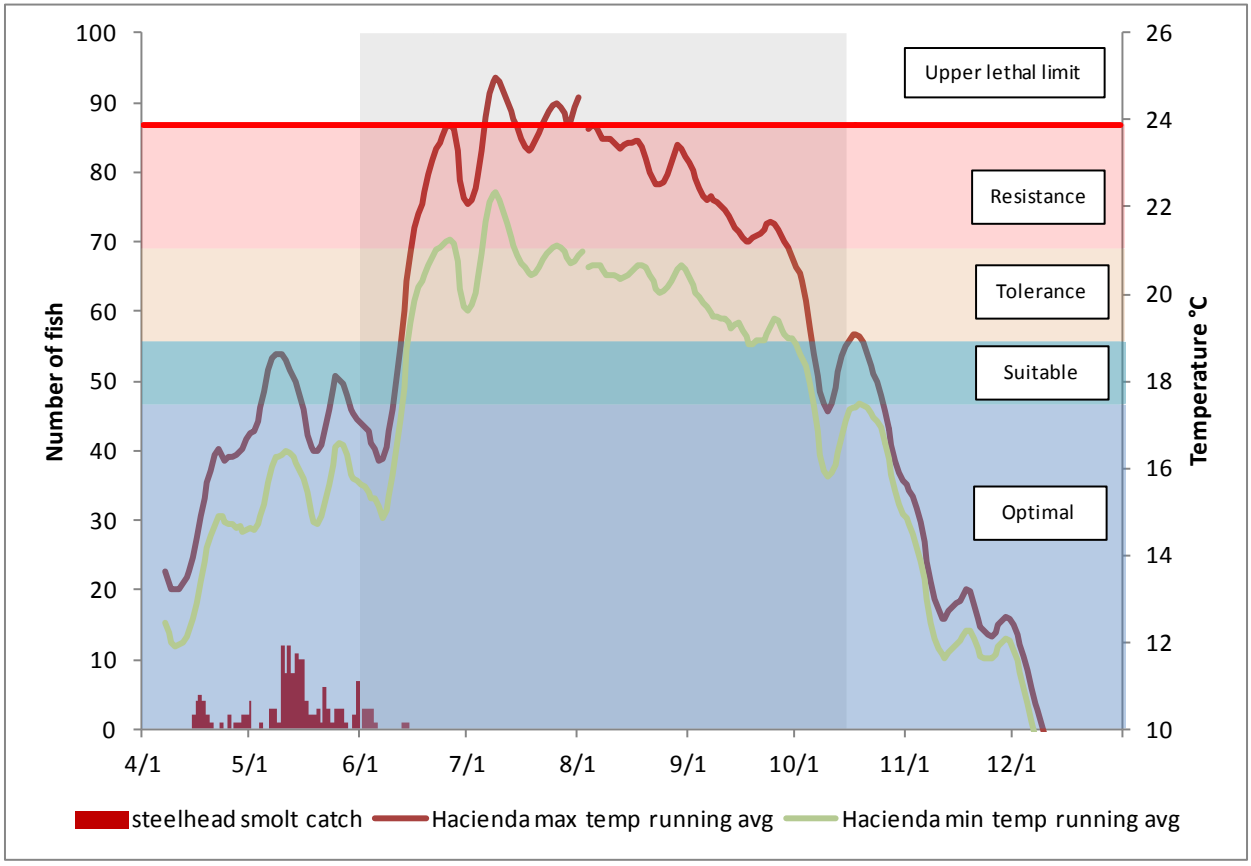

Figure 4-15. The number of steelhead smolts captured at Mirabel shown with the maximum and minimum daily water temperature 7-day running averages collected at Hacienda. Also shown are the temperature zones of optimal (<17 °C), suitable (17.5-18.9 °C), tolerance 18.9-21.1 °C), resistance (21.1-23.8 °C), and the upper critical lethal limit (>23.9 °C) for steelhead smolts. The period of the Order is shaded in grey.

Chinook

Chinook adults were present in the Russian River during the latter portion of the time span regulated by the Order. The first Chinook adult of 2011 was observed on September 25. By October 15, a total of 923 Chinook were estimated to have passed the dam, or 29% of the Chinook adults detected at the inflatable dam. During this time period daily water temperatures at Hacienda were generally in the zone of resistance for the portion of the Chinook run that took place during the Order (Figure 4-16). Dry Creek is an important spawning area and many Chinook salmon migrating upstream during this time period may have been destined for by Dry Creek and the colder water the creek offers.

The 2011 Chinook run began earlier than a typical year. The cause of this early run timing is unknown, but the reduced flows mandated by the Order did not appear to affect migration.

