SONOMA
COUNTY
WATER
AGENCY

CF/42-0.19-9.1 CORRESPONDENCE RELATED TO SWRCB ORDER
APPROVING TEMPORARY URGENCY CHANGE IN PERMITS 12947A,
12949, 12950 & 16596 FOR 2013 (ID 4675)

March 31, 2014

Ms. Barbara Evoy
Deputy Director of Water Rights
State Water Resources Control Board
Division of Water Rights
P.O. Box 2000
Sacramento, CA 9S812-2000

RE: Reporting Requirements for Provisions 12, 16 and 18 of the State Water Resources Control Board Order Dated May 1, 2013

Dear Ms. Evoy:

Enclosed please find the following reports prepared by the Sonoma County Water Agency:

- Provision 12 – Water Quality Monitoring Summary Report
- Provision 16 – Water Loss and Water Use Efficiency; and
- Provision 18 – Progress of Santa Rosa Plain Groundwater Management Planning Program.

These reports have been prepared to meet the requirements of Provisions 12, 16 and 18 of the State Water Resources Control Board's Order dated May 1, 2013. If you have any questions or comments regarding the plan, please do not hesitate to contact me directly (707 547-1925).

Sincerely,

Don Seymour

Don Seymour, P.E.
Water Agency Principal Engineer

c: Katherine Lee, Emily Hyland - State Water Resources Control Board, Division of Water Rights
Pamela Jeane, Jay Jasperse, Todd Schram - Water Agency
Alan Lilly, Bartkiewicz, Kronick & Shanahan

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State Water Resources Control Board
Order 5/1/2013

Provision 12 – Water Quality Monitoring Summary Report

SONOMA COUNTY WATER AGENCY

March 31, 2014

Prepared by

Sonoma County Water Agency
404 Aviation Blvd
Santa Rosa, CA 95403

Contents

1.0 Introduction

On April 25, 2013, the Sonoma County Water Agency (Water Agency) petitioned the State Water Resources Control Board (SWRCB) to temporarily reduce minimum instream 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* (Biological Opinion, NMFS 2008).

In summary, the Water Agency requested that the SWRCB make the following temporary changes to the Decision 1610 (D1610) instream flow requirements:

(1) From May 1 through June 30, 2013, reduce 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) from 185 cubic feet per second (cfs) to 75 cfs, and reduce the requirements for the lower Russian River (downstream of its confluence with Dry Creek) from 125 cfs to 85 cfs; and

(2) From July 1 through October 28, 2013, reduce instream flow requirements for the upper Russian River from 185 cfs to 75 cfs, and reduce the requirements for the lower Russian River from 125 cfs to 85 cfs, if during the period from July 1 through October 28 storage in Lake Mendocino remains above the Water Agency's calculated critical storage curve; or

(3) From July 1 through October 28, 2013, further reduce instream flow requirements to 25 cfs for upper Russian River and 35 cfs for the lower Russian River, if during the period from July 1 through October 28 storage in Lake Mendocino drops below the Water Agency's calculated critical storage curve for more than three consecutive days.

The SWRCB issued an Order (Order) approving the Water Agency's Temporary Urgency Change Petition (TUCP) on May 1, 2013. The Order included several terms and conditions, including requirements for the preparation of a water quality monitoring plan (Term 11). The Water Agency submitted a plan in coordination with SWRCB Division of Water Rights (DWR), North Coast Regional Water Quality Control Board (NCRWQCB), NMFS, and United States Geological Survey (USGS) to meet the requirements of Term 11 on May 30, 2013. This report provides and summarizes all data collected during the 2013 water quality monitoring program as required by Term 12 of the Order.

2.0 2013 Russian River Flow Summary

As described in the Order, the Water Agency requested temporary changes to D1610 instream flow requirements including reductions from 185 cfs to 75 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 85 cfs in the lower Russian River (downstream of its confluence with Dry Creek). The purpose of the 2013 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 for steelhead in the upper mainstem of the Russian River.

Prior to and during the term of the TUC, sufficient inflow into Lake Pillsbury allowed for classifying 2013 as a Normal year under D1610. Storage in Lake Mendocino, while initially above conditions experienced in 2009, was well below 2012 conditions and by early July dropped below 2009 conditions (Figure 2-1).

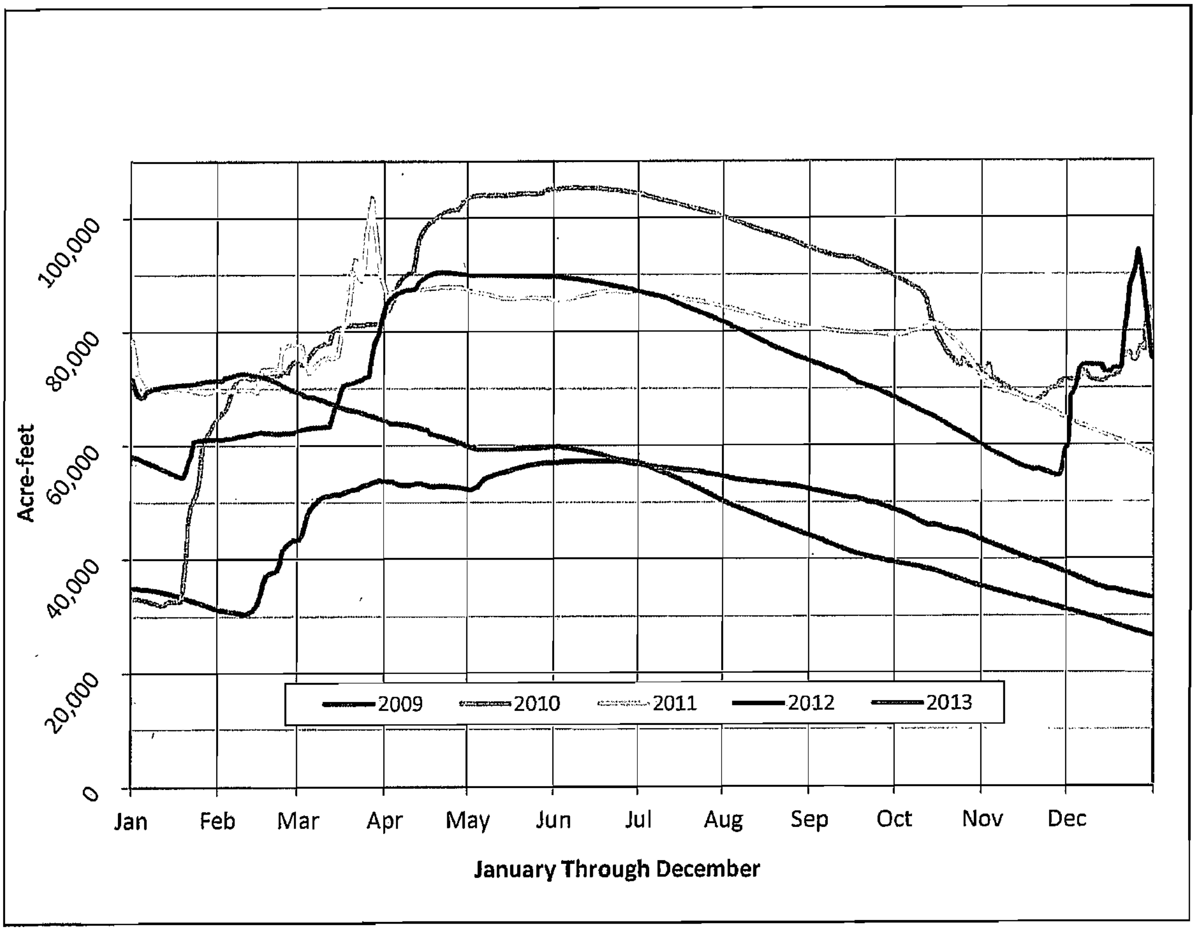

Figure 2-1. Lake Mendocino water storage levels, in acre-feet, from 2009 to 2013.

The reduced Coyote Valley Dam releases authorized by the Order allowed flows to drop below D1610 minimum flows in most sections of the Russian River. However, a moderate demand season allowed stable releases from Lake Mendocino. Figure 2-2 shows 2013 average daily flows.

In the section of the Russian River from Ukiah to the confluence of Dry Creek (upper Russian River) flows dropped well below D1610 minimum flow requirements and occasionally below the 75 cfs five-day running average TUC flow, but did not drop below the instantaneous flow of 65 cfs authorized by the Order. Flows in the upper Russian River above the Dry Creek confluence were below 185 cfs from May 2 to October 31 at Hopland, including two days with flows below 75 cfs. Flows at Digger's Bend dropped to less than 185 cfs shortly after May 6 and dropped below the five-day running average of 75 cfs for several days throughout the Order, but did not drop below the instantaneous minimum flow of 65 cfs (Figure 2-3).

Flows in the lower Russian River at Hacienda (downstream of the confluence with Dry Creek) dropped below D1610 minimum flow requirements from late May through October and occasionally dropped below the five-day running average of 85 cfs, but remained higher than the TUC instantaneous minimum flow of 70 cfs (Figure 2-4).

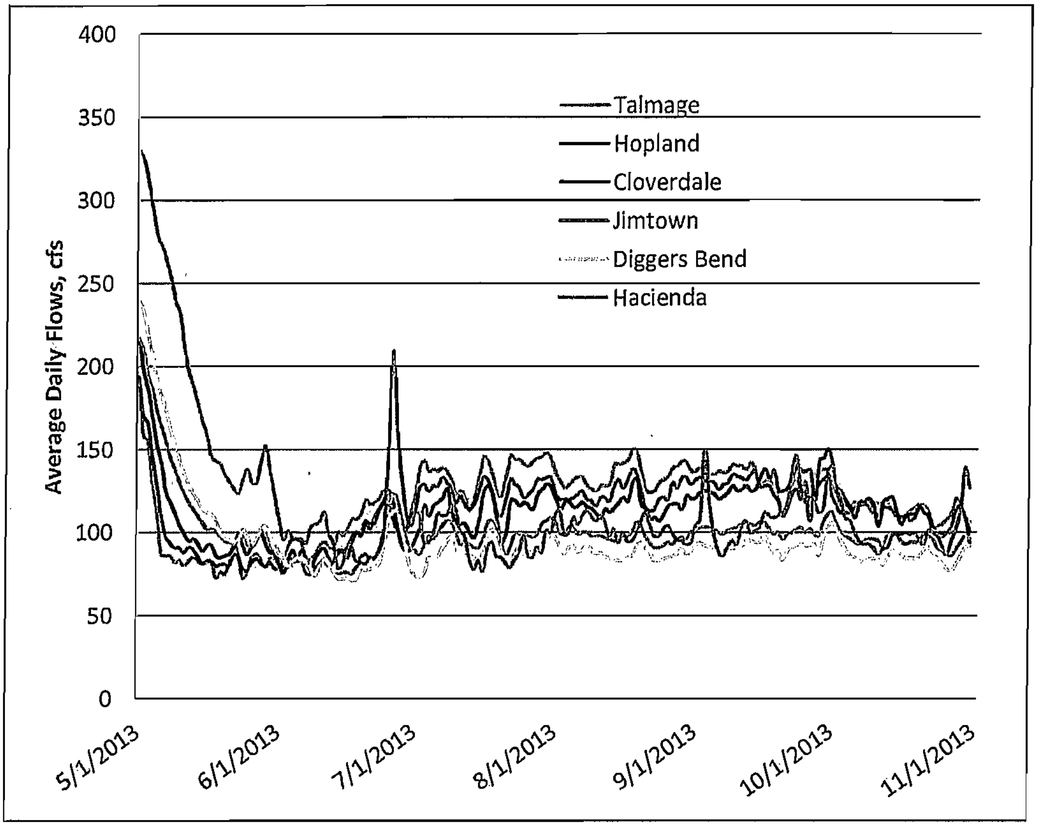

Figure 2-2. 2013 average daily flows in the Russian River as measured at U.S. Geological Survey (USGS) gages in cubic feet per second (cfs).

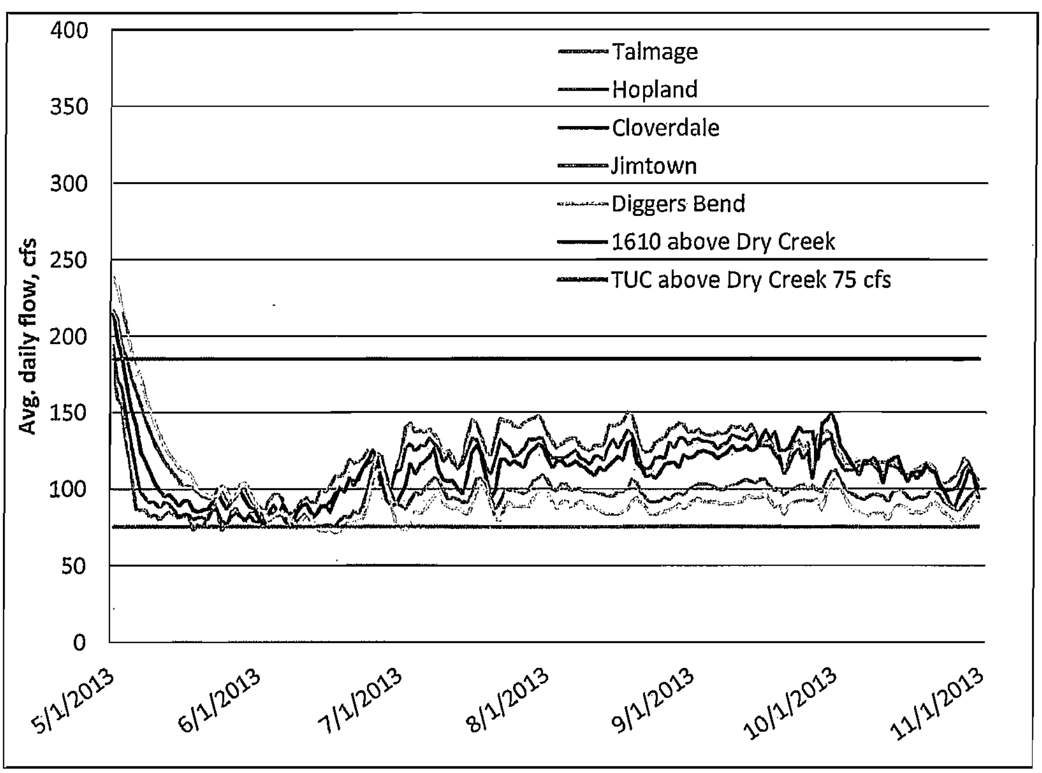

Figure 2-3. 2013 average daily flows in the Russian River as measured at USGS gages above the Dry Creek confluence in cubic feet per second.

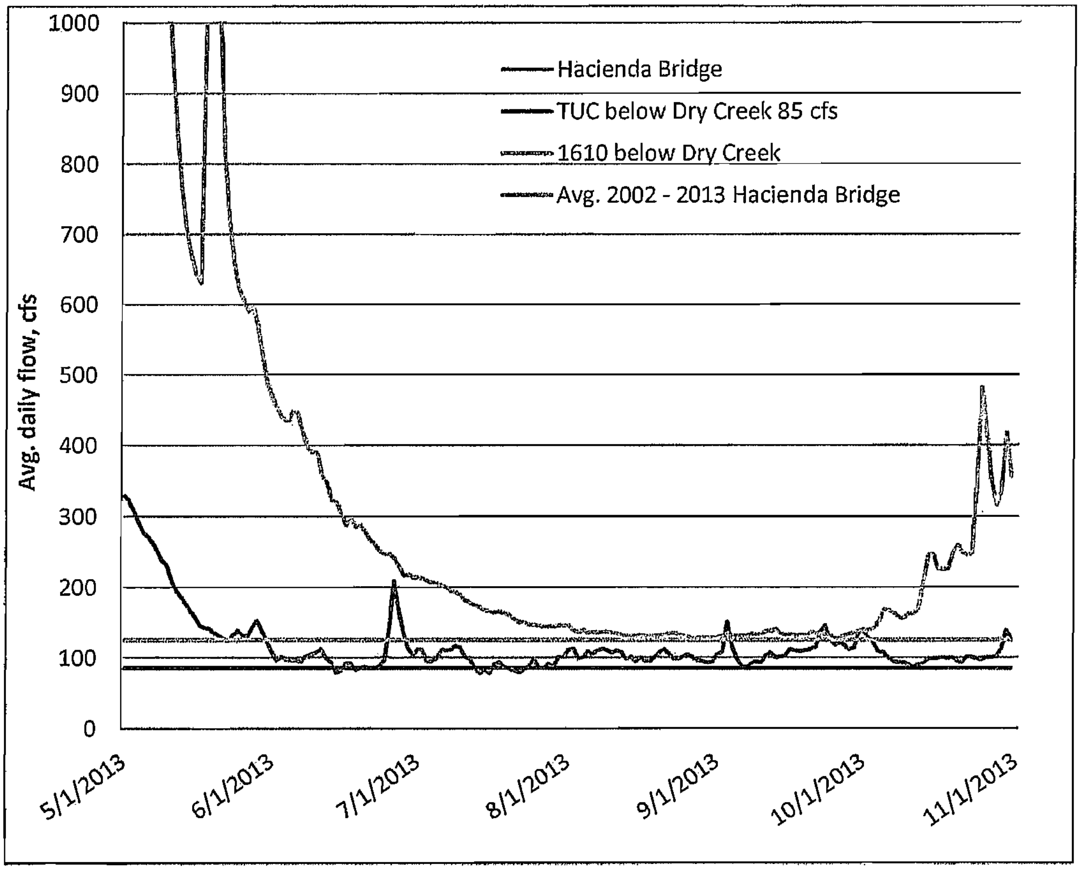

Figure 2-4. 2013 average daily flows in the Russian River as measured at USGS gages below the Dry Creek confluence in cubic feet per second.

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 instream flows that are mandated by the Biological Opinion. A complete evaluation of the water quality data is being conducted as part of the California Environmental Quality Act (CEQA) analysis associated with proposed permanent changes to D1610.

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 30 through September 4, the North Coast Regional Water Quality Control Board (NCRWQCB) conducted weekly bacteriological sampling at eight beaches with recreational activities involving the greatest body contact. From May 28 through September 3, the Sonoma County Department of Health Services (DHS), in cooperation with the NCRWQCB, also monitored bacterial levels in the water at eight beaches on the Russian River, including seven beaches that the NCRWQCB monitors. To support the analysis and evaluation of water quality data needed for the CEQA requirements as noted above, the Water Agency conducted weekly bacteriological, nutrient and algal mainstem sampling at six sites along the Russian River from May 16 through October 31.

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 (CDPH 2011). The CDPH draft guideline for single sample maximum concentrations is: 10,000 most probable numbers (MPN) per 100 milliliters (ml) for total coliform, 235 MPN per 100 ml for *E. coli*, and 61 MPN per 100 ml for Enterococcus. In 2012, the United States Environmental Protection Agency (EPA) issued Clean Water Act (CWA) §304(a) Recreational Water Quality Criteria (RWQC) for States (EPA 2012). The RWQC recommends using two criteria for assessing water quality relating to fecal indicator bacteria: the geometric mean (GM) of the dataset, and changing the single sample maximum (SSM) to a Statistical Threshold Value (STV) representing the 75^{th} percentile of an acceptable water-quality distribution. However, the EPA recommends using STV values as SSM values for potential recreational beach posting and those values are provided in this report for comparative purposes. Exceedances of the STV values are highlighted in Table 3-1. It must be emphasized that these are draft guidelines and criteria, not adopted standards, and are therefore both subject to change (if it is determined that the guidelines and/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. Currently, there are no numeric guidelines or criteria that have been developed for estuarine areas. Even so, the EPA recommended freshwater criteria for Nutrients, Chlorophyll a, and Turbidity in Rivers and Streams in Aggregate Ecoregion III (EPA 2000) are also used throughout for comparative purposes, with exceedances highlighted in Tables 3-2 to 3-4.

3.1.1 2013 Water Agency Mainstem Water Quality Sampling

Water samples were collected from the following six (6) surface-water sites in the mainstem of the Russian River and as shown on Figure 3-1: Hopland; Comminsky Station; Jimtown Bridge; Digger's Bend; Riverfront Park; and Hacienda.

All samples were analyzed for nutrients, chlorophyll *a*, standard bacterial indicators (total coliforms, *E. coli* and enterococci), total and dissolved organic carbon, turbidity, and total dissolved solids. Samples were not analyzed specifically for total coliforms, but concentrations are determined as part of the analytical process for determining *E. coli* concentrations and the results are included in the lab report. As such, it should be noted that the dilution rates that are utilized to accurately quantify *E. coli* concentrations for comparison to the draft guidelines do not allow for the quantification of total coliform concentrations at a high enough level to compare with the draft guidelines and are instead reported as greater than 2419.6 MPN (>2419.6). The decision to focus on *E. coli* and Enterococcus for the analysis of potential water quality impacts and not total coliform concentrations was done in coordination and consultation with NCRWQCB staff.

The Water Agency submitted samples to the Sonoma County DHS Public Health Division Lab in Santa Rosa for bacteria analysis. *E. coli* and total coliform were analyzed using the Colilert method and Enterococcus was analyzed using the Enterolert method. Table 3-1 and Figures 3-2 and 3-3 summarize the bacteria data collected during the term of the Order.

Based upon the recommended RWQC for fresh water beaches, Enterococcus exceedances varied throughout the term of the Order with several exceedances being observed at Hopland. A few exceedances were also observed in the latter half of the season at Comminsky Station and Digger's Bend. Jimtown had two exceedances and Hacienda had one. There were no exceedances of the RWQC for *E. coli* at any of the mainstem sites throughout the term of the Order. Nutrient results at Hopland and Comminsky Station predominantly exceeded the EPA criteria for Total Phosphorous and Total Nitrogen. Turbidity results at Hopland exceeded recommended EPA criteria throughout the duration of the Order and predominantly exceeded the criteria at Comminsky Station. Algal (chlorophyll *a*) results were also frequently exceeded at these two stations, though not as often as turbidity or Total Phosphorus. Jimtown Bridge experienced exceedances of the nutrient and algal criteria, but to a lesser degree than the two upstream stations and did not have any exceedances of the turbidity criteria. Digger's Bend had one exceedance for each of the nutrient criteria, and a few exceedances of the algal criteria, but did not exceed the turbidity criteria at all during the monitoring period. Riverfront Park had several exceedances of the Total Phosphorus criteria and one exceedance of the Total Nitrogen criteria, but did not have any exceedances of the turbidity or algal criteria. Finally, Hacienda had several exceedances of the Total Phosphorus criteria, two exceedances of the Total Nitrogen criteria, and a few exceedances each of the turbidity and algal criteria. See Tables 3-2 through 3-4.

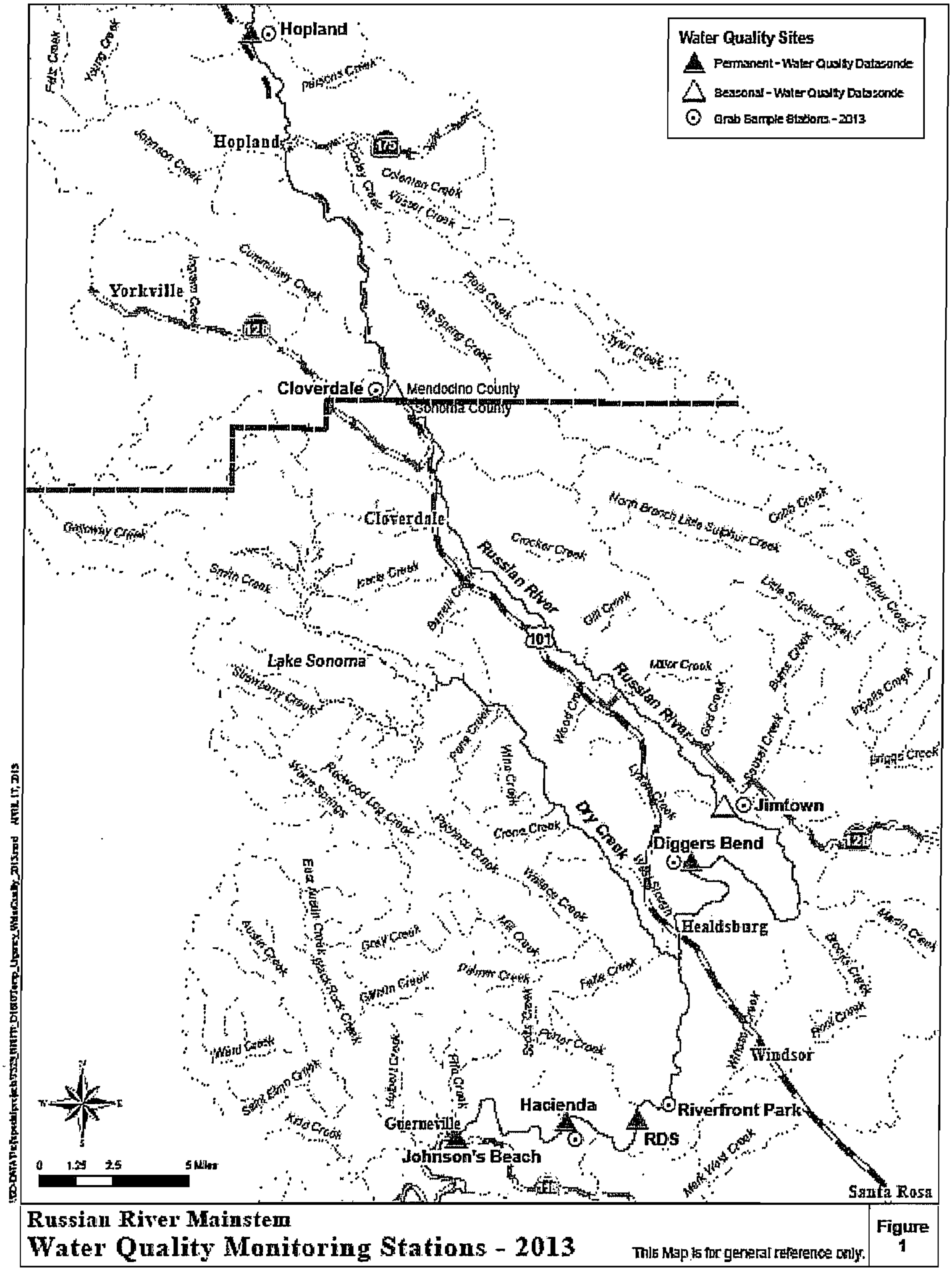

Figure 3-1. 2013 Russian River mainstem water quality monitoring stations sampled by the Sonoma County Water Agency.

Table 3-1. 2013 Mainstem Russian River bacteria concentrations for samples collected by the Sonoma County Water Agency.

Hopland	Time	Temperature	pH	Total Coliforms (Colilert)	E. coli (Colilert)	Enterococcus (Enterolert)	USGS 11462500 RR Near Hopland**
MDL*				20	20	2	Flow Rate***
Date		°C		MPN/100mL	MPN/100mL	MPN/100mL	(cfs)
5/16/2013	9:40:00	14.3	7.3	>2419.6	98.3	46.5	83
5/23/2013	9:20:00	12.4	7.3	>2419.6	104.6	45.7	86
5/30/2013	9:00:00	14.2	7.3	>2419.6	95.7	47.1	82
6/6/2013	9:40:00	15.1	7.4	>2419.6	83.0	**88.6**	83
6/13/2013	9:00:00	14.0	7.3	>2419.6	111.9	52.0	83
6/20/2013	9:00:00	13.6	7.3	>2419.6	75.4	**86**	107
6/27/2013	10:20:00	15.2	7.3	1986.3	67	39.5	103
7/3/2013	9:00:00	16.2	7.3	>2419.6	95.8	**128.1**	129
7/11/2013	8:50:00	14.9	7.5	1553.1	67	**79.4**	122
7/18/2013	9:20:00	15.1	7.4	2419.6	88.6	**77.6**	125
7/25/2013	9:10:00	16.2	7.4	1553.1	146.1	**69.7**	121
8/1/2013	9:20:00	15.3	7.5	1046.2	99.1	41.0	124
8/8/2013	9:20:00	16.1	7.4	>2419.6	60.9	50.4	120
8/15/2013	9:30:00	17.3	7.2	1986.3	93.2	**104.2**	132
8/22/2013	9:20:00	17.5	7.2	>2419.6	70.3	52.1	113
8/29/2013	9:00:00	18.2	7.3	>2419.6	90.9	51.2	133
9/5/2013	9:10:00	17.7	7.3	>2419.6	67	**72.3**	130
9/12/2013	9:00:00	18.7	7.4	>2419.6	71.7	**248.1**	132
9/19/2013	9:00:00	16.9	7.3	>2419.6	35.9		119
9/26/2013	9:00:00	17.1	7.6	>2419.6	68.9	**222.4**	107
10/3/2013	9:20:00	16.5	7.6	>2419.6	45.0	**172.2**	112
10/10/2013	10:30:00	14.3	7.6	2419.6	52.9	**63.1**	112
10/17/2013	9:40:00	14.4	7.7	1299.7	54.6	53.8	110
10/24/2013	9:30:00	14.2	7.7	290.9	52.1	**365.4**	100
10/31/2013	9:20:00	13.2	7.8	579.4	53.8	**68.3**	103

Comminsky Station	Time	Temperature	pH	Total Coliforms (Colilert)	E. coli (Colilert)	Enterococcus (Enterolert)	USGS 11463000 RR Near Cloverdale (Comminsky)**
MDL*				20	20	2	Flow Rate***
Date		°C		MPN/100mL	MPN/100mL	MPN/100mL	(cfs)
5/16/2013	10:10:00	17.1	7.7	1986.3	40.8	22.6	92
5/23/2013	9:50:00	14.9	7.7	1203.3	77.6	30.9	99
5/30/2013	9:20:00	16.6	7.9	1553.1	41.7	14.5	88
6/6/2013	10:10:00	18.5	7.8	1553.1	44.8	24.6	89
6/13/2013	9:30:00	17.0	7.9	1986.3	39.9	26.2	83
6/20/2013	9:30:00	16.3	7.6	>2419.6	43.9	43.3	106
6/27/2013	11:00:00	17.9	7.8	1119.7	26.2	10.9	104
7/3/2013	9:30:00	20.0	7.9	>2419.6	81.6	39.3	116
7/11/2013	9:30:00	17.8	7.8	2419.6	28.8	33.1	105
7/18/2013	9:50:00	17.8	7.8	1986.3	34.5	35.5	123
7/25/2013	9:50:00	18.4	7.8	1119.9	187.2	43.7	118
8/1/2013	9:50:00	17.1	7.8	>2419.6	69.7	35.5	120
8/8/2013	9:50:00	17.5	7.8	1986.3	50.4	**62.9**	115
8/15/2013	9:50:00	18.5	7.4			**67.6**	118
8/22/2013	10:00:00	18.4	7.5	1986.3	36.8	45.2	108
8/29/2013	9:30:00	18.8	7.5	1732.9	62.7	37.7	114
9/5/2013	9:40:00	17.9	7.6	1986.3	38.8	27.8	123
9/12/2013	9:30:00	18.5	7.7	2419.6	34.1	32.3	128
9/19/2013	9:30:00	16.4	7.7	1986.3	27.5	29.8	125
9/26/2013	9:30:00	16.4	7.8	1413.6	31.5	35.5	137
10/3/2013	9:50:00	15.5	8.0	1553.1	19.1	18.3	124
10/10/2013	11:10:00	13.7	7.6	461.1	20.9	17.1	116
10/17/2013	10:00:00	13.3	7.9	>2419.6	30.9	9.6	110
10/24/2013	10:00:00	14.1	7.9	150.0	38.4	**123.4**	98
10/31/2013	9:50:00	12.4	8.1	816.4	26.5	15.6	94

* Method Detection Limit - limits can vary for individual samples depending on matrix interference and dilution factors, all results are preliminary and subject to final revision.
** United States Geological Survey (USGS) Continuous-Record Gaging Station
*** Flow rates are preliminary and subject to final revision by USGS.

Recommended EPA Recreational Water Quality Criteria - Statistical Threshold Value (STV) and Geomteric Mean (GM)
(Beach posting is recommended when indicator organisms exceed the STV) - Indicated by red text
E. coli (STV): 235 per 100 ml | Enterococcus (STV): 61 per 100 ml
E. coli (GM): 126 per 100mL | Enterococcus (GM): 33 per 100 mL

Table 3-1 cont. 2013 Mainstem Russian River bacteria concentrations - samples collected by Sonoma County Water Agency.

Jimtown Bridge	Time	Temperature	pH	Total Coliforms (Colilert)	E. coli (Colilert)	Enterococcus (Enterolert)	USGS 11463682 RR at Jimtown**
MDL*				20	20	2	Flow Rate***
Date		°C		MPN/100mL	MPN/100mL	MPN/100mL	(cfs)
5/16/2013	10:50:00	18.5	7.4	>2419.6	9.8	3.1	102
5/23/2013	10:30:00	16.4	7.3	120.7	32.9	47.9	95
5/30/2013	10:00:00	18.0	7.5	737.0	224.7	18.5	93
6/6/2013	10:50:00	20.1	7.5	816.4	40.4	23.3	82
6/13/2013	10:00:00	18.0	7.5	1413.6	23.3	34.1	76
6/20/2013	10:10:00	18.4	7.6	1732.9	24.6	22.8	81
6/27/2013	11:50:00	22.0	7.6	770.1	51.2	46.2	121
7/3/2013	10:10:00	22.2	7.4	>2419.6	30.5	83.9	92
7/11/2013	10:00:00	20.2	7.7	1732.9	10.9	45.7	93
7/18/2013	10:30:00	20.5	7.6	870.4	5.2	50.4	107
7/25/2013	10:30:00	21.0	7.6	1413.6	10.8	19.9	99
8/1/2013	10:30:00	19.5	7.7	1732.9	10.9	14.8	106
8/8/2013	10:30:00	19.1	7.7	2419.6	10.9	23.1	100
8/15/2013	10:30:00	20.7	7.6	1986.3	6.3	31.1	95
8/22/2013	10:40:00	19.0	7.4	>2419.6	3.0	47.3	94
8/29/2013	10:00:00	20.4	7.4	>2419.6	13.4	48.0	97
9/5/2013	10:30:00	19.3	7.6	1986.3	21.3	26.9	102
9/12/2013	10:10:00	18.8	7.6	>2419.6	4.1	54.5	106
9/19/2013	10:20:00	18.1	7.7	1203.3	8.6	29.9	100
9/26/2013	10:20:00	16.9	7.8	1203.3	6.3	40.4	102
10/3/2013	10:30:00	16.3	7.9	866.4	9.1	28.8	101
10/10/2013	12:10:00	15.8	7.7	816.4	16	7.5	96
10/17/2013							93
10/24/2013	10:40:00	15.7	7.7	224.7	13.4	**1203.3**	91
10/31/2013	10:30:00	13.9	7.8	547.5	17.5	41.0	96

Digger's Bend	Time	Temperature	pH	Total Coliforms (Colilert)	E. coli (Colilert)	Enterococcus (Enterolert)	USGS 11463980 RR at Digger's Bend**
MDL*				20	20	2	Flow Rate***
Date		°C		MPN/100mL	MPN/100mL	MPN/100mL	(cfs)
5/16/2013	11:20:00	19.0	7.7	2419.6	3.1	8.4	112
5/23/2013	11:10:00	16.3	7.7	142.5	8.5	9.7	96
5/30/2013	10:50:00	19.1	7.9	1732.9	10.9	45.5	99
6/6/2013	11:30:00	19.8	7.8	1533.1	16.0	5.2	84
6/13/2013	10:30:00	19.1	7.9	1732.9	25.6	9.7	76
6/20/2013	10:50:00	19.2	7.8	2419.6	12.2	9.8	77
6/27/2013	12:30:00	22.0	7.8	1203.3	11	12.1	113
7/3/2013	10:40:00	23.5	7.8	>2419.6	12.2	5.2	75
7/11/2013	10:40:00	20.8	8.0	2419.6	14.6	34.1	88
7/18/2013	11:10:00	20.8	7.8	>2419.6	4.1	24.1	102
7/25/2013	11:10:00	21.5	7.9	1986.3	4.1	18.1	88
8/1/2013	11:10:00	19.9	7.9	1986.3	9.7	15.6	97
8/8/2013	11:00:00	19.2	7.9	>2419.6	9.7	36.9	92
8/15/2013							83
8/22/2013	11:10:00	19.7	7.8	>2419.6	6.3	**69.7**	88
8/29/2013	10:30:00	21.3	7.8	>2419.6	24.9	57.3	90
9/5/2013	11:00:00	20.3	7.7	2419.6	4.1	35.0	91
9/12/2013	10:40:00	19.1	7.8	2419.6	11.6	**90.8**	95
9/19/2013	11:00:00	18.2	7.5	1553.1	9.8	28.8	89
9/26/2013	10:50:00	17.3	8.0	980.4	8.5	31.5	92
10/3/2013	11:00:00	16.7	8.1	816.4	12.2	41.0	95
10/10/2013	12:50:00	15.3	7.7	547.5	3.1	2.0	84
10/17/2013	11:00:00	15.0	8.1	387.3	11	11.9	84
10/24/2013	11:20:00	15.3	8.1	151.5	12.1	**387.3**	84
10/31/2013	10:50:00	13.4	8.1	435.2	18.7	42.0	92

* Method Detection Limit - limits can vary for individual samples depending on matrix interference and dilution factors, all results are preliminary and subject to final revision.
** United States Geological Survey (USGS) Continuous-Record Gaging Station
*** Flow rates are preliminary and subject to final revision by USGS.

Recommended EPA Recreational Water Quality Criteria - Statistical Threshold Value (STV) and Geomteric Mean (GM)
(Beach posting is recommended when indicator organisms exceed the STV) - Indicated by red text

E. coli (STV): 235 per 100 ml	Enterococcus (STV): 61 per 100 ml
E. coli (GM): 126 per 100mL	Enterococcus (GM): 33 per 100 mL

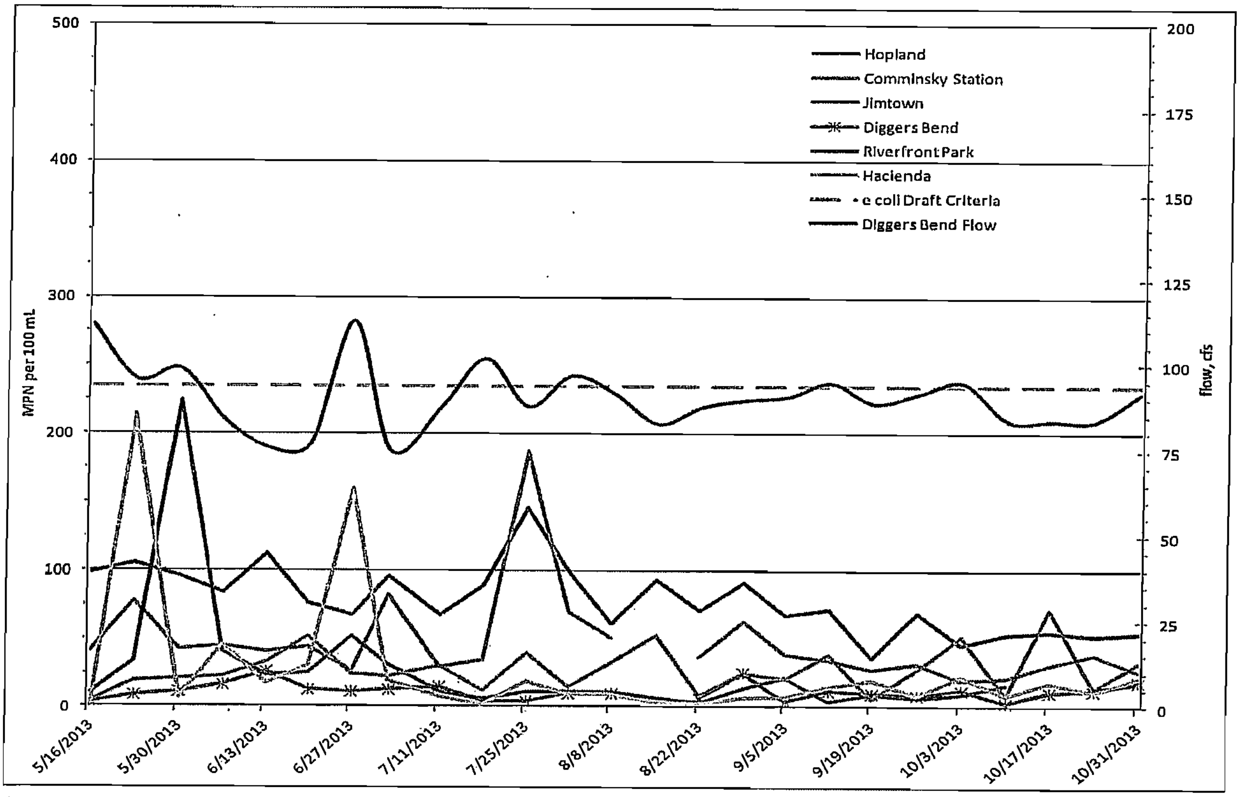

Figure 3-2. E. coli results for samples collected by the Sonoma County Water Agency on the Russian River from Hopland to Hacienda Bridge in 2013.