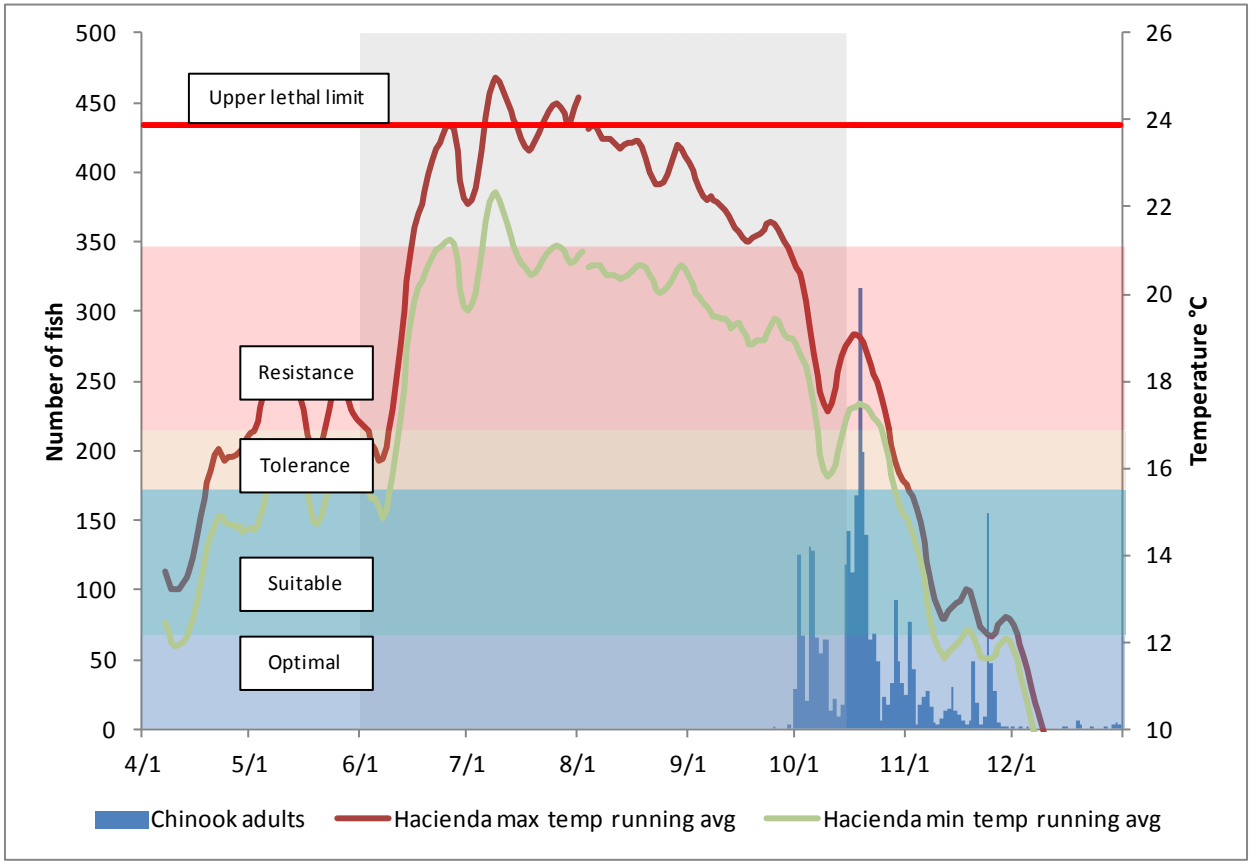

Figure 4-16. The number of Chinook adults detected at Mirabel shown with the maximum daily water temperature 7-day running average collected at Hacienda. Also shown are the temperature zones of optimal (<12.2 °C), suitable (12.2-15.5 °C), tolerance (15. 5-16.9 °C), resistance (16.9-21.1 °C), and the upper critical lethal limit (>23.9) for Chinook adults. The period of the Order is shaded in grey.

Between June 1, 2011 and when the traps were removed on July 19, 2011, a total of 3,006 Chinook smolts were captured at Mirabel. During the period of the Order daily maximum water temperatures at Hacienda were in the zones of optimal, suitable, tolerance, and resistance temperature conditions, with the tolerance, and resistance temperature conditions occurring during the tail of the Chinook smolt run (Figure 4-17). Based on water temperatures it is likely that many of the Chinook smolts that originated in the mainstem Russian River would have emigrated by the time the Order went into effect. Many of the Chinook smolts detected at the Mirabel traps during the Order likely originated in Dry Creek. This is reflected in the weekly population estimates constructed for the Mirabel and Dry Creek fish traps. Before May 25 the weekly population estimate at Mirabel was much larger than at Dry Creek. This suggests that the mainstem Russian River is contributing a large portion of the fish seen at the Mirabel trap. However after May 25 the population estimates between Mirabel and Dry Creek are similar, which suggests that Dry Creek is the dominate source of fish seen at Mirabel and that the mainstem Russian River is contributing much less to the Mirabel catch (Figure 4-18). Fish emigrating from Dry Creek would have entered the mainstem Russian River downstream of Healdsburg and not experienced the water temperatures at Diggers Bend and Jimtown. These fish would have passed Hacienda as they emigrated from the Russian River. While water temperatures entered the zones of tolerance and resistance

Russian River Chinook adapted under historic conditions that were likely naturally warm. Smolts from the Russian River Chinook population may be able to cope with warmer water than the populations of Chinook used in the literature to construct these temperature zones.