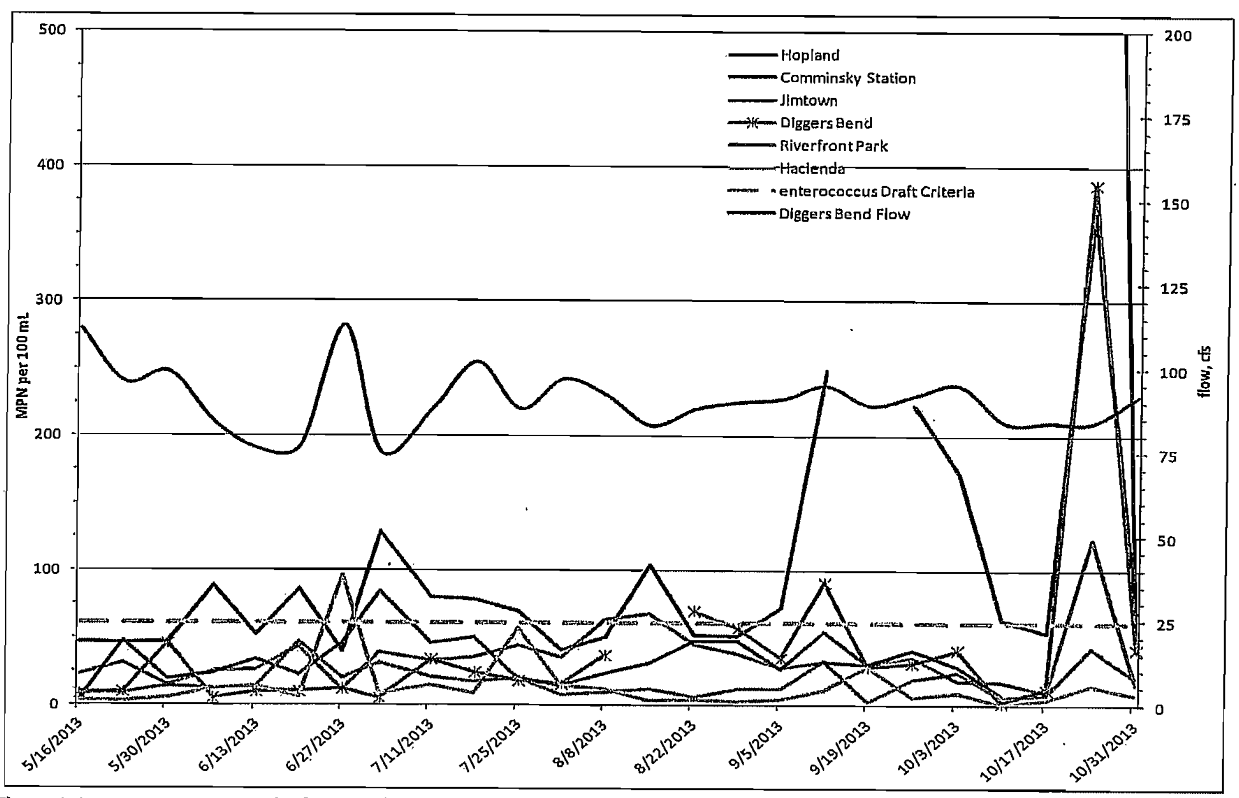

Figure 3-3. Enterococcus results for samples collected by the Sonoma County Water Agency on the Russian River from Hopland to Hacienda Bridge in 2013.

Table 3-2. 2013 nutrient results for grab samples collected by the Sonoma County Water Agency at Hopland and Comminsky Station. Highlighted values exceed EPA criteria.

Hopland	Time	Temperature	pH	Total Organic Nitrogen	Ammonia as N	Ammonia as N Unionized	Nitrate as N	Nitrite as N	Total Kjeldahl Nitrogen	Total Nitrogen**	Phosphorus, Total	Total Orthophosphate	Dissolved Organic Carbon	Total Organic Carbon	Total Dissolved Solids	Turbidity	Chlorophyll-a	USGS 11462500 RR Near Hopland***
MDL*				0.200	0.10	0.00010	0.030	0.030	0.10		0.020	0.020	0.0400	0.0400	4.2	0.020	0.000050	Flow Rate****
Date		°C		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	NTU	mg/L	(cfs)
5/16/2013	9:40	14.3	7.3	ND	0.14	0.00068	0.43	ND	0.28	0.71	0.055	0.21	1.81	2.56	120	5.7	0.0023	83
5/23/2013	9:20	12.4	7.3	ND	0.14	0.00058	0.36	ND	0.24	0.60	0.042	0.081	1.90	2.58	120	5.3	0.0026	86
5/30/2013	9:00	14.2	7.3	ND	0.14	0.00067	0.35	ND	ND	0.53	0.043	0.084	1.80	2.33	140	5.8	0.0033	82
6/6/2013	9:40	15.1	7.4	ND	ND	ND	0.32	ND	0.24	0.56	0.052	0.13	2.12	2.56	120	6.8	0.0028	83
6/13/2013	9:00	14.0	7.3	ND	0.10	0.00051	0.34	ND	0.24	0.58	0.077	0.19	1.99	2.67	140	6.1	0.00058	83
6/20/2013	9:00	13.6	7.3	ND	0.10	0.00053	0.27	ND	0.21	0.48	0.062	0.15	2.02	2.77	120	7.3	0.0025	107
6/27/2013	10:20	15.2	7.3	ND	ND	ND	0.28	ND	0.24	0.52	0.063	0.16	1.98	2.62	120	6.9	0.0022	103
7/3/2013	9:00	16.2	7.3	0.24	ND	ND	0.23	ND	0.32	0.54	0.054	0.14	2.15	2.80	110	7.7	0.0032	129
7/11/2013	8:50	14.9	7.5	0.21	ND	ND	0.17	ND	0.28	0.45	0.052	0.14	2.06	2.87	120	8.0	0.0061	122
7/18/2013	9:20	15.1	7.4	0.28	ND	ND	0.20	ND	0.35	0.55	0.051	0.12	2.09	3.07	120	11	0.0033	125
7/25/2013	9:10	16.2	7.4	0.21	0.10	ND	0.16	ND	0.32	0.47	0.047	0.10	2.05	2.71	110	8.3	0.0044	121
8/1/2013	9:20	15.3	7.5	ND	0.10	ND	0.14	ND	0.24	0.39	0.050	0.10	2.28	2.66	110	10	0.0037	124
8/8/2013	9:20	16.1	7.4	ND	ND	ND	0.13	ND	0.21	0.34	0.060	0.14	1.95	2.65	120	7.0	0.0045	120
8/15/2013	9:30	17.3	7.2	0.24	ND	ND	0.15	ND	0.28	0.43	0.084	0.24	2.22	3.00	120	8.9	0.0053	132
8/22/2013	9:20	17.5	7.2	ND	ND	ND	0.15	ND	0.21	0.36	0.085	0.21	2.35	2.88	150	6.6	0.0034	113
8/29/2013	9:00	18.2	7.3	0.21	ND	ND	0.14	ND	0.21	0.35	0.099	0.23	2.13	3.03	120	9.7	0.0046	133
9/5/2013	9:10	17.7	7.3	ND	0.14	ND	0.16	ND	0.21	0.37	0.11	0.27	2.24	2.67	120	7.8	0.0035	130
9/12/2013	9:00	18.7	7.4	ND	0.14	ND	0.16	ND	0.24	0.40	0.11	0.28	2.32	2.91	120	7.4	0.0027	132
9/19/2013	9:00	16.9	7.3	ND	0.10	ND	0.21	ND	0.24	0.46	0.11	0.29	2.16	2.80	120	3.1	0.00042	119
9/26/2013	9:00	17.1	7.6	0.28	ND	ND	0.20	ND	0.35	0.55	0.090	0.19	2.19	2.95	150	13	0.0027	107
10/3/2013	9:20	16.5	7.6	ND	0.10	ND	ND	ND	0.21	0.21	0.080	0.30	2.23	2.97	130	12	0.0032	112
10/10/2013	10:30	14.3	7.6	0.28	0.10	ND	0.20	ND	0.38	0.58	0.071	0.17	2.20	2.86	130	15	0.0030	112
10/17/2013	9:40	14.4	7.7	0.46	0.10	0.0013	0.18	ND	0.35	0.53	0.064	0.14	2.14	2.62	120	7.5	0.0033	110
10/24/2013	9:30	14.2	7.7	ND	0.21	0.0023	0.15	ND	0.24	0.39	0.051	0.13	2.38	2.71	130	8.5	0.0028	100
10/31/2013	9:20	13.2	7.8	ND	0.10	0.0013	0.20	ND	0.24	0.45	0.052	0.13	2.25	2.82	140	7.7	0.0015	103

Comminsky Station	Time	Temperature	pH	Total Organic Nitrogen	Ammonia as N	Ammonia as N Unionized	Nitrate as N	Nitrite as N	Total Kjeldahl Nitrogen	Total Nitrogen**	Phosphorus, Total	Total Orthophosphate	Dissolved Organic Carbon	Total Organic Carbon	Total Dissolved Solids	Turbidity	Chlorophyll-a	USGS 11463000 RR Near Cloverdale (Comminsky)***
MDL*				0.200	0.10	0.00010	0.030	0.030	0.10		0.020	0.020	0.0400	0.0400	4.2	0.020	0.000050	Flow Rate****
Date		°C		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	NTU	mg/L	(cfs)
5/16/2013	10:10	17.1	7.7	ND	0.21	0.0032	0.56	ND	0.24	0.80	0.064	0.14	1.60	2.10	140	5.0	0.0016	92
5/23/2013	9:50	14.9	7.7	ND	0.14	0.0018	0.33	ND	0.21	0.54	0.037	0.060	1.65	2.12	140	3.2	0.0022	99
5/30/2013	9:20	16.6	7.9	ND	0.14	0.0033	0.28	ND	0.21	0.49	0.030	0.053	1.63	2.08	150	2.8	0.0040	88
6/6/2013	10:10	18.5	7.8	ND	0.18	0.0039	0.24	ND	0.28	0.52	0.041	0.071	1.76	2.10	130	3.5	0.0057	89
6/13/2013	9:30	17.0	7.9	ND	0.10	0.0023	0.28	ND	0.24	0.53	0.050	0.10	1.75	2.29	140	3.7	0.0011	83
6/20/2013	9:30	16.3	7.6	ND	0.14	0.0017	0.21	ND	ND	0.39	0.098	0.095	1.73	2.34	130	4.5	0.0060	106
6/27/2013	11:00	17.9	7.8	ND	0.10	ND	0.19	ND	ND	0.36	0.039	0.089	2.16	2.33	130	3.6	0.0042	104
7/3/2013	9:30	20.0	7.9	ND	0.18	ND	0.12	ND	0.32	0.43	0.039	0.084	1.99	2.55	120	5.4	0.0093	116
7/11/2013	9:30	17.8	7.8	ND	0.14	ND	ND	ND	0.28	0.28	0.040	0.069	1.91	2.64	130	4.8	0.0066	105
7/18/2013	9:50	17.8	7.8	ND	0.18	ND	0.12	ND	0.32	0.44	0.038	0.089	2.20	2.84	120	4.3	0.0076	123
7/25/2013	9:50	18.4	7.8	ND	0.10	ND	0.11	ND	0.3	0.39	0.034	0.075	2.20	2.59	120	7.0	0.0049	118
8/1/2013	9:50	17.1	7.8	0.24	ND	ND	0.11	ND	0.28	0.39	0.036	0.070	2.22	2.43	110	6.6	0.0029	120
8/8/2013	9:50	17.5	7.8	ND	ND	ND	0.11	ND	ND	0.14	0.039	0.090	1.91	2.48	110	4.4	0.0019	115
8/15/2013	9:50	18.5	7.4	ND	0.10	ND	0.11	ND	0.21	0.32	0.060	0.13	2.19	2.81	120	3.7	0.0020	118
8/22/2013	10:00	18.4	7.5	ND	0.10	ND	0.12	ND	0.21	0.33	0.057	0.14	2.07	2.66	130	2.4	0.0014	108
8/29/2013	9:30	18.8	7.5	ND	ND	ND	0.12	ND	0.21	0.33	0.060	0.12	2.11	2.79	120	1.8	0.0022	114
9/5/2013	9:40	17.9	7.6	ND	0.10	ND	0.13	ND	ND	0.16	0.071	0.18	1.86	2.57	120	2.1	0.0016	123
9/12/2013	9:30	18.5	7.7	ND	ND	ND	0.12	ND	ND	0.29	0.073	0.21	2.41	2.62	130	1.9	0.0017	128
9/19/2013	9:30	16.4	7.7	ND	ND	ND	0.15	ND	ND	0.25	0.076	0.20	2.07	2.62	120	1.7	0.00014	125
9/26/2013	9:30	16.4	7.8	ND	ND	ND	0.16	ND	0.21	0.37	0.054	0.15	2.30	2.62	150	2.0	0.0011	137
10/3/2013	9:50	15.5	8.0	ND	0.10	ND	ND	ND	ND	0.18	0.050	0.13	2.45	2.63	120	3.0	0.0015	124
10/10/2013	11:10	13.7	7.6	0.24	ND	ND	0.14	ND	0.32	0.45	0.045	0.10	2.08	2.55	140	3.4	0.00067	116
10/17/2013	10:00	13.3	7.9	ND	0.14	0.0025	0.14	ND	0.24	0.38	0.039	0.097	2.27	2.70	120	2.3	0.0018	110
10/24/2013	10:00	14.1	7.9	ND	0.24	0.0046	0.11	ND	0.24	0.35	0.035	0.082	2.47	2.42	150	1.8	0.0012	98
10/31/2013	9:50	12.4	8.1	ND	0.14	0.0034	0.15	ND	0.21	0.36	0.033	0.078	2.10	2.74	130	1.3	0.00031	94

* Method Detection Limit - limits can vary for individual samples depending on matrix interference and dilution factors, all results are preliminary and subject to final revision.

** Total nitrogen is calculated through the summation of the different components of total nitrogen: organic and ammoniacal nitrogen (together referred to as Total Kjeldahl Nitrogen or TKN) and nitrate/nitrite nitrogen.

*** United States Geological Survey (USGS) Continuous-Record Gaging Station

**** Flow rates are preliminary and subject to final revision by USGS.

Recommended EPA Criteria based on Aggregate Ecoregion III

Total Phosporus: 0.02188 mg/L (21.88 ug/L) = 0.022 mg/L

Total Nitrogen: 0.38 mg/L

Chlorophyll *a*: 0.00178 mg/L (1.78 ug/L) ≈ 0.0018 mg/L

Turbidity: 2.34 FTU/NTU

Table 3-3. 2013 nutrient results for grab samples collected by the Sonoma County Water Agency at Jimtown and Digger's Bend. Highlighted values exceed the EPA criteria.

Jimtown Bridge	Time	Temperature	pH	Total Organic Nitrogen	Ammonia as N	Ammonia as N Unionized	Nitrate as N	Nitrite as N	Total Kjeldahl Nitrogen	Total Nitrogen**	Phosphorus, Total	Total Orthophosphate	Dissolved Organic Carbon	Total Organic Carbon	Total Dissolved Solids	Turbidity	Chlorophyll-a	USGS 11463682 RR at Jimtown***
MDL*				0.200	0.10	0.00010	0.030	0.030	0.10		0.020	0.020	0.0400	0.0400	4.2	0.020	0.000050	Flow Rate****
Date		°C		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	NTU	mg/L	(cfs)
5/16/2013	10:50	18.5	7.4	ND	0.18	0.0016	0.26	ND	ND	0.36	ND	0.025	1.00	1.35	170	0.82	0.0013	102
5/23/2013	10:30	16.4	7.3	ND	0.10	0.00059	0.24	ND	ND	0.42	ND	ND	0.962	1.28	180	0.93	0.0011	95
5/30/2013	10:00	18.0	7.5	ND	0.14	0.0013	0.23	ND	ND	0.40	ND	0.025	1.05	1.30	190	0.79	0.0014	93
6/6/2013	10:50	20.1	7.5	ND	0.18	0.0021	0.21	ND	ND	0.35	0.022	0.036	0.860	1.08	180	0.90	0.0019	82
6/13/2013	10:00	18.0	7.5	ND	0.14	0.0048	0.21	ND	ND	0.35	ND	0.028	0.842	1.26	200	0.46	0.00094	76
6/20/2013	10:10	18.4	7.6	ND	0.10	0.0013	0.19	ND	ND	0.33	ND	0.064	0.902	1.34	170	0.75	0.0016	81
6/27/2013	11:50	22.0	7.6	ND	0.14	ND	0.14	ND	ND	0.32	ND	0.026	1.16	1.65	150	0.90	0.0019	121
7/3/2013	10:10	22.2	7.4	ND	0.14	ND	0.15	ND	ND	0.29	ND	0.035	1.08	1.36	160	0.96	0.0022	92
7/11/2013	10:00	20.2	7.7	ND	0.14	ND	0.12	ND	ND	0.30	ND	0.025	0.746	1.62	170	0.49	0.0029	93
7/18/2013	10:30	20.5	7.6	ND	0.18	ND	0.15	ND	0.21	0.36	0.021	0.026	1.26	1.82	160	0.48	0.0030	107
7/25/2013	10:30	21.0	7.6	ND	0.14	ND	0.15	ND	0.24	0.39	ND	0.024	1.32	1.68	160	0.63	0.0025	99
8/1/2013	10:30	19.5	7.7	0.21	ND	ND	0.14	ND	0.21	0.35	0.022	0.027	1.29	1.52	130	0.55	0.0017	106
8/8/2013	10:30	19.1	7.7	ND	ND	ND	0.14	ND	ND	0.32	ND	0.031	1.30	1.67	150	0.81	0.0036	100
8/15/2013	10:30	20.7	7.6	0.21	ND	ND	0.14	ND	0.21	0.35	ND	0.025	1.38	1.97	160	0.71	0.0031	95
8/22/2013	10:40	19.0	7.4	0.21	ND	ND	0.13	ND	0.21	0.34	ND	0.026	1.30	1.84	160	0.67	0.0034	94
8/29/2013	10:00	20.4	7.4	ND	ND	ND	0.13	ND	ND	0.31	ND	ND	1.34	2.07	150	0.83	0.0043	97
9/5/2013	10:30	19.3	7.6	ND	ND	ND	0.11	ND	ND	0.11	0.021	0.038	1.48	1.85	150	0.64	0.0025	102
9/12/2013	10:10	18.8	7.6	ND	ND	ND	0.11	ND	ND	0.25	0.025	0.052	1.38	1.93	160	1.0	0.0021	106
9/19/2013	10:20	18.1	7.7	ND	0.14	ND	0.12	ND	ND	0.19	0.025	0.060	1.30	1.91	150	0.51	0.00042	100
9/26/2013	10:20	16.9	7.8	ND	ND	ND	0.13	ND	ND	0.27	0.024	0.061	1.37	1.73	160	0.41	0.00040	102
10/3/2013	10:30	16.3	7.9	ND	ND	ND	0.10	ND	ND	0.24	0.024	0.042	1.39	1.69	150	0.49	0.00098	101
10/10/2013	12:10	15.8	7.7	ND	0.14	ND	0.13	ND	0.28	0.41	0.024	0.039	1.43	1.72	170	0.38	0.00040	96
10/17/2013																		93
10/24/2013	10:40	15.7	7.7	ND	0.21	0.0028	0.12	ND	0.24	0.37	ND	0.040	1.31	1.55	160	0.27	0.00040	91
10/31/2013	10:30	13.9	7.8	ND	ND	0.00096	0.15	ND	ND	0.29	ND	0.039	1.38	1.39	170	0.29	ND	96

Digger's Bend	Time	Temperature	pH	Total Organic Nitrogen	Ammonia as N	Ammonia as N Unionized	Nitrate as N	Nitrite as N	Total Kjeldahl Nitrogen	Total Nitrogen**	Phosphorus, Total	Total Orthophosphate	Dissolved Organic Carbon	Total Organic Carbon	Total Dissolved Solids	Turbidity	Chlorophyll-a	USGS 11463980 RR at Digger's Bend***
MDL*				0.200	0.10	0.00010	0.030	0.030	0.10		0.020	0.020	0.0400	0.0400	4.2	0.020	0.000050	Flow Rate****
Date		°C		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	NTU	mg/L	(cfs)
5/16/2013	11:20	19.0	7.7	ND	0.21	0.0037	0.20	ND	ND	0.38	ND	0.021	0.991	1.45	170	1.7	0.0013	112
5/23/2013	11:10	16.3	7.7	ND	0.14	0.0020	0.19	ND	ND	0.33	ND	ND	1.01	1.25	180	1.0	0.00056	96
5/30/2013	10:50	19.1	7.9	ND	0.14	0.0036	0.18	ND	ND	0.36	ND	0.021	1.11	1.27	180	1.1	0.0018	99
6/6/2013	11:30	19.8	7.8	ND	0.14	0.0033	0.14	ND	ND	0.28	ND	0.032	0.991	1.08	170	0.79	0.0015	84
6/13/2013	10:30	19.1	7.9	ND	0.18	0.0018	0.13	ND	ND	0.27	ND	0.040	1.07	1.25	190	0.55	0.00094	76
6/20/2013	10:50	19.2	7.8	ND	ND	ND	0.11	ND	ND	0.25	ND	0.029	0.972	1.27	160	0.67	ND	77
6/27/2013	12:30	22.0	7.8	ND	0.10	ND	ND	ND	ND	0.18	ND	0.022	1.29	1.61	160	0.70	0.0039	113
7/3/2013	10:40	23.5	7.8	ND	0.14	ND	ND	ND	ND	0.14	ND	0.031	1.09	1.24	170	1.1	0.00087	75
7/11/2013	10:40	20.8	8.0	ND	ND	ND	ND	ND	ND	0.14	ND	0.041	1.20	1.70	170	0.54	0.00038	88
7/18/2013	11:10	20.8	7.8	ND	0.21	0.0051	ND	ND	ND	0.18	ND	0.038	1.27	1.87	160	0.74	0.0010	102
7/25/2013	11:10	21.5	7.9	ND	ND	ND	ND	ND	0.21	0.21	ND	0.028	1.39	1.80	160	0.80	0.00052	88
8/1/2013	11:10	19.9	7.9	0.21	ND	ND	ND	ND	ND	0.18	ND	0.035	1.35	1.58	160	0.75	ND	97
8/8/2013	11:00	19.2	7.9	ND	ND	ND	ND	ND	ND	0.18	0.020	0.035	1.45	1.75	170	0.99	0.00013	92
8/15/2013																		83
8/22/2013	11:10	19.7	7.8	ND	ND	ND	ND	ND	ND	0.18	0.026	0.026	1.69	2.06	180	0.82	0.00026	88
8/29/2013	10:30	21.3	7.8	ND	0.14	ND	ND	ND	ND	0.18	ND	ND	1.42	2.14	160	0.93	0.00064	90
9/5/2013	11:00	20.3	7.7	ND	ND	ND	0.10	ND	ND	0.10	ND	0.022	1.56	1.68	150	0.97	ND	91
9/12/2013	10:40	19.1	7.8	ND	ND	ND	ND	ND	ND	0.14	ND	0.052	1.51	2.14	160	1.0	ND	95
9/19/2013	11:00	18.2	7.5	ND	ND	ND	0.10	ND	ND	0.17	ND	0.033	1.37	1.84	150	0.65	0.00014	89
9/26/2013	10:50	17.3	8.0	ND	ND	ND	ND	ND	ND	0.10	0.020	0.037	1.29	1.67	150	0.52	0.00013	92
10/3/2013	11:00	16.7	8.1	ND	ND	ND	0.10	ND	ND	0.28	0.021	0.034	1.31	1.93	160	0.57	0.00014	95
10/10/2013	12:50	15.3	7.7	ND	0.18	ND	ND	ND	0.35	0.35	ND	0.031	1.40	1.61	180	0.42	ND	84
10/17/2013	11:00	15.0	8.1	ND	0.10	0.0035	ND	ND	ND	0.18	ND	0.022	1.22	1.59	150	0.24	0.00027	84
10/24/2013	11:20	15.3	8.1	ND	0.21	0.0061	ND	ND	ND	0.18	ND	0.028	1.29	1.45	160	0.38	0.0027	84
10/31/2013	10:50	13.4	8.1	2.0	ND	0.0020	ND	ND	0.21	0.21	ND	0.031	1.30	1.68	180	0.35	0.00031	92

* Method Detection Limit - limits can vary for individual samples depending on matrix interference and dilution factors, all results are preliminary and subject to final revision.
** Total nitrogen is calculated through the summation of the different components of total nitrogen: organic and ammoniacal nitrogen (together referred to as Total Kjeldahl Nitrogen or TKN) and nitrate/nitrite nitrogen.
*** United States Geological Survey (USGS) Continuous-Record Gaging Station
**** Flow rates are preliminary and subject to final revision by USGS.

Recommended EPA Criteria based on Aggregate Ecoregion III
Total Phosporus: 0.02188 mg/L (21.88 ug/L) = 0.022 mg/L
Total Nitrogen: 0.38 mg/L
Chlorophyll *a*: 0.00178 mg/L (1.78 ug/L) = 0.0018 mg/L
Turbidity: 2.34 FTU/NTU

Table 3-4. 2013 nutrient results for grab samples collected by the Sonoma County Water Agency at Riverfront Park and Hacienda. Highlighted values exceed the EPA criteria.

Riverfront Park	Time	Temperature	pH	Total Organic Nitrogen	Ammonia as N	Ammonia as N Unionized	Nitrate as N	Nitrite as N	Total Kjeldahl Nitrogen	Total Nitrogen**	Phosphorus, Total	Total Orthophosphate	Dissolved Organic Carbon	Total Organic Carbon	Total Dissolved Solids	Turbidity	Chlorophyll-a	USGS 11465390 RR near Windsor (Riverfront Park)***
MDL*				0.200	0.10	0.00010	0.030	0.030	0.10		0.020	0.020	0.0400	0.0400	4.2	0.020	0.000050	Flow Rate****
Date		°C		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	NTU	mg/L	(cfs)
5/16/2013	12:00	17.7	7.5	ND	0.25	0.0026	0.16	ND	ND	0.30	0.02	0.028	1.17	1.64	150	1.8	0.0012	220
5/23/2013	11:50	15.4	7.5	ND	0.10	0.00086	0.16	ND	ND	0.33	ND	ND	1.16	1.59	150	1.5	0.00083	196
5/30/2013	12:00	17.3	7.7	ND	0.1	0.0017	0.14	ND	ND	0.28	0.024	0.033	1.20	1.55	140	1.5	0.0011	200
6/6/2013	12:10	18	7.7	ND	0.1	0.0017	0.13	ND	ND	0.24	0.023	0.044	1.140	1.42	140	1.9	0.0013	159
6/13/2013	11:15	17.3	7.8	ND	0.1	0.0053	0.13	ND	ND	0.27	0.025	0.036	1.140	1.53	160	1.2	0.00047	148
6/20/2013	11:40	16.9	7.7	ND	0.10	0.0015	0.12	ND	ND	0.19	0.025	0.033	1.28	1.62	120	1.2	ND	187
6/27/2013	13:20	19.9	7.7	ND	0.1	ND	ND	ND	ND	0.18	0.022	0.034	1.25	1.71	130	1.1	0.0015	222
7/3/2013	11:30	19.9	7.4	ND	0.1	ND	ND	ND	ND	0.18	ND	0.067	1.30	1.63	130	1.8	0.00050	180
7/11/2013	11:10	17.8	7.6	ND	0.18	ND	ND	ND	ND	0.14	ND	0.041	1.28	1.76	150	2.0	0.00064	191
7/18/2013	12:00	18.5	7.6	ND	0.21	0.00	0.11	ND	0.21	0.32	ND	0.034	1.13	1.64	75	1.4	0.0007	176
7/25/2013	12:00	18.5	7.6	ND	0.10	ND	ND	ND	0.28	0.28	ND	0.035	1.28	1.67	140	1.5	0.00039	180
8/1/2013	12:00	17.2	7.6	ND	ND	ND	0.12	ND	ND	0.29	0.026	0.039	1.29	1.6	120	1.3	0.00065	204
8/8/2013	11:50	16.7	7.5	ND	0.1	ND	ND	ND	ND	0.18	0.021	0.039	1.30	1.69	120	1.3	0.00052	203
8/15/2013	11:50	18	7.5	ND	ND	ND	0.14	ND	0.21	0.35	ND	0.045	1.47	1.98	140	1.5	0.00053	188
8/22/2013	12:00	17.1	7.3	ND	0.21	0.0014	ND	ND	ND	0.18	ND	0.026	1.42	1.90	140	1.6	0.00039	193
8/29/2013	11:30	18.2	7.8	ND	0.1	ND	0.11	ND	ND	0.28	ND	0.034	1.38	1.99	130	1.1	0.00025	195
9/5/2013	11:50	17.2	7.4	ND	0.1	ND	0.12	ND	ND	0.12	0.026	0.038	1.62	1.88	130	1.6	0.0008	201
9/12/2013	11:30	16	7.4	ND	0.14	ND	0.12	ND	ND	0.22	0.023	0.048	1.47	1.85	130	2.4	0.00013	203
9/19/2013	11:50	15.8	7.3	ND	ND	ND	0.13	ND	ND	0.27	ND	0.045	1.40	1.87	120	1.6	ND	195
9/26/2013	11:40	15.1	7.9	ND	0.1	ND	ND	ND	ND	0.18	0.021	0.041	1.37	1.81	140	1.5	0.00080	204
10/3/2013	11:50	14.9	7.9	ND	ND	ND	ND	ND	ND	0.18	ND	0.026	1.33	1.87	140	1.1	0.00056	199
10/10/2013	13:50	13.5	7.8	ND	0.14	ND	0.11	ND	0.32	0.42	0.02	0.035	1.37	1.69	130	0.93	0.00013	176
10/17/2013	11:40	13	8	ND	ND	ND	ND	ND	ND	0.14	ND	0.038	1.35	1.67	120	0.48	0.00082	175
10/24/2013	12:00	14	7.8	ND	0.24	0.0037	0.093	ND	0.21	0.30	ND	0.040	1.39	1.64	130	0.66	0.00067	186
10/31/2013	11:30	12	7.9	ND	0.14	0.0023	ND	ND	ND	0.18	ND	0.035	1.37	1.75	140	0.72	0.00031	202

Hacienda	Time	Temperature	pH	Total Organic Nitrogen	Ammonia as N	Ammonia as N Unionized	Nitrate as N	Nitrite as N	Total Kjeldahl Nitrogen	Total Nitrogen**	Phosphorus, Total	Total Orthophosphate	Dissolved Organic Carbon	Total Organic Carbon	Total Dissolved Solids	Turbidity	Chlorophyll-a	USGS 11467000 RR near Guerneville (Hacienda)***
MDL*				0.200	0.10	0.00010	0.030	0.030	0.10		0.020	0.020	0.0400	0.0400	4.2	0.020	0.000050	Flow Rate****
Date		°C		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	NTU	mg/L	(cfs)
5/16/2013	12:40	19.6	7.8	ND	0.18	0.0042	0.14	ND	0.28	0.42	0.042	0.071	1.50	1.99	160	2.1	0.00058	158
5/23/2013	12:30	17.7	7.6	ND	0.21	0.0025	0.14	ND	ND	0.31	0.039	0.077	1.45	1.83	160	2.0	0.00069	124
5/30/2013	12:30	20.2	7.8	ND	0.1	0.0022	0.14	ND	ND	0.28	0.047	0.100	1.42	1.80	160	2.3	0.00076	138
6/6/2013	12:40	20.1	7.8	ND	0.14	0.0033	0.12	ND	ND	0.12	0.054	0.14	1.7	1.93	150	2.2	0.0012	96
6/13/2013	11:50	19.6	7.9	ND	0.18	0.088	0.11	ND	0.21	0.32	0.059	0.130	1.71	2.09	180	1.7	0.0011	94
6/20/2013	12:10	19.8	7.3	ND	0.1	0.002	0.11	ND	ND	0.28	0.037	0.092	1.46	1.79	130	2.6	0.00065	87
6/27/2013	13:50	21.3	7.5	ND	0.14	ND	0.17	ND	0.28	0.44	0.096	0.25	2.76	3.63	130	3.4	0.0018	167
7/3/2013	12:00	23.5	7.5	ND	0.14	ND	ND	ND	0.21	0.21	0.11	0.34	2.34	2.89	150	2.5	0.0021	95
7/11/2013	11:50	20.6	7.8	ND	0.10	ND	ND	ND	ND	0.14	0.047	0.11	1.55	2.04	150	2.1	0.0010	101
7/18/2013	12:30	20.2	7.8	ND	0.14	ND	0.11	ND	ND	0.29	0.032	0.077	1.34	1.77	150	1.6	0.0007	94
7/25/2013	12:40	21.2	7.8	ND	ND	ND	ND	ND	ND	0.18	0.024	0.067	1.44	1.76	140	1.7	0.00039	98
8/1/2013	12:40	19.3	7.8	ND	ND	ND	0.1	ND	ND	0.28	0.044	0.058	1.38	1.67	140	1.6	0.0018	111
8/8/2013	12:20	18	7.7	ND	ND	ND	ND	ND	0.21	0.21	0.025	0.059	1.26	1.62	120	1.7	0.00026	113
8/15/2013	12:20	20.5	7.4	ND	ND	ND	ND	ND	0.21	0.21	0.021	0.058	1.56	1.97	150	1.4	0.00040	94
8/22/2013	12:40	19.1	7.5	ND	ND	ND	ND	ND	ND	0.18	ND	0.038	1.46	1.94	140	1.6	0.00065	105
8/29/2013	13:30	21.3	7.5	ND	ND	ND	ND	ND	ND	0.07	0.022	ND	1.47	1.96	140	1.3	0.00051	95
9/5/2013	12:40	19.7	7.5	ND	ND	ND	ND	ND	ND	ND	0.021	0.042	1.67	1.86	140	1.3	ND	99
9/12/2013	12:00	17.9	7.6	ND	ND	ND	ND	ND	ND	0.1	ND	0.036	1.40	1.79	140	1.5	0.00027	107
9/19/2013	12:20	17.6	7.4	ND	0.10	ND	ND	ND	ND	0.18	0.020	0.045	1.45	1.89	140	1.2	ND	110
9/26/2013	12:20	17.3	7.9	ND	0.1	ND	0.1	ND	ND	0.28	0.026	0.045	1.55	1.87	130	1.6	0.00027	122
10/3/2013	12:40	16.7	7.9	ND	ND	ND	ND	ND	ND	0.18	0.021	0.042	1.54	1.84	130	1.4	0.00042	121
10/10/2013	14:30	15	7.5	ND	0.24	0.002	ND	ND	0.32	0.32	0.02	0.035	1.34	1.71	140	0.71	0.00013	91
10/17/2013	12:10	14.4	7.9	ND	0.14	0.0026	ND	ND	0.21	0.21	ND	0.03	1.33	1.61	120	0.6	0.00014	100
10/24/2013	12:20	14.7	7.8	ND	0.28	0.0044	ND	ND	0.32	0.32	ND	0.082	1.43	1.59	140	0.8	0.00027	99
10/31/2013	12:10	13	7.9	ND	ND	0.0011	ND	ND	ND	0.18	0.02	0.035	1.42	1.73	140	0.65	0.00031	127

* Method Detection Limit - limits can vary for individual samples depending on matrix interference and dilution factors, all results are preliminary and subject to final revision.

** Total nitrogen is calculated through the summation of the different components of total nitrogen: organic and ammoniacal nitrogen (together referred to as Total Kjeldahl Nitrogen or TKN) and nitrate/nitrite nitrogen.

*** United States Geological Survey (USGS) Continuous-Record Gaging Station

**** Flow rates are preliminary and subject to final revision by USGS.

Recommended EPA Criteria based on Aggregate Ecoregion III

Total Phosporus: 0.02188 mg/L (21.88 ug/L) ≈ 0.022 mg/L

Total Nitrogen: 0.38 mg/L

Chlorophyll *a*: 0.00178 mg/L (1.78 ug/L) ≈ 0.0018 mg/L

Turbidity: 2.34 FTU/NTU

3.1.2 2013 Seasonal Bacterial Sampling (Beach Sampling)

The NCRWQCB, in collaboration with the Sonoma County DHS, conducts seasonal bacteriological sampling at Russian River beaches to monitor levels of pathogens. Results are used by the Sonoma County DHS to determine whether or not bacteria levels fall within the State guidelines. In 2013, the NCRWQCB also collected pathogen samples as part of the development of a Total Maximum Daily Load (TMDL) for Russian River pathogens.

The 2013 Sonoma County DHS seasonal beach sampling locations consisted of: Cloverdale River Park; Camp Rose Beach; Healdsburg Veterans Memorial Beach; Steelhead Beach; Forestville Access Beach; Sunset Beach; Johnson's Beach; and Monte Rio Beach. Bacteriological samples were collected weekly beginning in late May and continuing until September 3. The samples were analyzed using the Colilert quantitray MPN method for total coliform and *E. coli*. Results from the sampling program are reported by the NCRWQCB and the Sonoma County DHS at their respective websites and on the Sonoma County DHS Beach Sampling Hotline. The 2013 seasonal results are shown in Table 3-5 and Figures 3-4 and 3-5.

The NCRWQCB TMDL river sampling locations consisted of: Cloverdale River Park; Alexander Valley; Camp Rose Beach; Healdsburg Veterans Memorial Beach; Steelhead Beach; Forestville Access Beach; Johnson's Beach; and Monte Rio Beach. Samples were collected approximately weekly from late May through early September. The 2013 seasonal results are shown in Table 3-6 and Figures 3-6 and 3-7. The analysis resulting from the 2013 sampling programs and prior years are being evaluated as part of the CEQA requirements associated with proposed permanent changes to D1610.

Table 3-5. Russian River Seasonal Beach Results collected by the NCRWQCB for Sonoma County DHS in 2013. Highlighted values indicate those values exceeding the California Department of Public Health Draft Guidance for Fresh Water Beaches.

	Cloverdale River Park		Camp Rose Beach		Healdsburg Veterans		Steelhead Beach		Forestville Access		Sunset Beach		Johnson's Beach		Monte Rio Beach	
	TC	EC	TC	EC	TC	EC	TC	EC	TC	EC	TC	EC	TC	EC	TC	EC
5/28/2013	1793	85	1450	20	798	10	12997	20	934	10	1162	52	1137	52	1607	20
5/29/2013							663	20								
6/4/2013	3,448	52	3,076	20	2,143	75	1,576	20	1,119	10	1,989	<10	1,968	31	1,723	10
6/11/2013	3,255	20	2,098	<10	1,374	74	1,789	30	2,143	41	2,603	41	1,739	31	2,851	209
6/18/2013	2,613	10	4,884	41	1,607	41	1,723	10	2,046	63	1,650	10	3,448	75	2,613	86
6/25/2013	2,448	504	4,106	75	14,136	959	2,481	85	2,014	63	4,611	52	14136	305	>24196	609
6/27/2013	2,913	52			3,654	241							2,613	97	3,873	355
7/2/2013	5,475	52	5,475	20	24,196	40	4,106	10	5,475	31	1,726	<10	2,382	52	4,106	132
7/3/2013					24,196	31										
7/5/2013					3,873	74										
7/9/2013	4,106	52	3,076	41	6,488	74	2,014	10	1,529	10	1,607	20	4,106	31	1,956	41
7/16/2013	6,867	31	2,909	20	2,143	41	1,130	31	1,439	<10	1,376	10	2,254	10	932	<10
7/23/2013	3,448	<10	2,909	<10	1,401	20	884	<10	865	10	93	10	2,909	<10	933	41
7/30/2013	3,076	41	3,448	20	2,755	<10			1,314	10	1,076	10	2,359	20	528	<10
7/31/2013							602	31								
8/6/2013	1,850	20	3,448	<10	1,664	31	960	10	1,076	<10	1,043	20	2,014	10	727	20
8/13/2013	2,282	20	3,654	20	1,553	20	934	<10	959	<10	833	<10	2,282	20	563	<10
8/20/2013	5,172	20	5,457	20	2,143	20	1,467	10	1,106	20	1,201	10	2,247	31	1,274	10
8/27/2013	5,475	10	3,255	<10	1,956	20	1,046	10	1,515	<10	959	10	1,785	10	1,439	<10
9/3/2013	7,270	20	5,475	<10	2,382	<10	1,565	10	1,607	20	1,050	10	1,515	<10	1,187	52

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
E. coli: 235 per 100 ml
Enterococcus: 61 per 100 ml

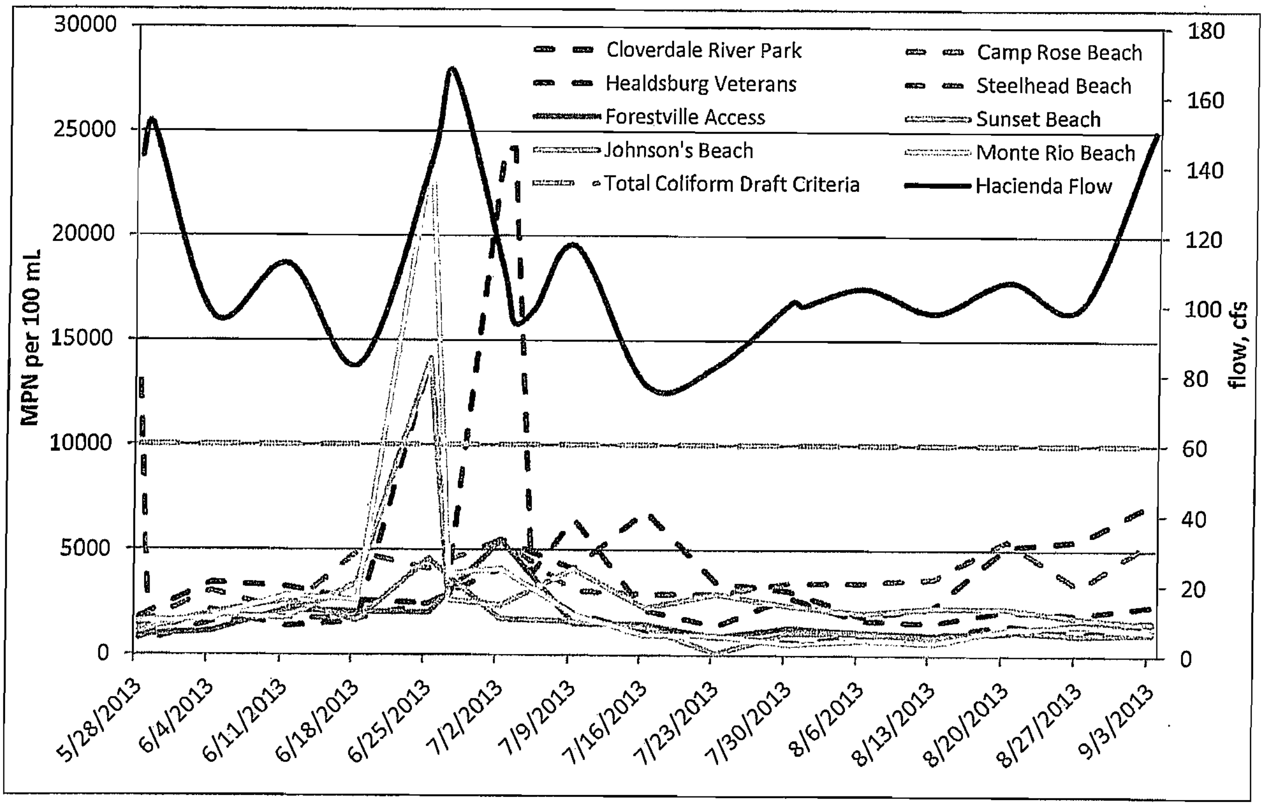

Figure 3-4. Russian River Beach Bacteria Sample Results for Total Coliform in 2013.