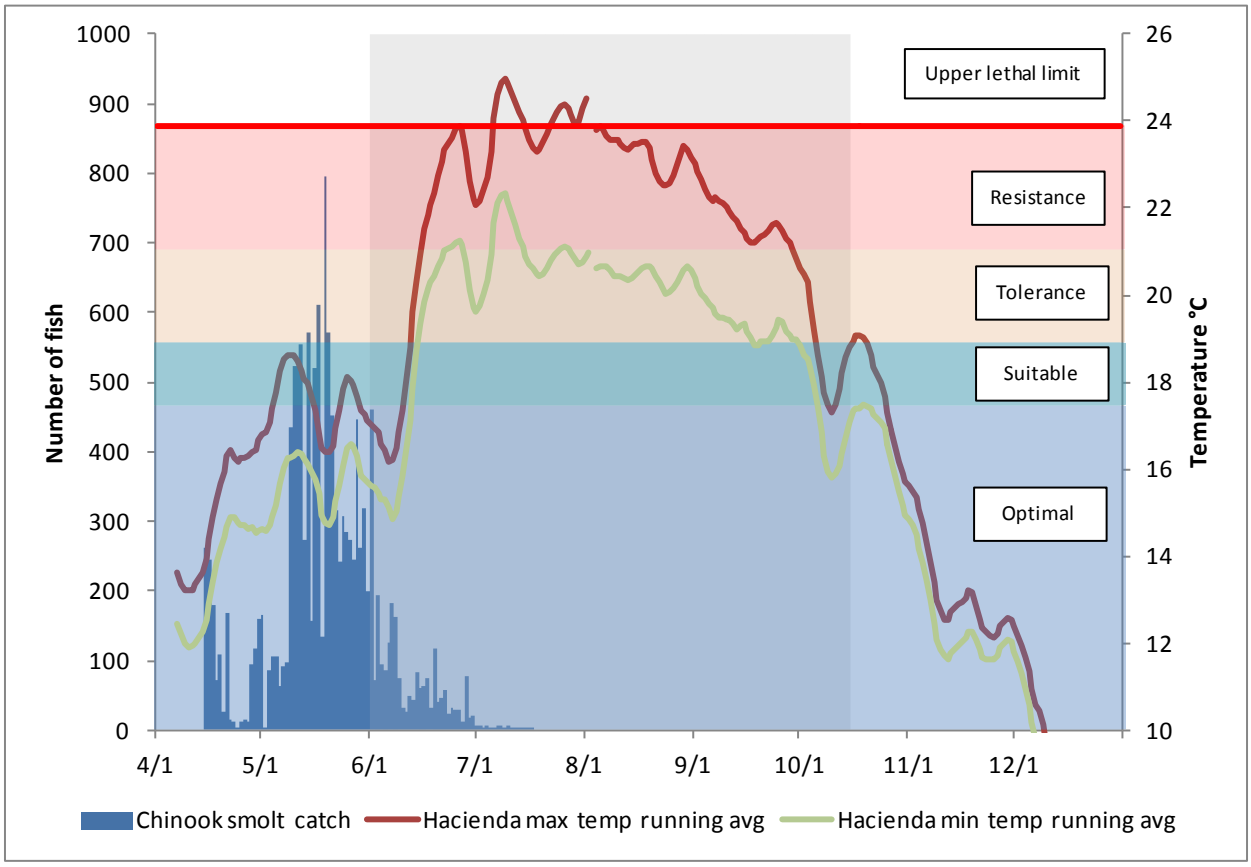

Figure 4-17. The number of Chinook smolts detected at Mirabel shown with the maximum daily water temperature 7-day running average collected at Hacienda. Also shown are the zones of optimal (<17 °C), suitable (17.5-18.9 °C), tolerance 18.9-21.1 °C), resistance (21.1-23.8 °C), and the upper critical lethal limit (>23.9 °C) for Chinook smolts. The period of the Order is shaded in grey.

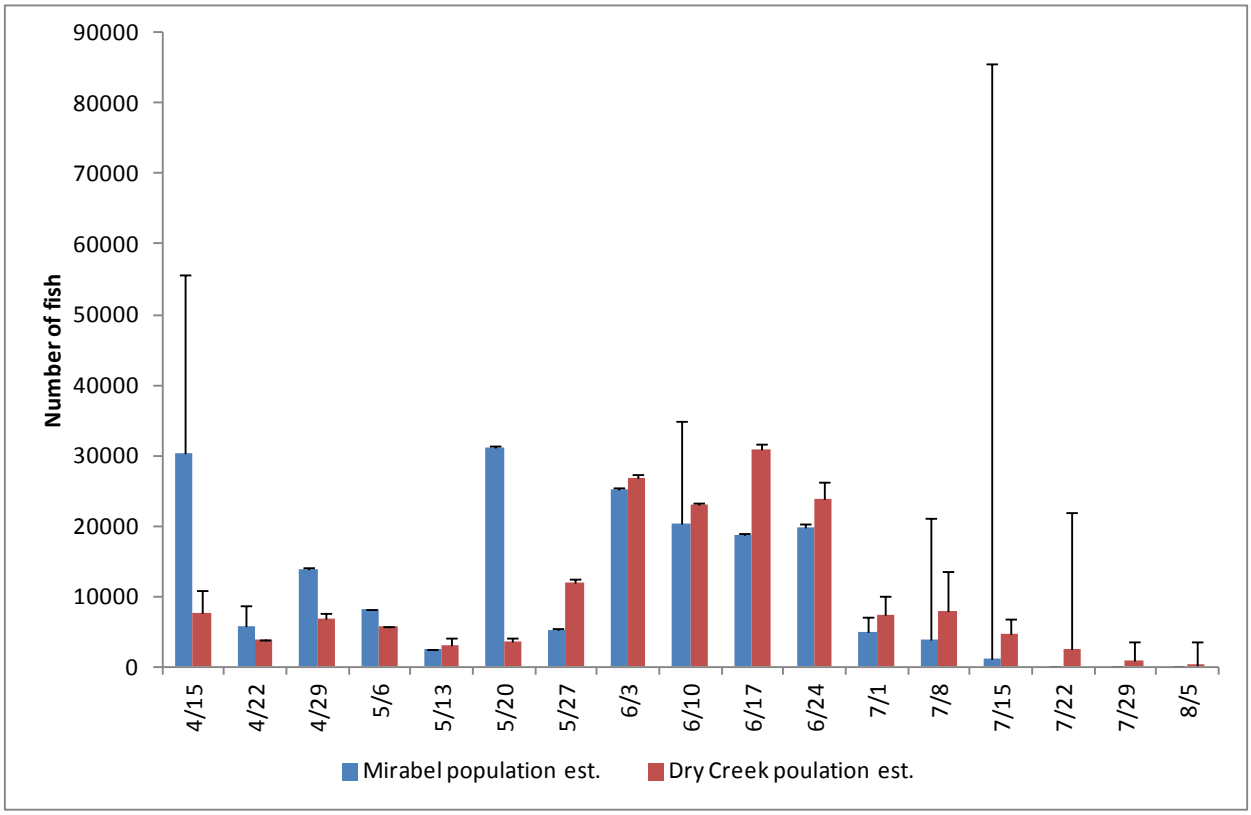

Figure 4-18. The weekly Chinook smolt population estimate at Mirabel and at Dry Creek during the 2011 trap season. Shown with the upper bounds of the estimate.

Dissolved Oxygen

The data for the DO section of this report has been summarized for the time period when the Order overlaps the presence of each salmonid life stage found in the upper mainstem of the Russian River. Unlike temperature Dissolved oxygen requirements are fairly similar between species.

Adult Salmonids

Adult steelhead and Chinook were present in the Russian River during a portion of the Order. During the Order no adult coho were observed on the Mirabel camera system. The first adult salmonid observed in 2011 at the Inflatable dam was a steelhead on September 29. A total of 21 adult steelhead (wild and hatchery origin) were observed passing the Inflatable dam before October 15, 2011. The first Chinook observed on the camera system was on September 25 and by October 15, 2011 a total of 923 Chinook were counted as they passed the Inflatable dam (SCWA unpublished data). From September 22 to October 15, 2011, the lowest minimum DO readings at Hopland, Cloverdale, Jimtown, Diggers Bend, and Hacienda were 8.3, 8.2, 6.9, 7.5, and 7.5 mg/L, respectively. Both daily minimum and maximum levels of DO were typically within the suitable zone for adult salmonids at Hacienda (Figure 4-19).

Daily minimum DO levels at Jimtown were typically in the zone of tolerance while daily maximum dissolved oxygen levels were typically in the suitable and optimal zones. Jimtown was the only monitoring station that had daily minimum DO levels below 7.0 mg/L during the September 22 and

October 15, 2011, time period. Daily minimum DO levels were below 7 mg/L for 3 days of the 24-day period between September 22 and October 15, 2011.

While daily minimum DO levels at Jimtown were low enough to enter the zone of tolerance Chinook adults may have been able to avoid these low levels by migrating past Jimtown during a portion of the day with higher DO levels, using other portions of the basin, or by holding downstream of Jimtown and migrating past Jimtown later in the year when conditions improved. During the 24 day long portion of the Order when adult salmonids were observed passing the Inflatable dam the lowest daily maximum DO level at Jimtown was 9.9 mg/L (Figure 4-20). This suggests that adult salmonids would be able to migrate past Jimtown during a portion of each day during the Order. The Russian River and Dry Creek confluence is located downstream of Jimtown. It is important to note that Dry Creek is heavily used by Chinook, steelhead, and coho (Martini-Lamb and Manning 2011) and that Dry Creek may have been the destination of many of the adult salmonids observed at Mirabel during the September 22 to October 15 time period. Furthermore, daily minimum DO levels reached 7 mg/L by September 24, 2011 at Jimtown and remained above 7 mg/L until at least when the gauge went offline on October 31.

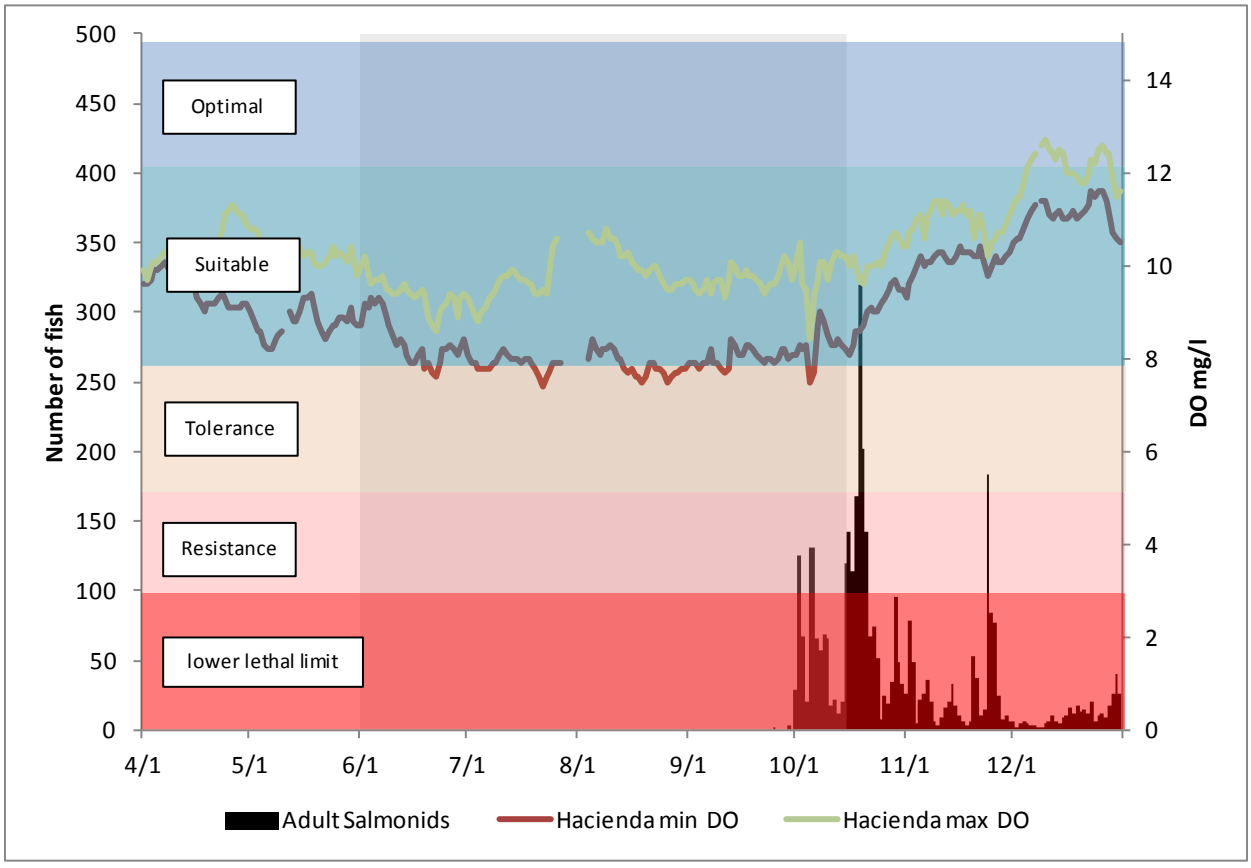

Figure 4-19. The number of adult salmonids observed at Mirabel shown with the daily minimum and daily maximum levels of DO at Hacienda. Also show are the DO zones of optimal (≥ 12 mg/L), suitable (8 to <12 mg/l), tolerance (5 to <8 mg/L), resistance (3.1 to <5 mg/L), and the lower lethal limit (≤3 mg/L) of DO for adult salmonids.