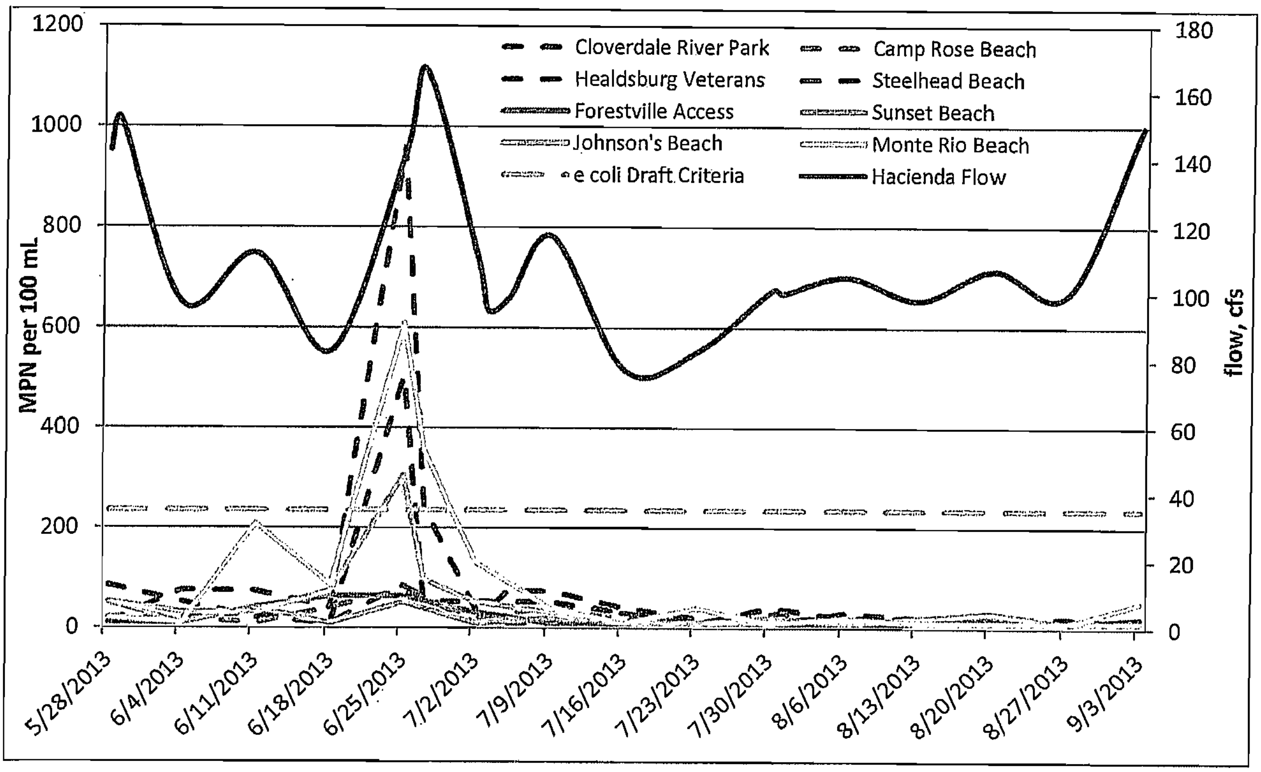

Figure 3-5. Russian River Beach Pathogen Sample Results for E. coli in 2013.

Table 3-6. Russian River TMDL Seasonal Results collected by the NCRWQCB for E coli and Enterococcus in 2013. Highlighted values indicate those values exceeding the California Department of Public Health Draft Guidance for Fresh Water Beaches.

	Cloverdale River Park		Alexander Valley		Camp Rose		Healdsburg		Steelhead Beach		Forestville		Johnson's Beach		Monte Rio Beach	
	EC	ENT	EC	ENT	EC	ENT	EC	ENT	EC	ENT	EC	ENT	EC	ENT	EC	ENT
5/30/2013	86	28	31	16	10	7	74	21	<10	15	41	35	10	46	63	122
6/5/2013	10	52	20	34	10	18	41	71	40	8	20	6	31	18	41	10
6/12/2013	10	31	30	12	52	11	20	20	<10	13	10	5	20	20	10	10
6/26/2013	52	411	86	291	52	1300	122	326	2014	>2420	1296	>2420	441	687	2098	>2420
7/2/2013	41	64	20	63	30	45	10	29	10	105	10	36	41	62	63	317
7/10/2013	20	308	<10	236	10	187	85	140	<10	47	10	13	<10	55	10	>2420
7/17/2013	41	135	41	158	<10	107	74	73	20	19	<10	12	<10	13	<10	139
7/24/2013	<10	16	<10	<1	<10	9	20	5	<10	4	<10	11	<10	17	10	2
8/1/2013	41	47	<10	31	20	86	52	19	10	10	10	23	31	4	10	13
8/7/2013	63	48	10	72	<10	91	<10	12	10	11	<10	30	10	36	63	2
8/14/2013	10	108	<10	19	10	70	10	21					20	12	10	12
8/21/2013	20	74	20	70	<10	46	10	15	10	41	10	8	<10	12	<10	4
8/28/2013	10	59	10	52	31	19	20	20	20	4	20	13	10	8	<10	3
9/4/2013	41	30	20	23	10	44	10	20	63	7	98	16	41	21	10	26

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
E. coli: 235 per 100 ml
Enterococcus: 61 per 100 ml

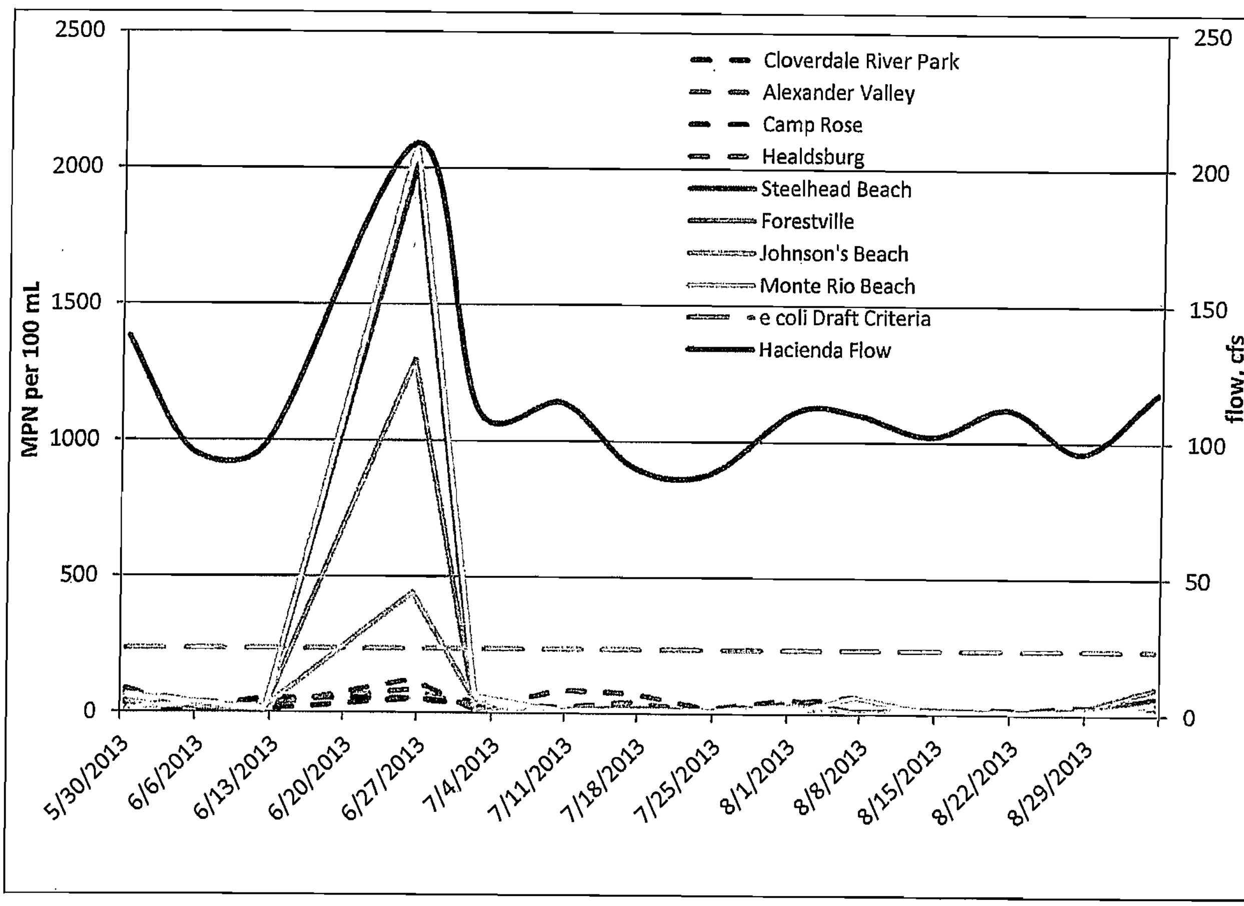

Figure 3-6. Russian River TMDL Seasonal Results collected by the NCRWQCB for E. coli in 2013.

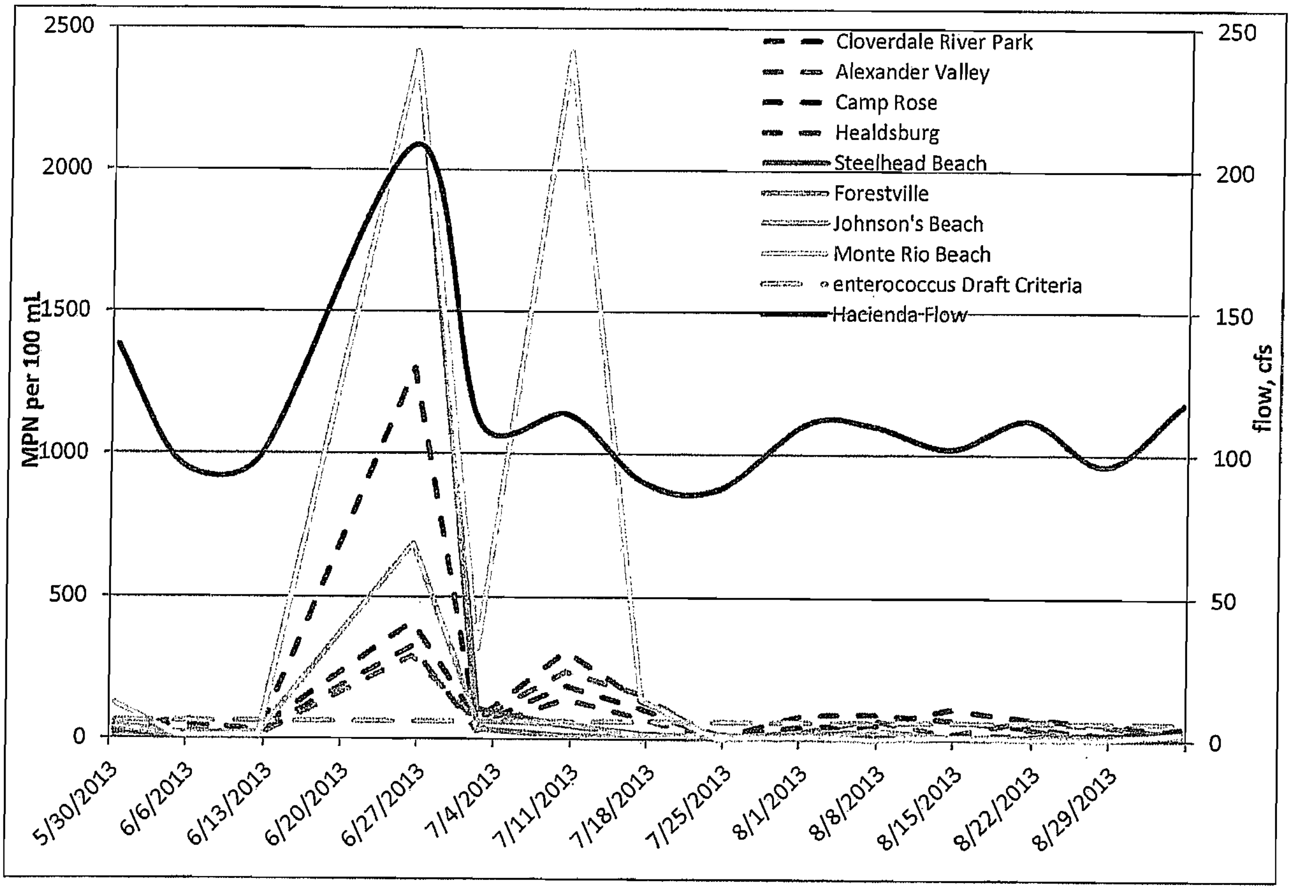

Figure 3-7. Russian River TMDL Seasonal Results collected by the NCRWQCB for Enterococcus in 2013.

3.2 Russian River Estuary Water Quality Monitoring

Flows in the lower Russian River at Hacienda (downstream of the confluence with Dry Creek) were affected by drought conditions in 2013 and dropped below D1610 minimum flow requirements from late May through October and occasionally dropped below the five-day running average of 85 cfs, but remained higher than TUC instantaneous minimum flow of 70 cfs. Long-term water quality monitoring and grab sampling was 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. Grab sampling was conducted weekly in the mainstem of the lower river for the term of the Order. Water Agency staff also continued to collect long-term monitoring data to: establish baseline information on water quality in the Estuary and assess the availability of aquatic habitat in the Estuary; gain a better understanding of the longitudinal and vertical water quality profile during the ebb and flow of the tide; and track changes to the water quality profile that may occur during periods of low flow conditions, barrier beach closure, lagoon outlet channel implementation, 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 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.

The Water Agency submits an annual report to the National Marine Fisheries Service and California Department of Fish and Wildlife documenting the status updates of the Water Agency's efforts in implementing the Biological Opinion. The water quality monitoring data for 2013 is currently being compiled and will be discussed in the "Russian River Biological Opinion Status and Data Report Year 2013-14" due to be released in June 2014. 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, this data will be evaluated as part of the CEQA requirements associated with proposed permanent changes to minimum flows under D1610. The grab sample sites are shown in Figure 3-8, and the results are summarized in Figures 3-9 and 3-10 and Tables 3-7 through 3-16.

Highlighted values indicate those values exceeding California Department of Public Health Draft Guidance for Fresh Water Beaches for Indicator Bacteria (CDPH 2011), EPA Recreational Water Quality Criteria (EPA 2012), and EPA recommended criteria for Nutrients, Chlorophyll a, and Turbidity in Rivers and Streams in Aggregate Ecoregion III (EPA 2000). However, it must be emphasized that 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.

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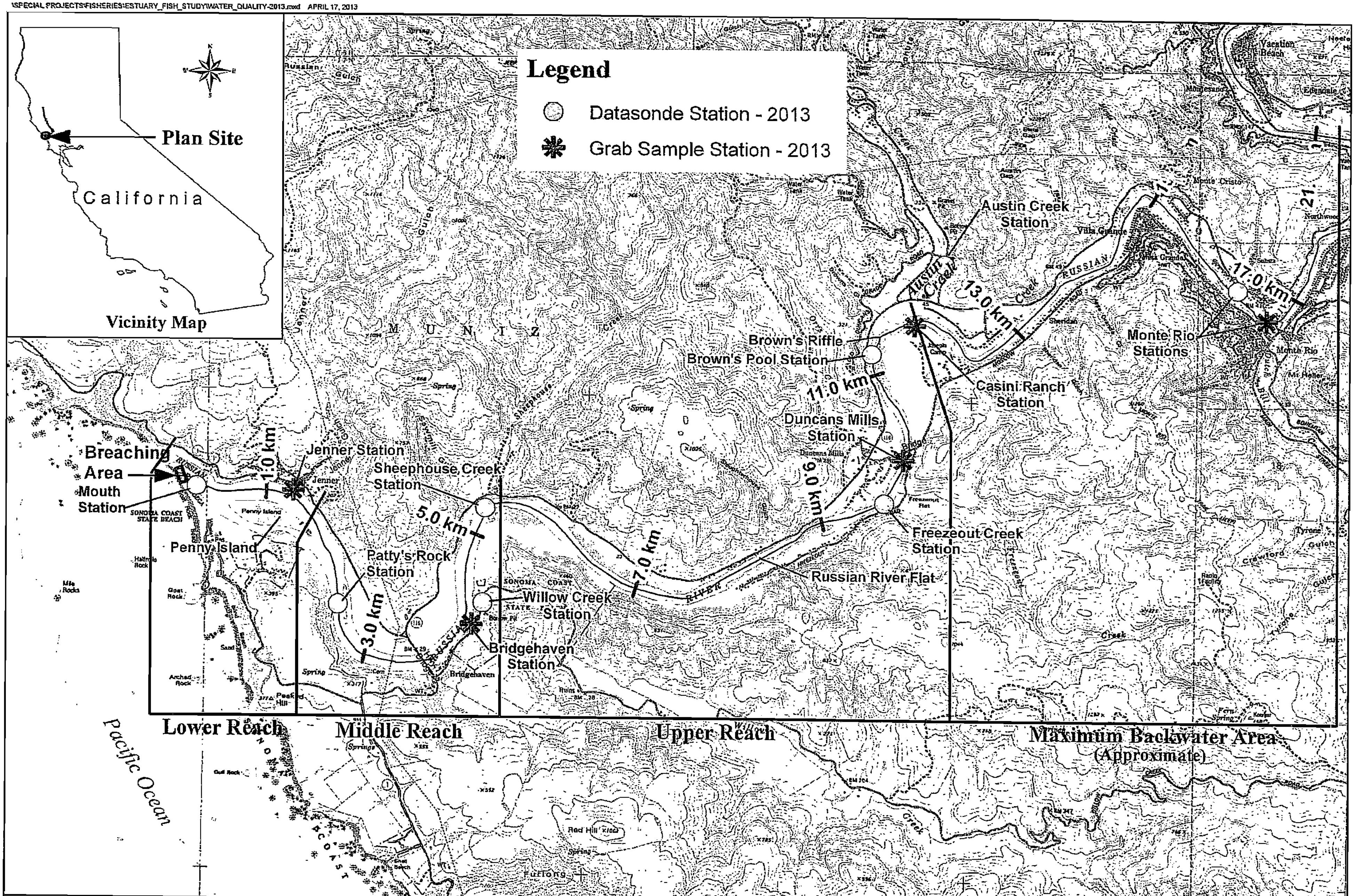


Russian River Estuary
Water Quality Monitoring Stations - 2013

Figure 2

This Map is for general reference only.

Table 3-7. 2013 Monte Rio bacteria concentrations for samples collected by the Sonoma County Water Agency. This site experiences freshwater conditions.

Monte Rio	Time	Temperature	pH	Total Coliforms (Colilert)	E. coli (Colilert)	Enterococcus (Enterolert)	USGS 11467000 RR near Guerneville (Hacienda)***
MDL*				20	20	2	Flow Rate****
Date		°C		MPN/100mL	MPN/100mL	MPN/100mL	(cfs)
5/14/2013	11:40	21.5	7.7	1553.1	7.5	5.2	177
5/21/2013	11:30	21.5	7.8	1986.3	6.3	6.2	131
5/28/2013	11:10	19.4	7.8	>2419.6	33.1	45.9	143
5/30/2013	11:50	21.4	8.0	1203.1	62.0	51.2	138
6/4/2013	11:00	21.7	7.8	1732.9	25.6	21.1	97
6/11/2013	11:15	21.0	7.8	1986.3	31.8	18.9	112
6/13/2013	11:40	21.8	7.7	2419.6	37.4	32.8	94
6/18/2013	10:40	22.1	7.9	1986.3	20.9	45.4	83
6/25/2013	10:50	21.0	7.8	2419.6	64.5	**158.5**	142
7/2/2013	12:20	25.9	7.9	>2419.6	79.8	**70.8**	111
7/9/2013	11:00	23.3	7.7	>2419.6	8.6	**2419.6**	117
7/11/2013	12:20	23.7	7.9	1732.9	5.2	**920.8**	101
7/16/2013	11:10	21.7	8.0	2419.6	4.1	**517.2**	77
7/23/2013	10:50	22.6	7.9	1203.3	9.7	11.8	83
7/30/0213	10:50	20.5	7.9	980.4	7.5	13.5	101
8/6/2013	11:20	21.1	7.9	365.4	3.1	4.1	105
8/13/2013	10:40	21.5	8.0	770.1	10.9	17.1	98
8/20/2013	10:30	21.8	7.6	1299.7	8.4	9.6	107
8/27/2013	12:00	21.8	7.9	1553.1	4.1	3.0	100
9/3/2013	11:40	19.7	7.7	980.4	8.5	13.2	150
9/10/2013	10:30	21.1	8.2	1986.3	6.3	13.5	93
9/17/2013	11:10	19.7	7.7	866.4	20.1	20.1	110
9/24/2013	11:00	18.2	7.5	727	14.5	19.5	127
9/26/2013	12:20	17.1	7.3	1203.3	11.0	20.1	122
10/1/2013	12:20	18.5	7.7	1732.9	116.9	**190.4**	140
10/3/2013	12:20	16.4	7.4	1986.3	166.4	**228.2**	121
10/8/2013	11:50	14.8	7.5	2419.6	**579.4**	**67.7**	93
10/15/2013	11:50	15.6	7.9	1299.7	111.2	**137.6**	99
10/17/2013	12:20	14.9	7.4	344.8	10.9	10.7	100
10/22/2013	10:10	14.5	7.8	233.3	8.6	13.1	101
10/24/2013	12:00	14.9	8.0	111.2	4.1	17.1	99
10/29/2013	10:40	13.7	8.0	435.2	19.7	36.4	113
10/31/2013	11:30	12.8	7.8	365.4	73.2	22.3	127

* Method Detection Limit - limits can vary for individual samples depending on matrix interference and dilution factors, all results are preliminary and subject to final revision.