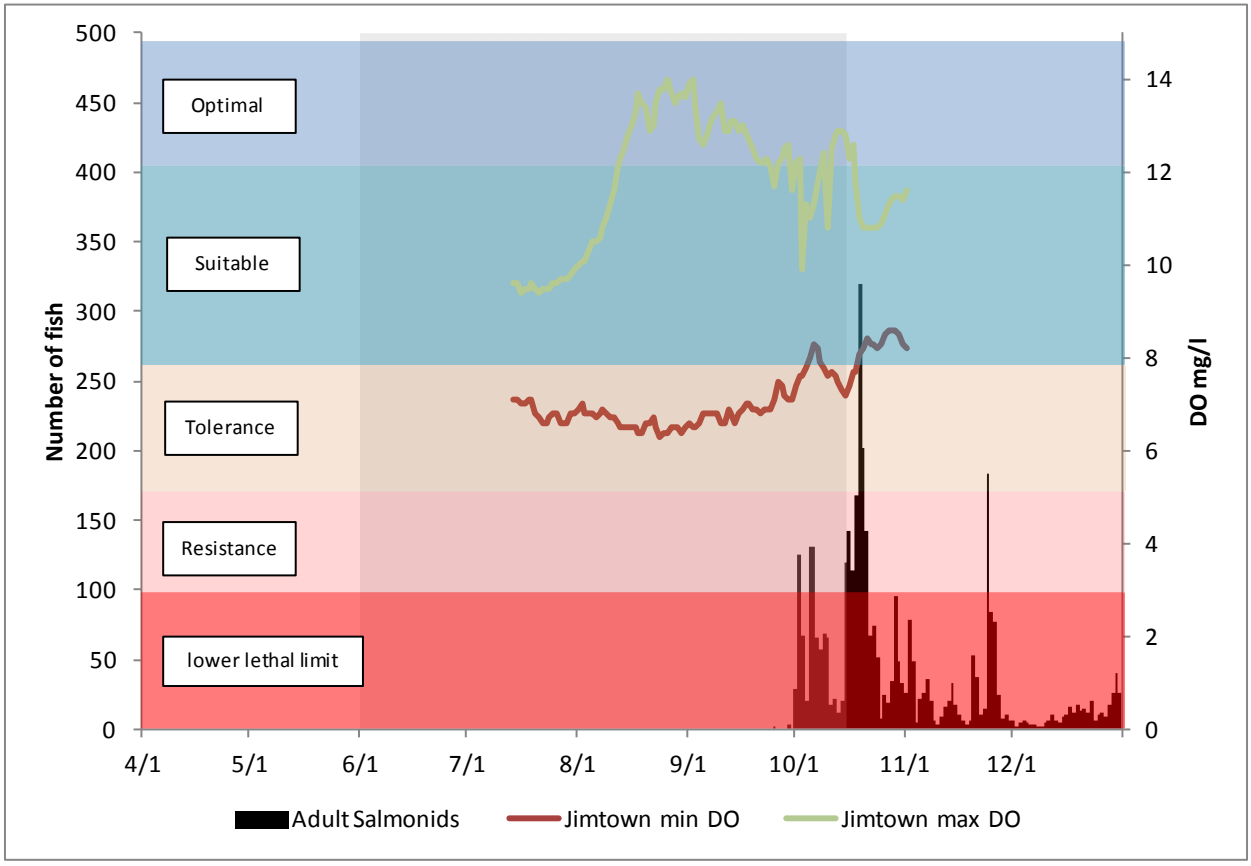

Figure 4-20. The number of adult salmonids observed at Mirabel shown with the daily minimum and daily maximum levels of DO at Jimtown. Also show are the DO zones of optimal (≥ 12 mg/L), suitable (8 to <12 mg/l), tolerance (5 to <8 mg/L), resistance (3.1 t to <5 mg/L), and the lower lethal limit (≤3 mg/L) of DO for salmonids.

Juvenile freshwater rearing

Steelhead parr rear in the upper mainstem of the Russian River above Cloverdale year around (NMFS 2008). During the order the lowest daily minimum DO readings at Hopland and Cloverdale was 8.1 mg/L. Dissolved oxygen levels remained in the suitable zone for steelhead parr rearing at Hopland throughout the duration of the Order (Figure 4-21). At Cloverdale daily minimum DO levels occasionally entered the zone of tolerance, but were typically in the suitable zone (Figure 4-22). Daily maximum DO levels at Cloverdale remained in the suitable zone throughout the duration of the Order.

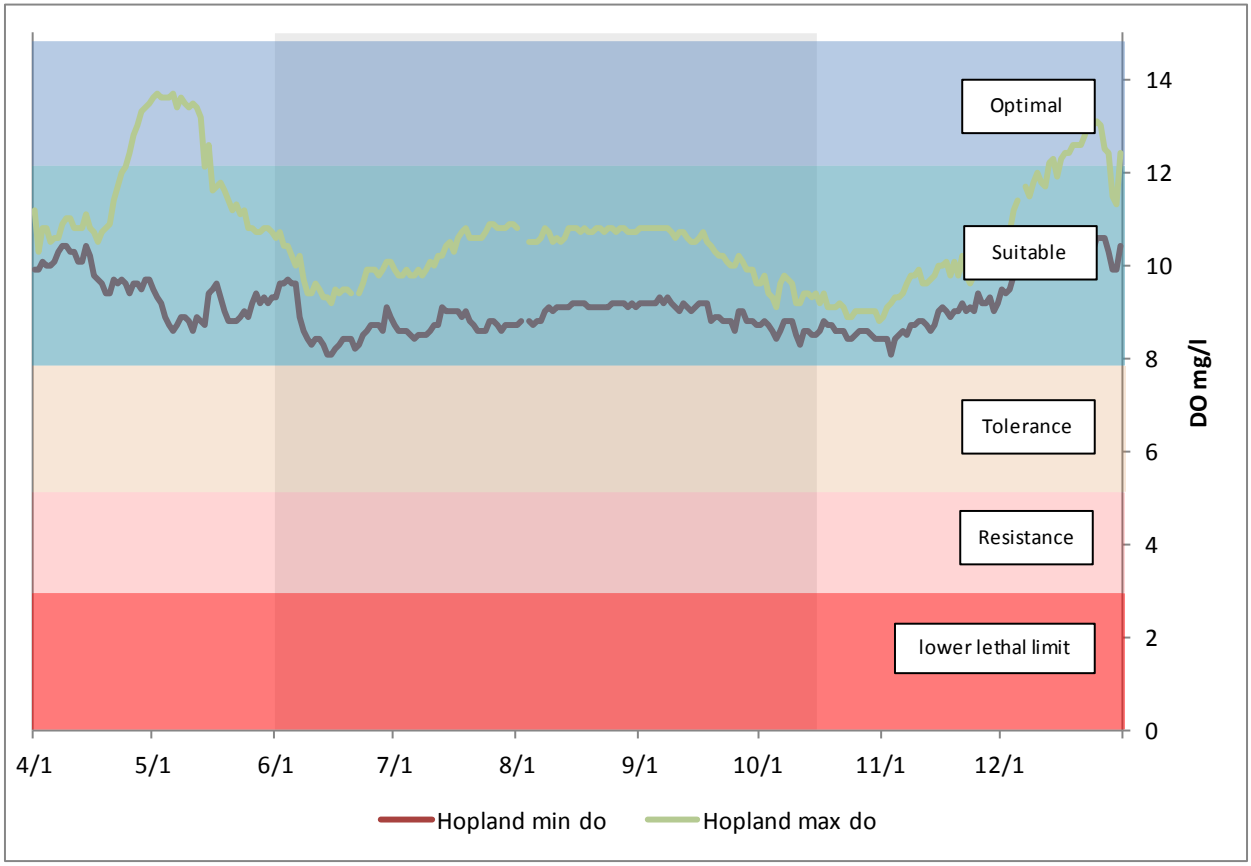

Figure 4-21. The daily minimum and daily maximum levels of DO at Hopland. Also show are the DO zones of optimal (≥ 12 mg/L), suitable (8 to <12 mg/l), tolerance (5 to <8 mg/L), resistance (3.1 to <5 mg/L), and the lower lethal limit (≤3 mg/L) of DO for salmonids.

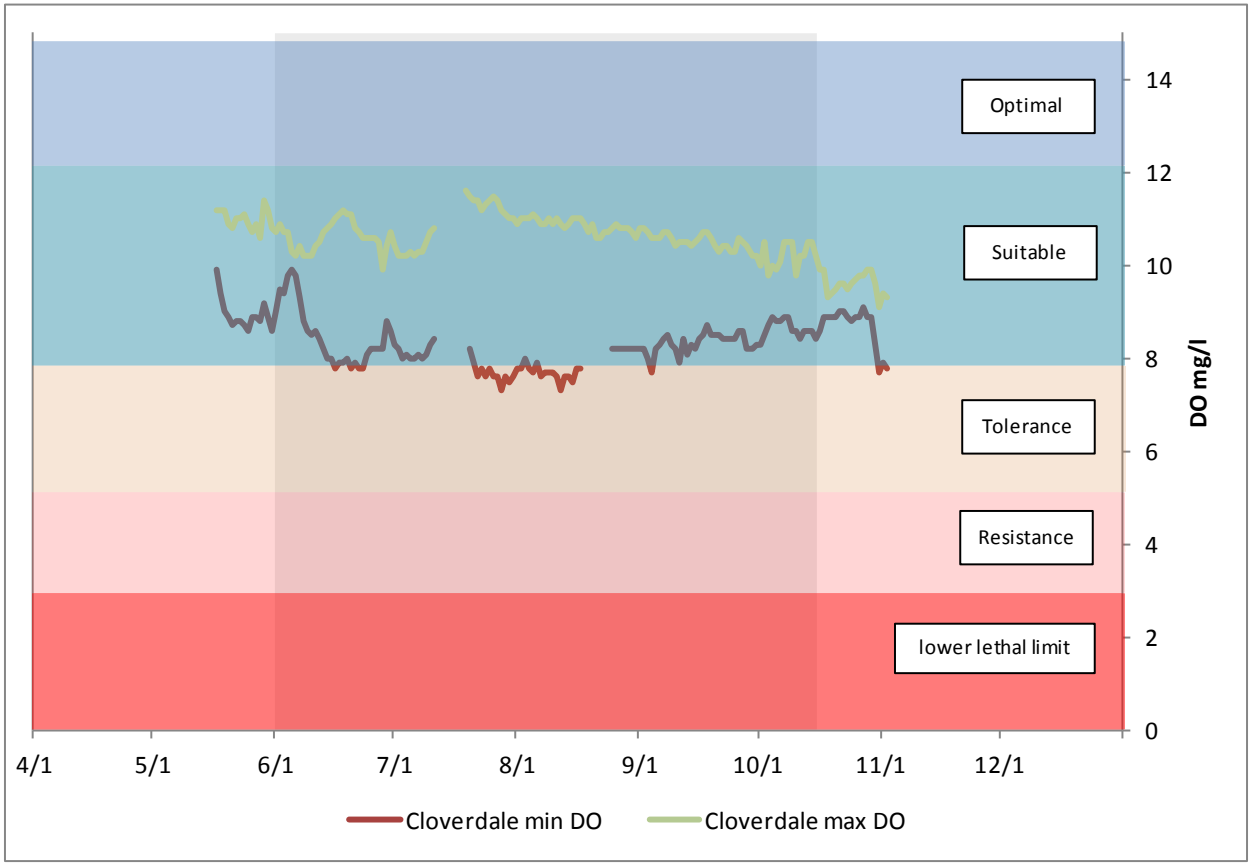

Figure 4-22. The daily minimum and daily maximum levels of DO at Cloverdale. Also show are the DO zones of optimal (≥ 12 mg/L), suitable (8 to <12 mg/l), tolerance (5 to <8 mg/L), resistance (3.1 to <5 mg/L), and the lower lethal limit (≤3 mg/L) of DO for salmonids.

Smolts

Salmonid smolts were observed in the mainstem Russian River during the June and July portion of the Order. Downstream migrant traps were installed at the Inflatable dam in 2011 before the Order went into effect and were operated until July 19, 2011. The traps were ultimately removed because the daily catch of salmonids was diminishing. In total 3,006 Chinook smolts, 53 hatchery and 5 wild coho smolts, and 17 wild steelhead smolts were captured in the downstream migrant traps from June 1 to July 19, 2011. During the time period that salmonid smolts were captured at the inflatable dam daily minimum and maximum DO readings Hacienda were 7.4 mg/L and 10.2 mg/L, respectively. During this time the daily minimum DO at Hacienda was typically in the suitable DO zone and occasionally in the zone of tolerance while the daily maximum DO remained in the suitable DO zone (Figure 4-23).