** United States Geological Survey (USGS) Continuous-Record Gaging Station

*** Flow rates are preliminary and subject to final revision by USGS.

Recommended EPA Recreational Water Quality Criteria - Statistical Threshold Value (STV) and Geomteric Mean (GM)

(Beach posting is recommended when indicator organisms exceed the STV) - Indicated by red text

E. coli (STV): 235 per 100 ml — Enterococcus (STV): 61 per 100 ml

E. coli (GM): 126 per 100mL — Enterococcus (GM): 33 per 100 mL

Table 3-8. 2013 Casini Ranch bacteria concentrations for samples collected by the Sonoma County Water Agency. This site may experience estuarine conditions.

Casini Ranch	Time	Temperature	pH	Total Coliforms (Colilert)	E. coli (Colilert)	Enterococcus (Enterolert)	USGS 11467000 RR near Guerneville (Hacienda)***
MDL*				20	20	2	Flow Rate****
Date		°C		MPN/100mL	MPN/100mL	MPN/100mL	(cfs)
5/14/2013	11:00	21.3	7.6	1732.9	7.4	3.1	177
5/21/2013	11:00	21.4	7.9	1732.9	8.5	<1.0	131
5/28/2013	10:45	20.0	7.9	>2419.6	55.7	**98.5**	143
5/30/2013	11:10	21.5	8.0	2419.6	45.0	**101.4**	138
6/4/2013	10:30	20.7	7.9	1413.6	17.5	4.1	97
6/11/2013	10:50	20.8	7.8	2419.6	22.8	36.4	112
6/13/2013	11:00	21.8	7.8	1299.7	24.1	18.3	94
6/18/2013	10:10	21.6	8.1	1732.9	16	24.1	83
6/25/2013	10:30	20.2	8.0	>2419.6	29.5	**146.7**	142
7/2/2013	11:50	24.8	7.9	>2419.6	35.9	34.5	111
7/9/2013	10:30	22.1	7.9	>2419.6	6.3	13.0	117
7/11/2013	11:50	22.6	8.0	>2419.6	5.1	20.3	101
7/16/2013	10:50	20.3	7.9	>2419.6	2.0	**80.5**	77
7/23/2013	10:20	22.5	8.2	2419.6	25.9	30.7	83
7/30/2013	10:20	19.6	8.0	1732.9	4.1	53.7	101
8/6/2013	10:40	20.1	8.0	204.6	3.1	20.9	105
8/13/2013	10:10	20.5	7.8	613.1	3.1	16.1	98
8/20/2013	10:10	20.8	7.8	686.7	9.6	47.1	107
8/27/2013	11:20	21.5	8.0	214.3	3.1	8.6	100
9/3/2013	11:10	20.0	8.4	1553.1	7.5	10.7	150
9/10/2013	10:10	19.7	8.1	1119.9	10.9	30.9	93
9/17/2013	10:40	20.0	8.4	435.2	4.1	12.6	110
9/24/2013	10:30	17.8	8.1	461.1	4.1	4.1	127
9/26/2013	11:30	18.5	8.0	816.4	21.8	10.8	122
10/1/2013	11:50	19.6	7.9	1119.9	55.6	**142.1**	140
10/3/2013	11:50	18.5	7.9	1986.3	165.8	**686.7**	121
10/8/2013	11:10	16.0	8.0	770.1	24.1	58.3	93
10/15/2013	11:20	16.4	8.2	648.8	6.2	**61.3**	99
10/17/2013	11:30	15.5	7.4	461.1	8.6	13.5	100
10/22/2013	9:50	14.5	8.2	461.1	15.8	5.1	101
10/24/2013	11:30	14.8	8.3	224.7	26.2	**148.3**	99
10/29/2013	10:20	14.1	8.1	488.4	32.4	32.7	113
10/31/2013	11:00	13.8	8.1	547.5	36.4	19.5	127

* Method Detection Limit - limits can vary for individual samples depending on matrix interference and dilution factors, all results are preliminary and subject to final revision.

** United States Geological Survey (USGS) Continuous-Record Gaging Station

*** Flow rates are preliminary and subject to final revision by USGS.

Recommended EPA Recreational Water Quality Criteria - Statistical Threshold Value (STV) and Geomteric Mean (GM)

(Beach posting is recommended when indicator organisms exceed the STV) - Indicated by red text

E. coli (STV): 235 per 100 ml | Enterococcus (STV): 61 per 100 ml

E. coli (GM): 126 per 100mL | Enterococcus (GM): 33 per 100 mL

Table 3-9. 2013 Duncans Mills bacteria concentrations for samples collected by the Sonoma County Water Agency. This site may experience estuarine conditions.

Duncans Mills	Time	Temperature	pH	Total Coliforms (Colilert)	E. coli (Colilert)	Enterococcus (Enterolert)	USGS 11467000 RR near Guerneville (Hacienda)***
MDL*				20	20	2	Flow Rate****
Date		°C		MPN/100mL	MPN/100mL	MPN/100mL	(cfs)
5/14/2013	10:30	20.8	8.0	1732.9	10.7	1.0	177
5/21/2013	10:40	21.6	8.0	1732.9	12	3.1	131
5/28/2013	10:25	19.5	8.0	1299.7	21.6	60.2	143
5/30/2013	10:30	21.2	8.2	1203.3	46.4	37.9	138
6/4/2013	10:10	20.5	7.8	1732.9	34.5	12.1	97
6/11/2013	10:20	20.4	7.9	2419.6	29.9	30.5	112
6/13/2013	10:20	21.3	8.0	1986.3	199.6	28.5	94
6/18/2013	9:50	20.9	8.3	>2419.6	11	18.7	83
6/25/2013	10:10	19.7	8.0	>2419.6	47.3	12.1	142
7/2/2013	11:20	24.1	8.0	>2419.6	78.5	**178.9**	111
7/9/2013	10:10	22.2	8.0	>2419.6	20.3	3.0	117
7/11/2013	11:10	22.4	8.1	>2419.6	9.7	8.4	101
7/16/2013	10:20	20.3	8.0	>2419.6	10.9	14.2	77
7/23/2013	10:10	21.9	8.3	>2419.6	21.3	48.2	83
7/30/2013	10:00	19.5	8.1	2419.6	5.2	41.7	101
8/6/2013	10:10	20.3	8.2	2419.6	3.1	39.3	105
8/13/2013	9:50	19.9	8.1	1413.6	2.0	25.0	98
8/20/2013	9:50	17.6	8.0	1986.3	18.7	**62.7**	107
8/27/2013							100
9/3/2013	10:50	18.9	8.1	179.3	2.0	25.6	150
9/10/2013	9:50	20.0	8.0	1986.3	13.2	48	93
9/17/2013	10:20	18.9	8.1	648.8	5.2	19.5	110
9/24/2013	10:10	18.3	8.0	579.4	3.1	21.1	127
9/26/2013	11:10	17.9	7.9	>2419.6	29.2	**68.9**	122
10/1/2013	11:00	19.0	7.8	1413.6	36.4	**69.7**	140
10/3/2013	11:20	17.1	7.8	1046.2	42.6	60.2	121
10/8/2013	10:40	15.5	8.0	>2419.6	26.2	**104.3**	93
10/15/2013	11:00	16.0	8.2	1732.9	5.2	46.4	99
10/17/2013	11:00	15.1	7.7	>2419.6	6.3	6.3	100
10/22/2013	9:40	14.5	8.2	>2419.6	27.5	7.4	101
10/24/2013	10:50	14.7	8.3	727.0	13.2	**106.3**	99
10/29/2013	10:00	13.9	8.2	980.4	42.0	21.1	113
10/31/2013	10:30	13.8	8.2	816.4	3.1	6.2	127

* Method Detection Limit - limits can vary for individual samples depending on matrix interference and dilution factors, all results are preliminary and subject to final revision.
** United States Geological Survey (USGS) Continuous-Record Gaging Station
*** Flow rates are preliminary and subject to final revision by USGS.

Recommended EPA Recreational Water Quality Criteria - Statistical Threshold Value (STV) and Geomteric Mean (GM)
(Beach posting is recommended when indicator organisms exceed the STV) - Indicated by red text

E. coli (STV): 235 per 100 ml	Enterococcus (STV): 61 per 100 ml
E. coli (GM): 126 per 100mL	Enterococcus (GM): 33 per 100 mL

Table 3-10. 2013 Bridgehaven bacteria concentrations for samples collected by the Sonoma County Water Agency. Estuarine conditions exist at this site.

Bridgehaven	Time	Temperature	pH	Total Coliforms (Colilert)	E. coli (Colilert)	Enterococcus (Enterolert)	USGS 11467000 RR near Guerneville (Hacienda)***
MDL*				20	20	2	Flow Rate****
Date		°C		MPN/100mL	MPN/100mL	MPN/100mL	(cfs)
5/14/2013	10:10	20.0	8.1	1986.3	9.7	6.0	177
5/21/2013	10:20	19.2	8.4	1732.9	12.0	19.7	131
5/28/2013	10:05	17.6	8.2	2419.6	71.4	20.1	143
5/30/2013	10:00	18.6	8.4	1986.3	**248.1**	**73.3**	138
6/4/2013	9:50	18.5	7.8	>2419.6	32.7	**365.4**	97
6/11/2013	10:00	18.8	8.4	>2419.6	26.2	9.6	112
6/13/2013	9:50	19.3	8.5	2419.6	63.1	6.2	94
6/18/2013	9:30	18.5	8.4	>2419.6	34.5	**95.9**	83
6/25/2013	9:50	17.2	7.9	>2419.6	**1046.2**	**387.3**	142
7/2/2013	10:40	22.3	8.2	>2419.6	63.8	3.1	111
7/9/2013	9:50	17.6	7.9	>2419.6	121.1	45.0	117
7/11/2013	10:30	19.0	7.9	>2419.6	23.5	48.9	101
7/16/2013	9:50	17.3	8.0	>2419.6	3.0	**62.4**	77
7/23/2013	9:50	17.8	7.9	>2419.6	24.3	32.3	83
7/30/2013	9:40	16.0	7.6	>2419.6	3.0	**82.3**	101
8/6/2013	9:40	17.4	8.1	>2419.6	4.1	6.3	105
8/13/2013	9:30	17.1	7.8	>2419.6	5.2	6.2	98
8/20/2013	9:30	19.1	8.0	>2419.6	13.4	42.2	107
8/27/2013	10:30	17.1	7.9	>2419.6	9.8	7.4	100
9/3/2013	10:30	17.1	8.0	>2419.6	6.3	11.4	150
9/10/2013	9:40	16.7	7.7	>2419.6	32	**185**	93
9/17/2013	10:00	17.1	8.0	>2419.6	5.2	39.3	110
9/24/2013	9:50	16.5	8.2	>2419.6	25.3	21.3	127
9/26/2013	10:30	14.3	8.3	>2419.6	193.5	**85.7**	122
10/1/2013	10:00	17.0	8.0	>2419.6	39.9	**118.7**	140
10/3/2013	11:00	14.7	7.9	>2419.6	50.4	**77.6**	121
10/8/2013	10:10	13.4	7.9	>2419.6	18.5	**71.2**	93
10/15/2013	10:30	14.5	8.1	1203.3	9.7	22.6	99
10/17/2013	10:30	15.0	7.7	>2419.6	5.2	32.6	100
10/22/2013	9:20	12.6	8.0	>2419.6	28.5	26.2	101
10/24/2013	10:20	13.2	8.3	325.5	48.8	28.7	99
10/29/2013	9:40	12.4	8.1	>2419.6	30.1	45.0	113
10/31/2013	10:10	11.5	8.1	1299.7	7.5	42.8	127

* Method Detection Limit - limits can vary for individual samples depending on matrix interference and dilution factors, all results are preliminary and subject to final revision.
** United States Geological Survey (USGS) Continuous-Record Gaging Station
*** Flow rates are preliminary and subject to final revision by USGS.

Recommended EPA Recreational Water Quality Criteria - Statistical Threshold Value (STV) and Geomteric Mean (GM)
(Beach posting is recommended when indicator organisms exceed the STV) - Indicated by red text

E. coli (STV): 235 per 100 ml | Enterococcus (STV): 61 per 100 ml
E. coli (GM): 126 per 100mL | Enterococcus (GM): 33 per 100 mL

Table 3-11. 2013 Jenner bacteria concentrations for samples collected by the Sonoma County Water Agency. Estuarine conditions exist at this site.

Jenner Boat Ramp	Time	Temperature	pH	Total Coliforms (Colilert)	E. coli (Colilert)	Enterococcus (Enterolert)	USGS 11467000 RR near Guerneville (Hacienda)**
MDL*				20	20	2	Flow Rate***
Unit of Measure		°C		MPN/100mL	MPN/100mL	MPN/100mL	(cfs)
5/14/2013	9:40	18.2	7.8	>2419.6	19.5	12.5	177
5/21/2013	10:00	17.2	8.2	>2419.6	112.6	**66.9**	131
5/28/2013	9:15	16.1	8.2	>2419.6	**1986.3**	**145.0**	143
5/30/2013	9:40	17.0	8.3	>2419.6	**>2419.6**	**214.3**	138
6/4/2013	9:30	19.2	7.9	>2419.6	70.3	18.9	97
6/11/2013	9:40	17.5	8.5	>2419.6	16.4	14.4	112
6/13/2013	9:30	17.7	8.4	>2419.6	73.3	**104.3**	94
6/18/2013	9:10	17.8	8.5	>2419.6	3.0	31.8	83
6/25/2013	9:40	17.8	8.4	>2419.6	95.7	**1413.6**	142
7/2/2013	10:20	22.2	8.2	>2419.6	63.8	**73.3**	111
7/9/2013	9:30	17.7	8.0	>2419.6	6.3	**579.6**	117
7/11/2013	9:50	18.2	8.5	2419.6	2.0	**136.7**	101
7/16/2013	9:30	16.5	8.0	>2419.6	6.1	**110.6**	77
7/23/2013	9:40	17.6	8.1	>2419.6	<1.0	53.7	83
7/30/2013	9:20	15.4	7.9	>2419.6	29.6	42.8	101
8/6/2013	9:10	15.8	7.9	>2419.6	7.3	21.1	105
8/13/2013	9:10	16.0	8.0	>2419.6	3.1	<1.0	98
8/20/2013	9:20	16.8	7.7	>2419.6	3.1	55.4	107
8/27/2013	10:00	16.6	8.0	>2419.6	4.1	2.0	100
9/3/2013	10:10	15.7	7.9	>2419.6	1.0	25.9	150
9/10/2013	9:20	15.8	7.8	>2419.6	43.7	**108.1**	93
9/17/2013	9:50	15.7	7.9	>2419.6	5.1	58.8	110
9/24/2013	9:20	14.5	8.1	>2419.6	4.1	13.4	127
9/26/2013	10:00	13.7	8.1	>2419.6	34.6	52.1	122
10/1/2013	9:40	16.4	8.2	372.4	36.8	**325.5**	140
10/3/2013	10:30	14.1	8.1	>2419.6	157.6	**344.8**	121
10/8/2013	9:50	13.9	8.0	>2419.6	21.8	**365.4**	93
10/15/2013	10:10	14.8	8.2	>2419.6	9.8	34.5	99
10/17/2013	10:00	15.1	7.7	>2419.6	1.0	50.4	100
10/22/2013	9:00	12.7	8.0	>2419.6	15.8	34.5	101
10/24/2013	10:00	12.4	8.3	71.7	19.7	9.5	99
10/29/2013	9:30	11.9	8.0	1732.9	25.6	42.8	113
10/31/2013	9:40	11.4	8.1	>2419.6	12.2	**62.0**	127

* Method Detection Limit - limits can vary for individual samples depending on matrix interference and dilution factors, all results are preliminary and subject to final revision.

** United States Geological Survey (USGS) Continuous-Record Gaging Station

*** Flow rates are preliminary and subject to final revision by USGS.

Recommended EPA Recreational Water Quality Criteria - Statistical Threshold Value (STV) and Geomteric Mean (GM)

(Beach posting is recommended when indicator organisms exceed the STV) - Indicated by red text

E. coli (STV): 235 per 100 ml | Enterococcus (STV): 61 per 100 ml

E. coli (GM): 126 per 100mL | Enterococcus (GM): 33 per 100 mL

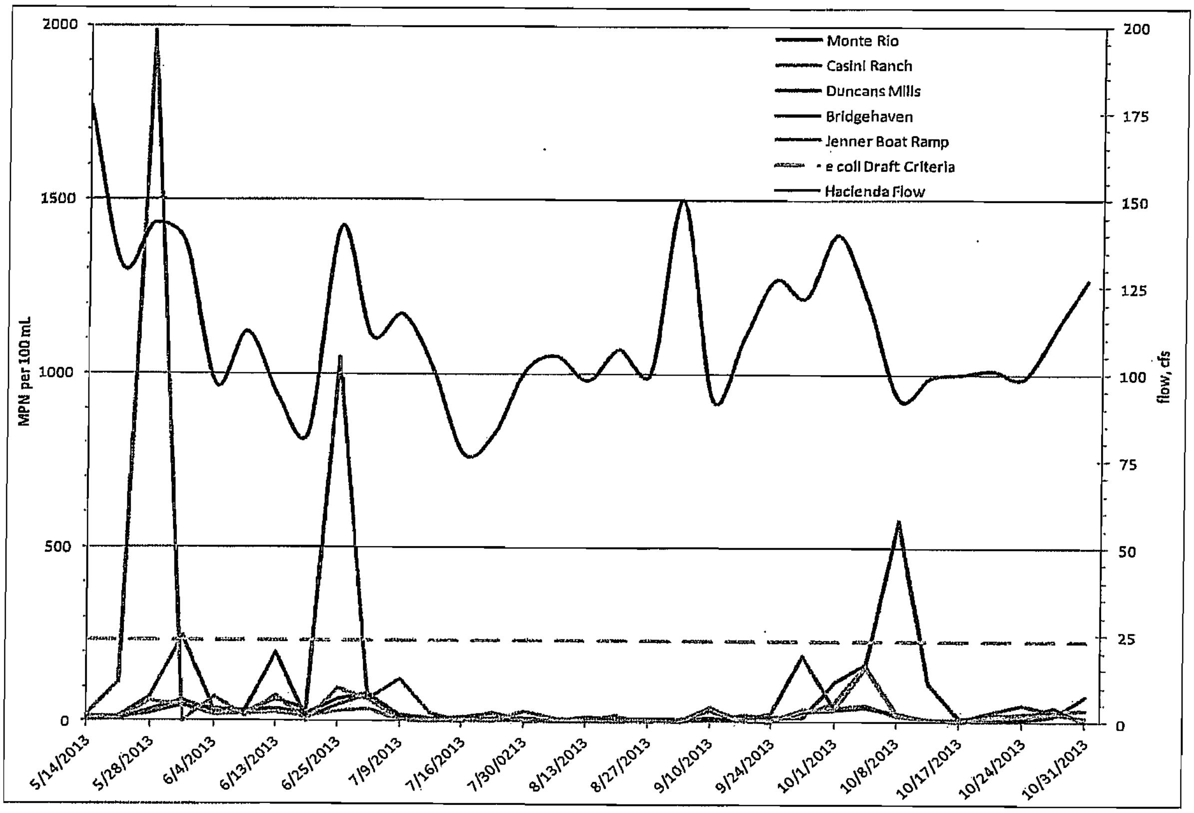


Figure 3-9. E. coli results on for the Russian River from Monte Rio to Jenner in 2013.