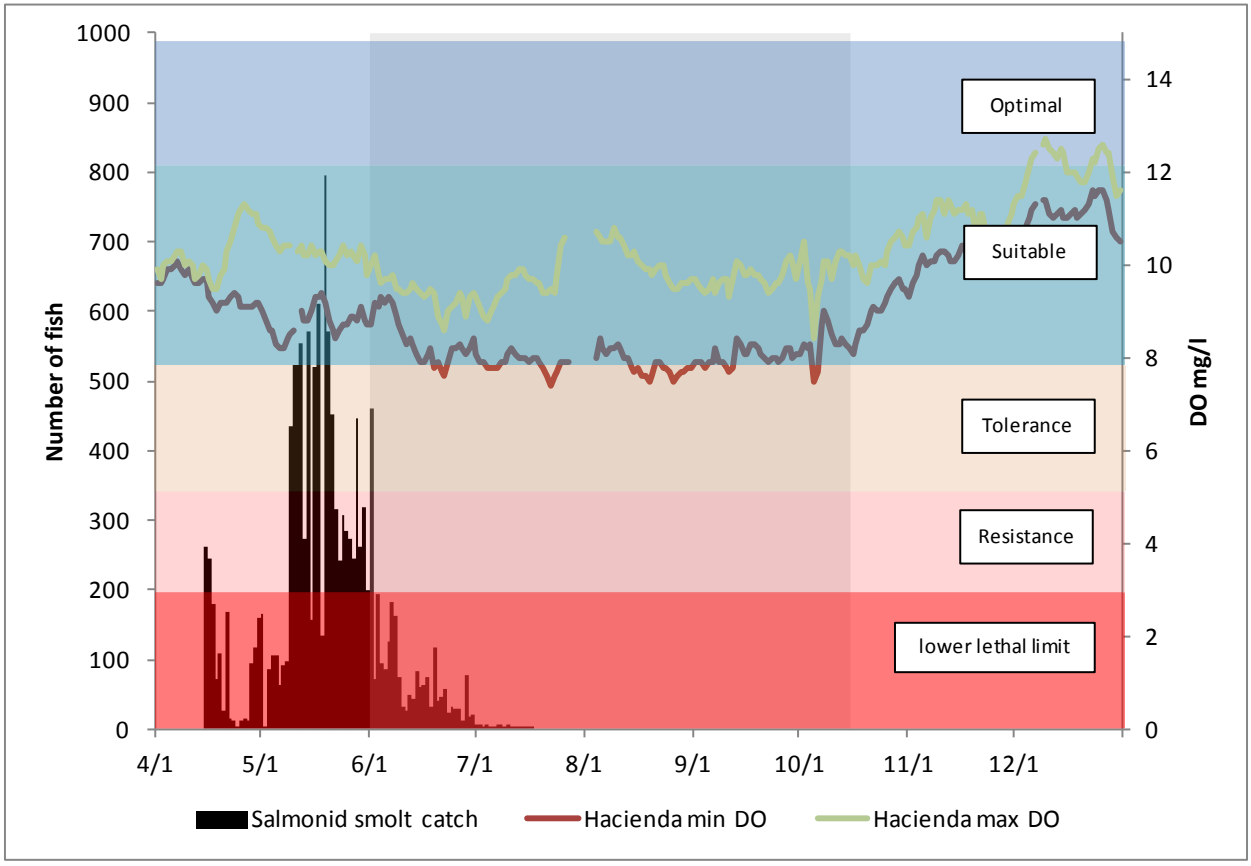

Figure 4-23. The number of salmonid smolts observed at Mirabel shown with the daily minimum and daily maximum levels of DO at Hacienda. Also show are the DO zones of optimal (≥ 12 mg/L), suitable (8 to <12 mg/l), tolerance (5 to <8 mg/L), resistance (3.1 to <5 mg/L), and the lower lethal limit (≤3 mg/L) of DO for salmonids.

4.2.5 Summary

The Water Agency was tasked with evaluating impacts to water quality and the availability of aquatic habitat for salmonids in the Russian River associated with flow reductions outlined in the Order. However due to a relatively small temperature and DO data set coupled with climate variability it is difficult to determine, in most cases, if changes in temperature or DO were due to flow changes related to the Order. Therefore the Water Agency summarized the environmental conditions experienced by salmonids during the Order and compared these conditions to standards outlined in the literature.

Flow

Flows were effectively reduced in summer steelhead rearing habitat in the upper Russian River during a portion of the time period covered by the Order. For much of the duration of the 2011 Order, flows in the upper Russian River were lower than D1610 flows and closer to the flows that are outlined in the Biological Opinion to improve salmonid habitat. However flows in the lower Russian River remained above D1610 minimum instream flows for all but 28 days in 2011 (Figures 4-2 and 4-6).

Temperature

At Hopland water temperatures were cooler in 2011 when compared to historic normal water years where flows were above D1610 minimums (Figure 4-4). This is likely due to preserving the cold water pool (the cooler portion of the lake below the thermocline) in Lake Mendocino during the 2011 flow

regime, but depleting the cold water pool during D1610 flows. This trend is not present at downstream gauge stations probably because stream temperatures at downstream gauge sites are more dependent on air temperatures since there is a longer period of time for the water to warm once released from the dam than water at the Hopland gauge site (Figure 4-7). Water temperature at Hacienda seemed to track local air temperatures fairly closely during the smolt season (Figure 4-9). In the early part of the order, during the smolt season, maximum daily air temperatures climbed at Santa Rosa and water temperatures at Hacienda rose sharply despite the flows remaining above 255 cfs which is well above D1610 minimum instream flows.

Coho

Adult coho were not observed in the Russian River during the Order, but both hatchery and wild Coho smolts were observed. Coho smolts use the mainstem Russian River as migratory habitat and were in the river during the beginning portion of the Order, but in relatively low numbers. By the time that the order went into effect the coho smolt emigration was ending. During the Order, daily maximum water temperatures for coho at Hacienda were in the zone of suitability and the zone of tolerance with only a few individuals emigrating during the tail of the run in the zone of tolerance. However, flows at Hacienda were well above D1610 minimum flows during the time period that water temperatures were in the zone of tolerance. Therefore the water temperatures seen at Hacienda during the coho smolt outmigration were not related to stream flows dropping below D1610 flows as that did not happen until after the end of the outmigration. The elevated water temperatures during the coho smolt migration were likely related to rising air temperatures in June (Figure 4-9).

Steelhead

Adult steelhead were observed in the Russian River during the time period that the Order was in effect. However, it is important to note that only a few individual adult steelhead were detected during the Order and that the bulk of the adult steelhead migration occurs later in the year from December through April when water temperatures are cooler. The water temperatures during the portion of the order that steelhead adults were observed in the Russian River were in the zone of resistance. It is important to note that adult steelhead voluntarily leave the ocean and enter the Russian River. It is important to note that while water temperatures at Hacienda were in the zone of resistance water temperatures at Hacienda in 2012 were similar to water temperatures during normal water years (2002, 2003, 2005, 2006) when flows were above D1610 minimum flows (Figure 4-7).

Steelhead parr rear throughout the summer in a section of the upper Russian River near Ukiah and Hopland. During the Order the maximum water temperature at Hopland remained in the suitable temperature zone and only briefly entered the zone of tolerance. The daily minimum water temperature remained in the optimal temperature zone for the duration of the order. Water temperatures in this section of the river are influenced by the temperature of water released from Coyote Valley Dam. The flow regime outlined by the Order may have preserved the cold water pool in Lake Mendocino later into the year than under D1610 releases (Figure 4-24). Juvenile steelhead that reared between Ukiah and Hopland may have benefited from the releases remaining cooler later into the year.