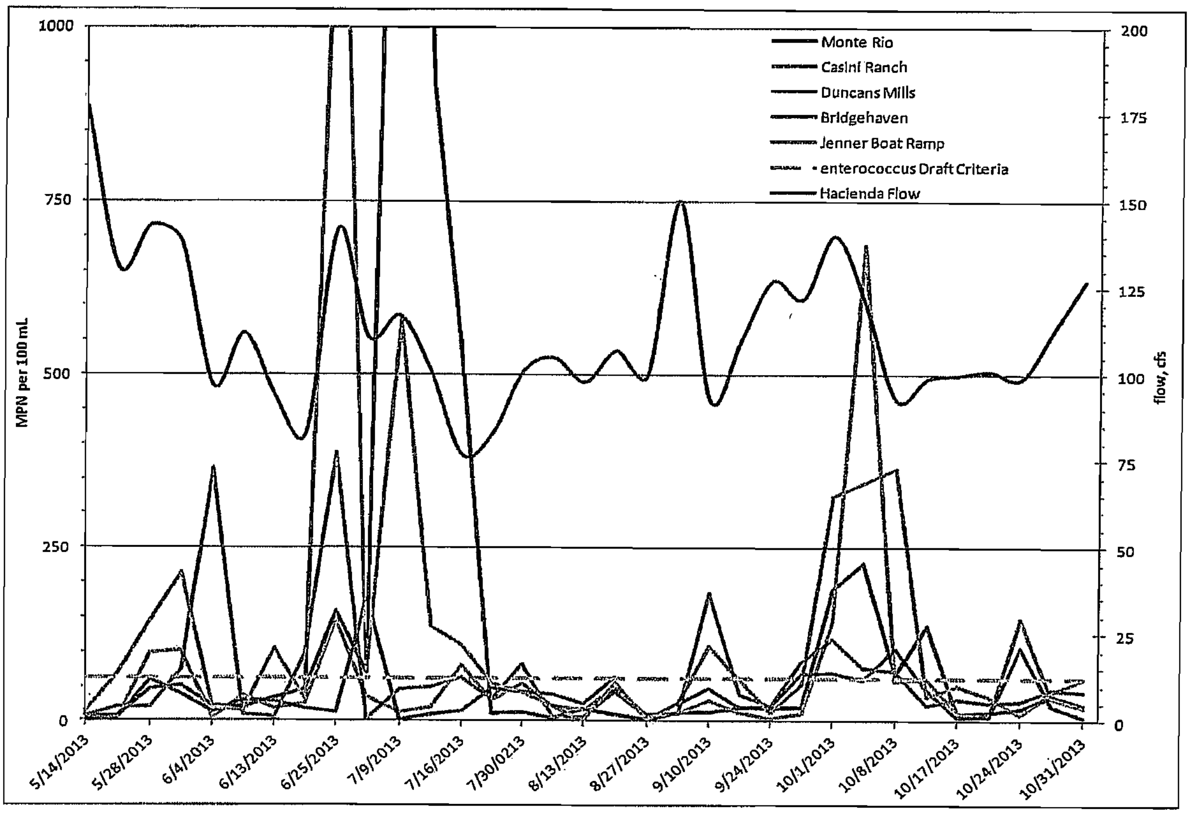


Figure 3-10. Enterococcus results for the Russian River from Monte Rio to Jenner in 2013.

Table 3-12. 2013 Monte Rio nutrient grab sample results. This site experiences freshwater conditions.

Monte Rio	Time	Temperature	pH	Total Organic Nitrogen	Ammonia as N	Ammonia as N Unionized	Nitrate as N	Nitrite as N	Total Kjeldahl Nitrogen	Total Nitrogen**	Phosphorus, Total	Total Orthophosphate	Dissolved Organic Carbon	Total Organic Carbon	Total Dissolved Solids	Turbidity	Chlorophyll-a
MDL*				0.200	0.10	0.00010	0.030	0.030	0.10		0.020	0.020	0.0400	0.0400	4.2	0.020	0.000050
Date		°C		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	NTU	mg/L
5/14/2013	11:40	21.5	7.7	ND	0.10	0.0023	0.12	ND	0.21	0.33	0.047	0.097	1.61	2.19	170	3.0	0.0028
5/21/2013	11:30	21.5	7.8	ND	0.18	0.0049	0.12	ND	0.21	0.34	0.051	0.043	1.58	2.02	160	3.6	0.0035
5/28/2013	11:10	19.4	7.8	ND	ND	ND	0.12	ND	0.24	0.37	0.05	0.10	1.44	1.82	42	2.7	0.0038
5/30/2013	11:50	21.4	8.0	ND	0.14	0.0055	ND	ND	0.21	0.21	0.043	0.088	1.53	1.78	160	2.8	0.0048
6/4/2013	11:00	21.7	7.8	0.21	0.14	0.0038	ND	ND	0.35	0.35	0.057	0.12	1.38	1.77	170	4.0	0.0052
6/11/2013	11:15	21.0	7.8	ND	0.10	0.0026	ND	ND	ND	0.18	0.056	0.14	1.60	2.07	160	2.3	0.0025
6/13/2013	11:40	21.8	7.7	ND	0.14	0.003	ND	ND	ND	0.18	0.056	0.12	1.83	2.12	180	2.7	0.0019
6/18/2013	10:40	22.1	7.9	ND	0.14	ND	ND	ND	0.24	0.24	0.054	0.13	1.66	5.18	170	2.4	0.0048
6/25/2013	10:50	21.0	7.8	ND	0.14	ND	ND	ND	ND	0.14	0.052	0.12	1.40	1.91	150	2.3	0.0064
7/2/2013	12:20	25.9	7.9	ND	0.14	ND	0.14	ND	0.32	0.45	0.066	0.16	1.74	3.51	140	1.9	0.0032
7/9/2013	11:00	23.3	7.7	ND	0.14	ND	ND	ND	0.24	0.24	0.088	0.24	2.40	2.76	150	2.6	0.0025
7/11/2013	12:20	23.7	7.9	ND	0.24	0.0095	0.1	ND	ND	0.28	0.073	0.19	1.92	2.37	150	1.8	0.0019
7/16/2013	11:10	21.7	8.0	ND	0.21	0.0089	ND	ND	ND	0.18	0.05	0.26	1.77	2.12	150	1.6	0.0017
7/23/2013	10:50	22.6	7.9	ND	0.10	ND	ND	ND	0.28	0.28	0.038	0.10	1.29	1.78	140	1.3	0.0014
7/30/0213	10:50	20.5	7.9	ND	ND	ND	ND	ND	ND	0.18	0.025	0.098	1.34	1.87	150	1.4	0.0018
8/6/2013	11:20	21.1	7.9	ND	0.14	ND	ND	ND	ND	0.14	0.028	0.071	1.39	1.68	140	1.2	0.00091
8/13/2013	10:40	21.5	8.0	ND	0.10	ND	ND	ND	ND	0.18	0.033	0.069	1.48	1.73	140	2.1	0.00053
8/20/2013	10:30	21.8	7.6	ND	0.10	ND	ND	ND	ND	0.18	0.027	0.073	1.55	2.15	130	1.6	0.0012
8/27/2013	12:00	21.8	7.9	ND	0.14	ND	ND	ND	0.21	0.21	0.027	0.060	1.52	1.86	140	0.46	0.00064
9/3/2013	11:40	19.7	7.7	ND	0.14	ND	ND	ND	ND	0.18	0.051	0.057	1.47	1.35	140	1.8	0.0011
9/10/2013	10:30	21.1	8.2	ND	0.18	ND	ND	ND	ND	0.14	0.026	0.054	1.68	2.07	140	1.8	0.0011
9/17/2013	11:10	19.7	7.7	ND	ND	ND	0.10	ND	0.24	0.35	0.024	0.054	1.41	2.25	130	1.3	0.00028
9/24/2013	11:00	18.2	7.5	ND	ND	ND	ND	ND	0.21	0.21	0.024	0.060	1.35	1.83	130	1.8	0.00080
9/26/2013	12:20	17.1	7.3	ND	ND	ND	ND	ND	ND	0.14	0.044	0.096	1.68	2.03	150	1.8	0.00040
10/1/2013	12:20	18.5	7.7	ND	ND	ND	ND	ND	ND	0.18	0.026	0.047	1.50	1.90	140	1.6	0.00028
10/3/2013	12:20	16.4	7.4	ND	ND	ND	0.1	ND	ND	0.28	0.027	0.054	1.13	1.61	120	1.5	0.00028
10/8/2013	11:50	14.8	7.5	ND	0.18	0.0014	0.11	ND	0.24	0.35	0.022	0.060	1.47	1.83	150	1.2	0.0008
10/15/2013	11:50	15.6	7.9	0.24	0.14	ND	0.2	ND	0.38	0.59	0.041	0.099	1.42	1.78	130	0.79	0.0011
10/17/2013	12:20	14.9	7.4	0.38	0.14	ND	0.16	ND	0.52	0.69	0.031	0.078	1.37	1.72	130	0.79	0.00068
10/22/2013	10:10	14.5	7.8	ND	0.10	0.0061	0.16	ND	0.28	0.44	0.034	0.080	1.37	1.65	140	0.89	0.00013
10/24/2013	12:00	14.9	8.0	ND	0.28	0.0071	0.12	ND	ND	0.30	0.027	0.040	1.41	1.55	140	0.91	0.0004
10/29/2013	10:40	13.7	8.0	0.21	ND	ND	0.16	ND	0.21	0.21	0.036	0.079	1.33	1.86	140	1.0	0.00046
10/31/2013	11:30	12.8	7.8	ND	0.10	0.0014	0.15	ND	ND	0.25	0.03	0.11	1.50	1.64	150	0.74	0.00061

* Method Detection Limit - limits can vary for individual samples depending on matrix interference and dilution factors, all results are preliminary and subject to final revi
** Total nitrogen is calculated through the summation of the different components of total nitrogen: organic and ammoniacal nitrogen (together referred to as Total Kjeldahl Nitrogen or TKN) and nitrate/nitrite nitrogen.
*** United States Geological Survey (USGS) Continuous-Record Gaging Station
**** Flow rates are preliminary and subject to final revision by USGS.

Recommended EPA Criteria based on Aggregate Ecoregion III

Total Phosporus: 0.02188 mg/L (21.88 ug/L) = 0.022 mg/L

Total Nitrogen: 0.38 mg/L

Chlorophyll *a*: 0.00178 mg/L (1.78 ug/L) = 0.0018 mg/L

Turbidity: 2.34 FTU/NTU

Table 3-13. 2013 Casini Ranch nutrient grab sample results. This site may experience estuarine conditions.

Casini Ranch	Time	Temperature	pH	Total Organic Nitrogen	Ammonia as N	Ammonia as N Unionized	Nitrate as N	Nitrite as N	Total Kjeldahl Nitrogen	Total Nitrogen**	Phosphorus, Total	Total Orthophosphate	Dissolved Organic Carbon	Total Organic Carbon	Total Dissolved Solids	Turbidity	Chlorophyll-a
MDL*				0.200	0.10	0.00010	0.030	0.030	0.10		0.020	0.020	0.0400	0.0400	4.2	0.020	0.000050
Date		°C		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	NTU	mg/L
5/14/2013	11:00	21.3	7.6	ND	0.14	0.0022	0.15	ND	0.32	0.46	0.057	0.13	1.74	2.24	170	2.8	0.0028
5/21/2013	11:00	21.4	7.9	ND	0.14	0.0044	0.13	ND	ND	0.3	0.048	0.042	1.62	2.16	180	2.3	0.0042
5/28/2013	10:45	20	7.9	ND	0.14	0.0043	ND	ND	0.28	0.28	0.044	0.098	1.72	1.91	160	2.5	0.0055
5/30/2013	11:10	21.5	8.0	ND	0.14	0.0059	ND	ND	0.21	0.21	0.045	0.076	1.48	1.79	160	2.6	0.0053
6/4/2013	10:30	20.7	7.9	ND	0.10	0.0033	0.12	ND	0.24	0.37	0.053	0.12	1.51	1.87	170	2.0	0.0049
6/11/2013	10:50	20.8	7.8	ND	0.14	0.0035	ND	ND	ND	0.14	0.049	0.14	1.52	2.02	160	0.95	0.0047
6/13/2013	11:00	21.8	7.8	ND	0.14	0.0038	ND	ND	0.21	0.21	0.061	0.13	1.66	2.18	160	1.9	0.0043
6/18/2013	10:10	21.6	8.1	ND	0.18	ND	ND	ND	ND	0.18	0.058	0.13	1.86	2.06	140	1.4	0.0027
6/25/2013	10:30	20.2	8.0	ND	ND	ND	ND	ND	0.21	0.21	0.054	0.12	1.48	2.07	140	1.7	0.0058
7/2/2013	11:50	24.8	7.9	0.21	0.14	ND	ND	ND	0.35	0.35	0.059	0.16	1.80	2.52	150	2.4	0.0030
7/9/2013	10:30	22.1	7.9	ND	0.10	ND	0.11	ND	0.28	0.39	0.080	0.22	2.22	2.78	150	2.3	0.0033
7/11/2013	11:50	22.6	8.0	ND	0.18	ND	ND	ND	ND	0.18	0.082	0.21	2.16	2.73	150	1.5	0.0028
7/16/2013	10:50	20.3	7.9	ND	0.24	0.0072	ND	ND	ND	0.18	0.058	0.084	1.84	2.25	140	1.2	0.0025
7/23/2013	10:20	22.5	8.2	ND	ND	ND	0.13	ND	0.21	0.34	0.050	0.11	1.78	1.90	150	1.5	0.0014
7/30/2013	10:20	19.6	8.0	ND	ND	ND	ND	ND	ND	0.18	0.039	0.12	1.44	1.99	140	0.85	0.0014
8/6/2013	10:40	20.1	8.0	ND	0.14	ND	0.12	ND	ND	0.22	0.033	0.083	1.44	1.73	140	1.2	0.00065
8/13/2013	10:10	20.5	7.8	ND	0.10	ND	0.12	ND	ND	0.29	0.035	0.065	1.29	1.88	140	1.2	0.00067
8/20/2013	10:10	20.8	7.8	ND	0.10	ND	ND	ND	0.28	0.28	0.033	0.077	1.61	2.22	140	1.4	0.0014
8/27/2013	11:20	21.5	8.0	ND	0.14	ND	0.11	ND	0.21	0.32	0.030	0.060	1.50	2.10	140	0.22	0.00089
9/3/2013	11:10	20.0	8.4	ND	ND	ND	ND	ND	0.21	0.21	0.050	0.057	1.52	1.99	150	1.3	0.0012
9/10/2013	10:10	19.7	8.1	ND	ND	ND	ND	ND	0.24	0.24	0.048	0.058	1.63	3.07	140	2.4	0.00093
9/17/2013	10:40	20.0	8.4	ND	ND	ND	0.17	ND	ND	0.34	0.028	0.054	1.54	1.99	120	1.2	0.00042
9/24/2013	10:30	17.8	8.1	ND	0.10	ND	ND	ND	0.24	0.24	0.026	0.057	1.66	2.00	120	1.2	0.00066
9/26/2013	11:30	18.5	8.0	ND	ND	ND	0.12	ND	ND	0.22	0.029	0.053	1.48	1.79	130	1.4	0.00013
10/1/2013	11:50	19.6	7.9	ND	ND	ND	ND	ND	ND	0.18	0.032	0.059	1.71	2.13	130	1.2	0.00056
10/3/2013	11:50	18.5	7.9	ND	ND	ND	ND	ND	ND	0.18	0.025	0.050	0.866	1.82	140	2.2	0.00056
10/8/2013	11:10	16.0	8.0	ND	0.18	0.0048	ND	ND	0.28	0.28	0.020	0.064	1.54	1.97	160	0.87	0.0011
10/15/2013	11:20	16.4	8.2	ND	0.10	ND	0.15	ND	0.28	0.43	0.041	0.11	1.73	1.92	130	0.9	0.0032
10/17/2013	11:30	15.5	7.4	0.21	0.14	ND	0.13	ND	0.35	0.48	0.034	0.081	1.39	1.73	140	1.1	0.00027
10/22/2013	9:50	14.5	8.2	ND	0.10	0.016	0.12	ND	0.28	0.40	0.030	0.065	1.30	1.74	150	1.1	0.00013
10/24/2013	11:30	14.8	8.3	ND	0.14	ND	ND	ND	ND	0.18	0.023	0.078	1.46	1.65	150	0.71	0.0004
10/29/2013	10:20	14.1	8.1	0.21	ND	ND	ND	ND	0.21	0.21	0.025	0.059	1.47	1.72	130	0.78	0.00061
10/31/2013	11:00	13.8	8.1	0.32	ND	ND	ND	ND	0.32	0.32	0.030	0.059	1.57	1.79	120	0.67	0.0021

* Method Detection Limit - limits can vary for individual samples depending on matrix interference and dilution factors, all results are preliminary and subject to final rev

** Total nitrogen is calculated through the summation of the different components of total nitrogen: organic and ammoniacal nitrogen (together referred to as Total Kjeldahl Nitrogen or TKN) and nitrate/nitrite nitrogen.

*** United States Geological Survey (USGS) Continuous-Record Gaging Station

**** Flow rates are preliminary and subject to final revision by USGS.

Recommended EPA Criteria based on Aggregate Ecoregion III

Total Phosporus: 0.02188 mg/L (21.88 ug/L) ≈ 0.022 mg/L

Total Nitrogen: 0.38 mg/L

Chlorophyll *a*: 0.00178 mg/L (1.78 ug/L) ≈ 0.0018 mg/L

Turbidity: 2.34 FTU/NTU

Table 3-14. 2013 Duncans Mills nutrient grab sample results. This site may experience estuarine conditions.

Duncans Mills	Time	Temperature	pH	Total Organic Nitrogen	Ammonia as N	Ammonia as N Unionized	Nitrate as N	Nitrite as N	Total Kjeldahl Nitrogen	Total Nitrogen**	Phosphorus, Total	Total Orthophosphate	Dissolved Organic Carbon	Total Organic Carbon	Total Dissolved Solids	Turbidity	Chlorophyll-a
MDL*				0.200	0.10	0.00010	0.030	0.030	0.10		0.020	0.020	0.0400	0.0400	4.2	0.020	0.000050
Date		°C		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	NTU	mg/L
5/14/2013	10:30	20.8	8.0	0.21	0.1	0.0041	0.14	ND	0.32	0.46	0.057	0.12	1.63	2.15	180	1.7	0.0022
5/21/2013	10:40	21.6	8.0	ND	0.10	0.0044	0.12	ND	0.24	0.37	0.044	0.036	1.70	1.94	180	1.7	0.0033
5/28/2013	10:25	19.5	8.0	ND	0.1	0.0039	0.13	ND	0.21	0.34	0.044	0.090	1.58	1.96	120	1.4	0.0063
5/30/2013	10:30	21.2	8.2	ND	0.25	0.014	ND	ND	0.28	0.18	0.043	0.076	1.51	1.83	150	1.8	0.0068
6/4/2013	10:10	20.5	7.8	0.32	ND	ND	0.13	ND	0.38	0.51	0.059	0.12	1.48	1.79	180	1.8	0.0052
6/11/2013	10:20	20.4	7.9	ND	0.18	0.0054	ND	ND	0.24	0.24	0.048	0.12	1.51	1.97	160	1.6	0.0080
6/13/2013	10:20	21.3	8.0	ND	0.14	0.0055	ND	ND	ND	0.18	0.053	0.11	1.59	2.18	180	1.5	0.0048
6/18/2013	9:50	20.9	8.3	ND	0.1	ND	ND	ND	ND	0.18	0.054	0.12	1.73	2.02	170	1.2	0.0043
6/25/2013	10:10	19.7	8.0	ND	0.14	ND	ND	ND	0.21	0.21	0.066	0.13	1.57	1.93	160	1.5	0.0067
7/2/2013	11:20	24.1	8.0	ND	0.18	ND	0.12	ND	0.28	0.40	0.040	0.090	1.03	2.00	130	2.2	0.0035
7/9/2013	10:10	22.2	8.0	0.24	ND	ND	0.11	ND	0.28	0.39	0.077	0.20	2.19	2.60	160	1.4	0.0028
7/11/2013	11:10	22.4	8.1	ND	0.14	ND	ND	ND	0.21	0.21	0.075	0.21	2.11	2.66	150	1.3	0.0025
7/16/2013	10:20	20.3	8.0	ND	0.14	ND	ND	ND	ND	0.18	0.057	0.14	1.65	2.18	150	1.2	0.0036
7/23/2013	10:10	21.9	8.3	ND	ND	ND	ND	ND	0.21	0.21	0.043	0.12	1.58	1.86	150	1.4	0.0020
7/30/0213	10:00	19.5	8.1	0.21	ND	ND	ND	ND	0.21	0.21	0.036	0.098	1.39	2.03	160	1.1	0.0012
8/6/2013	10:10	20.3	8.2	ND	0.14	ND	0.12	ND	0.21	0.33	0.033	0.071	1.46	1.76	140	1.5	0.0012
8/13/2013	9:50	19.9	8.1	ND	0.18	ND	ND	ND	0.21	0.21	0.033	0.057	1.29	1.98	150	1.4	0.0012
8/20/2013	9:50	17.6	8.0	ND	ND	ND	0.11	ND	0.24	0.36	0.037	0.073	1.65	2.21	140	1.6	0.0016
8/27/2013																	
9/3/2013	10:50	18.9	8.1	ND	0.10	ND	0.10	ND	ND	0.28	0.041	0.065	1.50	1.96	150	1.3	0.0016
9/10/2013	9:50	20.0	8.0	ND	0.14	ND	ND	ND	0.21	0.21	0.034	0.058	1.72	2.26	140	1.4	0.0016
9/17/2013	10:20	18.9	8.1	ND	ND	ND	0.10	ND	ND	0.28	0.030	0.054	1.46	2.06	140	0.92	0.00057
9/24/2013	10:10	18.3	8.0	0.28	ND	ND	0.10	ND	0.28	0.38	0.036	0.060	1.45	1.99	87	1.3	0
9/26/2013	11:10	17.9	7.9	ND	0.14	ND	0.13	ND	ND	0.30	0.029	0.049	1.51	1.90	140	1.1	0.00053
10/1/2013	11:00	19.0	7.8	0.21	ND	ND	ND	ND	0.21	0.21	0.030	0.070	1.81	2.33	150	0.83	0.00084
10/3/2013	11:20	17.1	7.8	ND	ND	ND	ND	ND	ND	0.18	0.027	0.054	1.19	1.80	150	1.0	0.00084
10/8/2013	10:40	15.5	8.0	ND	0.1	0.0028	0.12	ND	ND	0.26	0.024	0.064	1.61	1.99	210	1.2	0.0011
10/15/2013	11:00	16.0	8.2	0.21	0.14	ND	ND	ND	0.35	0.35	0.039	0.064	1.59	1.98	160	1.2	0.0085
10/17/2013	11:00	15.1	7.7	ND	0.18	ND	0.14	ND	0.32	0.45	0.038	0.081	1.44	1.77	280	1.0	0.00082
10/22/2013	9:40	14.5	8.2	ND	ND	0.013	0.11	ND	0.24	0.36	0.025	0.057	1.50	1.72	160	1.3	0.00067
10/24/2013	10:50	14.7	8.3	ND	0.18	ND	ND	ND	ND	0.14	0.023	0.067	1.42	1.66	140	0.78	0.00081
10/29/2013	10:00	13.9	8.2	0.24	ND	ND	ND	ND	0.24	0.24	0.024	0.052	1.49	1.76	140	0.76	0.00092
10/31/2013	10:30	13.8	8.2	ND	ND	ND	ND	ND	ND	0.10	0.025	0.051	1.57	1.74	160	0.69	0.0028

* Method Detection Limit - limits can vary for individual samples depending on matrix interference and dilution factors, all results are preliminary and subject to final rev

** Total nitrogen is calculated through the summation of the different components of total nitrogen: organic and ammoniacal nitrogen (together referred to as Total Kjeldahl Nitrogen or TKN) and nitrate/nitrite nitrogen.