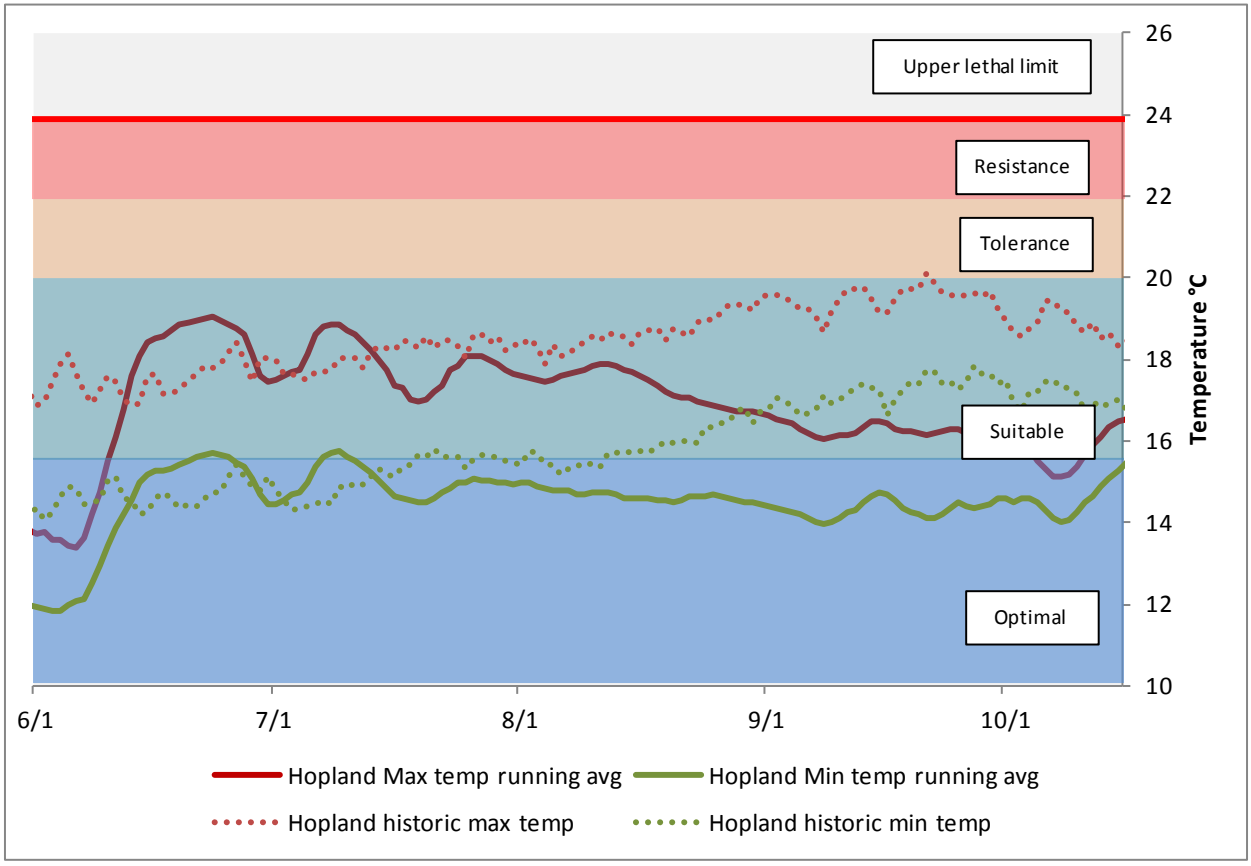

Figure 4-24. The daily maximum and minimum water temperature 7-day running average collected at Hopland shown with the daily maximum and minimum water temperature for normal water years (2002, 2003, 2005, 2006) and temperature zones of optimal (>15.5 °C), suitable (15.5-20 °C), tolerance (20-21.1 °C), resistance (21.9-23.8 °C), and the upper critical lethal limit (>23.9 °C) for steelhead parr.

Steelhead smolts were in the mainstem Russian River during the beginning portion of the Order, but in relatively low numbers. By the time that the order went into effect the catches of steelhead smolts at Mirabel were waning. During the Order daily maximum water temperatures for steelhead smolts at Hacienda were in the optimum zone, the zone of suitability, and the zone of tolerance with only a few individuals emigrating during the tail of the run in the zone of tolerance. However flows at Hacienda were well above D1610 minimum flows during the time period that water temperatures were in the zone of tolerance. Therefore the water temperatures seen at Hacienda during June were not related to stream flows dropping below D1610 flows as that did not happen until after the end of the steelhead smolt outmigration. The elevated water temperatures during the steelhead smolt migration were likely related to rising air temperatures in June (Figure 4-9).

Chinook

Chinook adult upstream migration in the Russian River begins during the latter portion of the time span regulated by the Order. At Hacienda, daily maximum water temperatures where generally in the zone of resistance for adult Chinook during the Order. The daily minimum water temperatures were in the zone of tolerance and zone of resistance during the period of the order that adult Chinook were observed at Hacienda. It is important to note that while water temperatures at Hacienda were in the zone of resistance water temperatures at Hacienda in 2012 were similar to water temperatures during

normal water years (2002, 2003, 2005, 2006) when flows were above D1610 minimum flows (Figure 4-7).

Chinook smolts were captured in mainstem Russian River traps during portions of the Order when water temperatures were in the zone of tolerance and the zone of resistance. However, flows at Hacienda were well above D1610 minimum flows during the time period that water temperatures were in the zone of tolerance. Therefore, this occurred independent of the Order.

DO

Dissolved oxygen levels were generally favorable for salmonids in the Russian River. For the adult life stage, Hacienda daily minimum DO was typically in the zone of suitability, occasionally dipping into the zone of tolerance. The daily maximum DO at Hacienda remained in the zone of suitability for the portion of the Order where adults were observed at Mirabel. For the parr life stage at Hopland, both the daily minimum and daily maximum DO remained in the zone of suitability for the duration of the order. At Cloverdale the daily minimum DO occasionally dipped into the zone of tolerance, but was generally in the zone of suitability while the daily maximum DO remained in the zone of suitability for the duration of the order. For the smolt life stage, similar trends were seen at Hacienda but flows at Hacienda were well above D1610 minimums when smolts were captured at Mirabel. Flows did not drop below 200 cfs before the fish traps were removed at Mirabel. Therefore any depressed DO levels observed at Hacienda during the time period that smolts were present were unrelated to flows dropping below D1610 minimums.

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