*** United States Geological Survey (USGS) Continuous-Record Gaging Station

**** Flow rates are preliminary and subject to final revision by USGS.

Recommended EPA Criteria based on Aggregate Ecoregion III

Total Phosporus: 0.02188 mg/L (21.88 ug/L) ≈ 0.022 mg/L

Total Nitrogen: 0.38 mg/L

Chlorophyll *a*: 0.00178 mg/L (1.78 ug/L) ≈ 0.0018 mg/L

Turbidity: 2.34 FTU/NTU

Table 3-15. 2013 Bridgehaven nutrient grab sample results. Estuarine conditions exist at this site.

Bridgehaven	Time	Temperature	pH	Total Organic Nitrogen	Ammonia as N	Ammonia as N Unionized	Nitrate as N	Nitrite as N	Total Kjeldahl Nitrogen	Total Nitrogen**	Phosphorus, Total	Total Orthophosphate	Dissolved Organic Carbon	Total Organic Carbon	Total Dissolved Solids	Turbidity	Chlorophyll-a
MDL*				0.200	0.10	0.00010	0.030	0.030	0.10		0.020	0.020	0.0400	0.0400	4.2	0.020	0.000050
Date		°C		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	NTU	mg/L
5/14/2013	10:10	20.0	8.1	ND	0.1	0.0041	0.28	ND	0.28	**0.56**	**0.056**	0.14	1.91	1.93	2100	**2.9**	0.00023
5/21/2013	10:20	19.2	8.4	0.38	0.14	0.0100	ND	ND	0.52	**0.52**	0.11	0.057	2.29	2.43	1100	**12**	**0.011**
5/28/2013	10:05	17.6	8.2	0.280	0.14	0.006	ND	ND	0.42	**0.42**	**0.054**	0.11	1.99	2.15	380	2.0	**0.0035**
5/30/2013	10:00	18.6	8.4	ND	0.21	0.016	ND	ND	0.28	0.28	**0.042**	0.084	2.09	2.14	720	2.3	**0.0024**
6/4/2013	9:50	18.5	7.8	0.280	0.14	0.0027	0.13	ND	0.42	**0.55**	**0.058**	0.13	1.99	2.26	1500	**2.9**	0.0012
6/11/2013	10:00	18.8	8.4	ND	0.18	0.015	ND	ND	ND	0.18	**0.051**	0.12	1.80	1.93	590	2.0	**0.0047**
6/13/2013	9:50	19.3	8.5	ND	0.14	0.012	ND	ND	0.28	0.28	**0.049**	0.087	1.92	2.03	1500	1.6	**0.0037**
6/18/2013	9:30	18.5	8.4	ND	0.14	ND	ND	ND	0.24	0.24	**0.042**	0.084	2.06	2.05	3000	1.4	0.0014
6/25/2013	9:50	17.2	7.9	ND	0.21	0.0041	ND	ND	0.21	0.21	**0.058**	0.10	2.23	2.33	3300	**2.4**	**0.0033**
7/2/2013	10:40	22.3	8.2	0.21	ND	ND	0.13	ND	0.28	**0.41**	**0.046**	0.091	1.97	2.58	730	1.9	**0.0032**
7/9/2013	9:50	17.6	7.9	0.24	0.1	ND	ND	ND	0.35	0.35	**0.043**	0.097	3.98	3.79	3300	1.5	0.00079
7/11/2013	10:30	19	7.9	ND	0.21	0.0047	ND	ND	0.24	0.24	**0.045**	0.10	3.26	3.32	3900	1.3	0.00076
7/16/2013	9:50	17.3	8	ND	0.1	ND	ND	ND	0.24	0.24	**0.066**	0.14	1.52	1.55	4800	1.6	**0.0032**
7/23/2013	9:50	17.8	7.9	ND	0.18	ND	ND	ND	0.24	0.24	**0.044**	0.093	1.18	1.12	8400	1.7	**0.0030**
7/30/2013	9:40	16	7.6	0.24	ND	ND	ND	ND	0.24	0.24	**0.038**	0.090	1.08	1.09	9700	1.4	**0.0024**
8/6/2013	9:40	17.4	8.1	ND	0.14	ND	ND	ND	0.21	0.21	**0.033**	0.079	1.33	1.13	4600	1.4	0.0016
8/13/2013	9:30	17.1	7.8	ND	0.10	ND	ND	ND	0.24	0.24	**0.038**	0.061	1.28	1.42	5300	1.5	0.00053
8/20/2013	9:30	19.1	8	0.24	0.14	ND	ND	ND	0.38	**0.38**	**0.041**	0.065	2.15	2.21	6000	1.6	**0.012**
8/27/2013	10:30	17.1	7.9	ND	ND	ND	0.60	ND	0.24	0.36	**0.035**	0.064	2.09	2.11	6400	0.77	**0.0029**
9/3/2013	10:30	17.1	8.0	0.32	0.1	ND	ND	ND	0.42	**0.42**	**0.040**	0.069	1.99	1.94	5700	1.3	**0.0088**
9/10/2013	9:40	16.7	7.7	ND	0.14	ND	ND	ND	0.24	0.24	**0.032**	0.046	1.63	1.57	11000	0.69	**0.0031**
9/17/2013	10:00	17.1	8.0	0.35	ND	ND	ND	ND	0.42	**0.42**	**0.045**	0.065	1.64	1.70	8400	1.7	**0.011**
9/24/2013	9:50	16.5	8.2	0.28	ND	ND	0.56	ND	0.35	**0.91**	**0.081**	0.060	2.40	2.37	2400	1.9	**0.0080**
9/26/2013	10:30	14.3	8.3	ND	0.18	ND	0.12	ND	0.28	**0.40**	**0.040**	0.057	2.33	2.34	1300	1.3	**0.0029**
10/1/2013	10:00	17	8.0	ND	ND	ND	ND	ND	0.21	0.21	**0.034**	0.074	2.37	2.56	510	0.92	**0.0035**
10/3/2013	11:00	14.7	7.9	ND	ND	ND	0.11	ND	ND	0.25	**0.037**	0.071	2.38	2.25	690	1.4	0.0011
10/8/2013	10:10	13.4	7.9	ND	0.18	0.0024	ND	ND	0.35	0.35	**0.025**	0.064	2.50	2.54	1800	1.1	**0.0019**
10/15/2013	10:30	14.5	8.1	0.21	0.14	ND	ND	ND	0.35	0.35	**0.034**	0.048	2.44	2.55	1400	1.3	**0.0019**
10/17/2013	10:30	15	7.7	0.63	0.18	ND	0.14	ND	0.46	**0.59**	**0.060**	0.14	2.25	2.34	1800	1.3	0.0014
10/22/2013	9:20	12.6	8.0	ND	ND	0.0059	0.14	ND	0.24	**0.38**	**0.044**	0.096	1.99	2.08	2000	1.3	0.00067
10/24/2013	10:20	13.2	8.3	0.21	0.14	ND	ND	ND	0.35	0.35	**0.038**	0.051	2.03	1.96	860	0.96	**0.0067**
10/29/2013	9:40	12.4	8.1	ND	0.1	0.0028	ND	ND	0.24	0.24	**0.037**	0.059	2.02	2.14	1900	1.3	**0.0061**
10/31/2013	10:10	11.5	8.1	ND	ND	ND	ND	ND	ND	0.18	**0.029**	0.051	2.17	2.04	1300	0.65	**0.0044**

* Method Detection Limit - limits can vary for individual samples depending on matrix interference and dilution factors, all results are preliminary and subject to final revi

** Total nitrogen is calculated through the summation of the different components of total nitrogen: organic and ammoniacal nitrogen (together referred to as Total Kjeldahl Nitrogen or TKN) and nitrate/nitrite nitrogen.

*** United States Geological Survey (USGS) Continuous-Record Gaging Station

**** Flow rates are preliminary and subject to final revision by USGS.

Recommended EPA Criteria based on Aggregate Ecoregion III

Total Phosporus: 0.02188 mg/L (21.88 ug/L) = 0.022 mg/L

Total Nitrogen: 0.38 mg/L

Chlorophyll *a*: 0.00178 mg/L (1.78 ug/L) ≈ 0.0018 mg/L

Turbidity: 2.34 FTU/NTU

Table 3-16. 2013 Jenner Boat Ramp nutrient grab sample results. Estuarine conditions exist at this site.

Jenner Boat Ramp	Time	Temperature	pH	Total Organic Nitrogen	Ammonia as N	Ammonia as N Unionized	Nitrate as N	Nitrite as N	Total Kjeldahl Nitrogen	Total Nitrogen**	Phosphorus, Total	Total Orthophosphate	Dissolved Organic Carbon	Total Organic Carbon	Total Dissolved Solids	Turbidity	Chlorophyll-a
MDL*				0.200	0.10	0.00010	0.030	0.030	0.10		0.020	0.020	0.0400	0.0400	4.2	0.020	0.000050
Date		°C		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	NTU	mg/L
5/14/2013	9:40	18.2	7.8	ND	0.18	0.0030	1.3	ND	0.24	1.50	0.054	0.14	1.35	1.27	8600	3.8	0.00023
5/21/2013	10:00	17.2	8.2	0.210	0.10	0.0004	0.14	ND	0.32	0.45	0.063	0.049	1.57	1.53	5700	16.	0.0021
5/28/2013	9:15	16.1	8.2	0.210	0.14	0.0051	ND	ND	0.32	0.32	0.050	0.090	2.16	2.21	1100	1.6	0.0033
5/30/2013	9:40	17.0	8.3	ND	0.14	0.0068	ND	ND	0.24	0.24	0.047	0.072	2.06	2.06	1900	2.4	0.0021
6/4/2013	9:30	19.2	7.9	0.21	0.14	0.0032	ND	ND	0.35	0.35	0.053	0.11	1.83	1.79	2600	3.1	0.0023
6/11/2013	9:40	17.5	8.5	ND	0.21	0.017	0.11	ND	0.24	0.36	0.056	0.10	1.98	2.00	1300	1.4	0.0036
6/13/2013	9:30	17.7	8.4	0.21	ND	ND	ND	ND	0.28	0.28	0.053	0.083	1.72	1.81	2800	2.2	0.0020
6/18/2013	9:10	17.8	8.5	ND	ND	ND	ND	ND	0.24	0.24	0.043	0.076	1.74	1.54	6200	2.2	0.0025
6/25/2013	9:40	17.8	8.4	ND	0.18	ND	0.15	ND	0.21	0.36	0.050	0.098	2.01	2.06	3200	4.4	0.0039
7/2/2013	10:20	22.2	8.2	ND	0.18	ND	0.13	ND	0.35	0.48	0.044	0.074	2.40	2.48	1900	2.1	0.0019
7/9/2013	9:30	17.7	8.0	0.24	0.1	ND	ND	ND	0.35	0.35	0.043	0.11	1.16	1.26	11000	1.8	0.0036
7/11/2013	9:50	18.2	8.5	ND	0.18	ND	ND	ND	0.21	0.21	0.051	0.13	1.26	1.23	12000	2.0	0.0023
7/16/2013	9:30	16.5	8.0	ND	0.14	ND	ND	ND	0.21	0.21	0.051	0.12	1.08	1.14	11000	2.1	0.0016
7/23/2013	9:40	17.6	8.1	0.24	ND	ND	ND	ND	0.24	0.24	0.040	0.093	0.921	0.840	18000	2.1	0.0049
7/30/0213	9:20	15.4	7.9	ND	0.14	ND	ND	ND	0.24	0.24	0.036	0.094	0.905	0.905	14000	0.9	0.0020
8/6/2013	9:10	15.8	7.9	ND	0.18	ND	ND	ND	0.24	0.24	0.037	0.079	1.00	0.92	12000	1.4	0.0042
8/13/2013	9:10	16.0	8.0	ND	ND	ND	ND	ND	ND	0.18	0.031	0.065	1.14	1.41	8100	1.2	0.00053
8/20/2013	9:20	16.8	7.7	0.32	0.1	ND	ND	ND	0.42	0.42	0.040	0.088	1.13	1.51	17000	1.3	0.0061
8/27/2013	10:00	16.6	8.0	ND	0.1	ND	0.58	ND	0.21	0.33	0.032	0.064	1.98	1.84	9600	0.56	0.0011
9/3/2013	10:10	15.7	7.9	0.28	ND	ND	1.1	ND	0.32	0.43	0.038	0.089	1.32	1.28	14000	2.0	0.0023
9/10/2013	9:20	15.8	7.8	0.28	0.1	ND	ND	ND	0.38	0.38	0.043	0.077	1.50	1.41	15000	3.1	0.0036
9/17/2013	9:50	15.7	7.9	0.28	ND	ND	1.2	ND	0.28	1.50	0.038	0.081	1.22	1.20	15000	1.9	0.0014
9/24/2013	9:20	14.5	8.1	ND	0	ND	ND	ND	0.28	0.28	0.035	0.060	2.18	2.12	5400	1.1	0.0061
9/26/2013	10:00	13.7	8.1	0.32	ND	ND	0.58	ND	0.35	0.47	0.048	0.053	2.18	1.99	5600	1.6	0.0049
10/1/2013	9:40	16.4	8.2	ND	ND	ND	0.12	ND	0.21	0.33	0.026	0.043	2.53	3.07	2200	1.0	0.0042
10/3/2013	10:30	14.1	8.1	ND	ND	ND	ND	ND	0.24	0.24	0.035	0.046	2.36	2.27	3100	1.5	0.0032
10/8/2013	9:50	13.9	8.0	ND	0.1	0.002	0.58	ND	0.28	0.86	0.029	0.052	2.67	2.68	2800	1.3	0.0032
10/15/2013	10:10	14.8	8.2	0.21	0.14	ND	ND	ND	0.35	0.35	0.038	0.052	2.68	2.71	2300	1.8	0.0024
10/17/2013	10:00	15.1	7.7	0.32	0.14	ND	0.24	ND	0.46	0.57	0.062	0.14	2.47	2.42	2800	2.8	0.0021
10/22/2013	9:00	12.7	8.0	ND	0.14	0.0076	ND	ND	0.24	0.24	0.060	0.10	2.02	1.98	3500	1.3	0.0027
10/24/2013	10:00	12.4	8.3	0.21	0.14	ND	ND	ND	0.35	0.35	0.035	0.063	2.19	2.17	3100	0.92	0.0026
10/29/2013	9:30	11.9	8.0	0.24	ND	ND	ND	ND	0.24	0.24	0.033	0.063	2.05	1.99	3500	1.9	0.0043
10/31/2013	9:40	11.4	8.1	ND	ND	ND	ND	ND	ND	0.18	0.029	0.055	2.25	2.15	2800	1.2	0.0054

* Method Detection Limit - limits can vary for individual samples depending on matrix interference and dilution factors, all results are preliminary and subject to final rev

** Total nitrogen is calculated through the summation of the different components of total nitrogen: organic and ammoniacal nitrogen (together referred to as Total Kjeldahl Nitrogen or TKN) and nitrate/nitrite nitrogen.

*** United States Geological Survey (USGS) Continuous-Record Gaging Station

**** Flow rates are preliminary and subject to final revision by USGS.

Recommended EPA Criteria based on Aggregate Ecoregion III

Total Phosporus: 0.02188 mg/L (21.88 ug/L) ≈ 0.022 mg/L

Total Nitrogen: 0.38 mg/L

Chlorophyll *a*: 0.00178 mg/L (1.78 ug/L) ≈ 0.0018 mg/L

Turbidity: 2.34 FTU/NTU

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, the 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 Comminsky 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 2013 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 instream flows that are mandated by the Biological Opinion. A complete evaluation of the water quality data is being conducted as part of the California Environmental Quality Act (CEQA) analysis associated with proposed permanent changes to D1610

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 there is concern that summer flows could be reduced to the point that water temperature may increase and dissolved oxygen (DO) may decrease, thereby degrading summer salmonid rearing habitat. In the Order issued on May 1, 2013, the SWRCB tasked the Water Agency with evaluating impacts associated with reductions in minimum instream flows authorized by the Order to water quality and the availability of aquatic habitat for salmonids in the Russian River. The period covered by the Order is May 1 through October 28, 2013 (SWRBC 2013). 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 Warm Springs Dam 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 from 2011 through 2013 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 Dam 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 in the main stem of the Russian River were distributed in the highest concentrations 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).

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, 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.

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 (May 1 to October 28, 2013) 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

Temperature

Daily minimum and daily maximum water temperature were collected at 4 sites (Hopland, Cloverdale, 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°C 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.

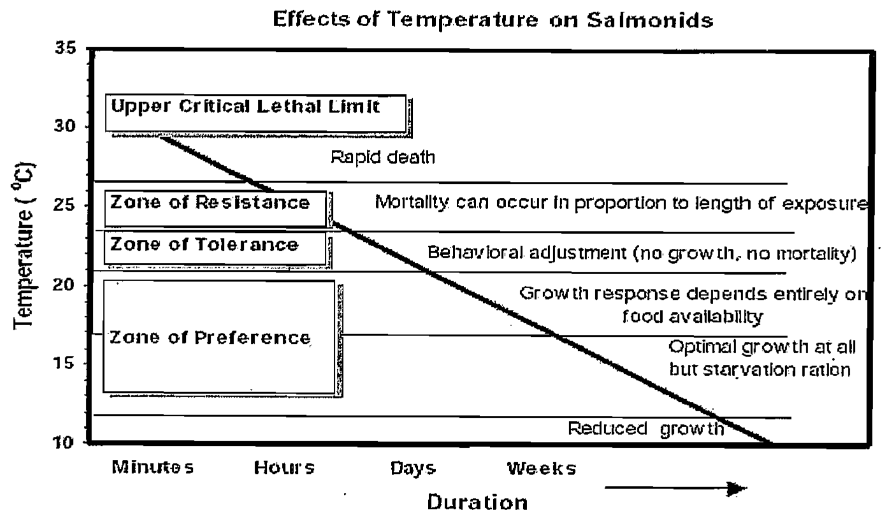


Figure 4-1. General environmental effects of temperature on salmonids in relation to duration and magnitude of temperature (from Sullivan et al. 2000, page 2-2).

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 10.6 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) (Tables 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

Flow in the Russian River was lower than in recent years. The spring of 2013 had the lowest rainfall on record. Storage in Lake Mendocino was extremely low entering the summer. The Water Agency petitioned the SWRCB to make a temporary change to minimum instream flows in the Russian River. These changes were implemented in early May. As a result flows in the upper Russian River (between Coyote Valley Dam and the confluence with Dry Creek) were lower than average and at times the lowest since 1960 (Figure 4-2).

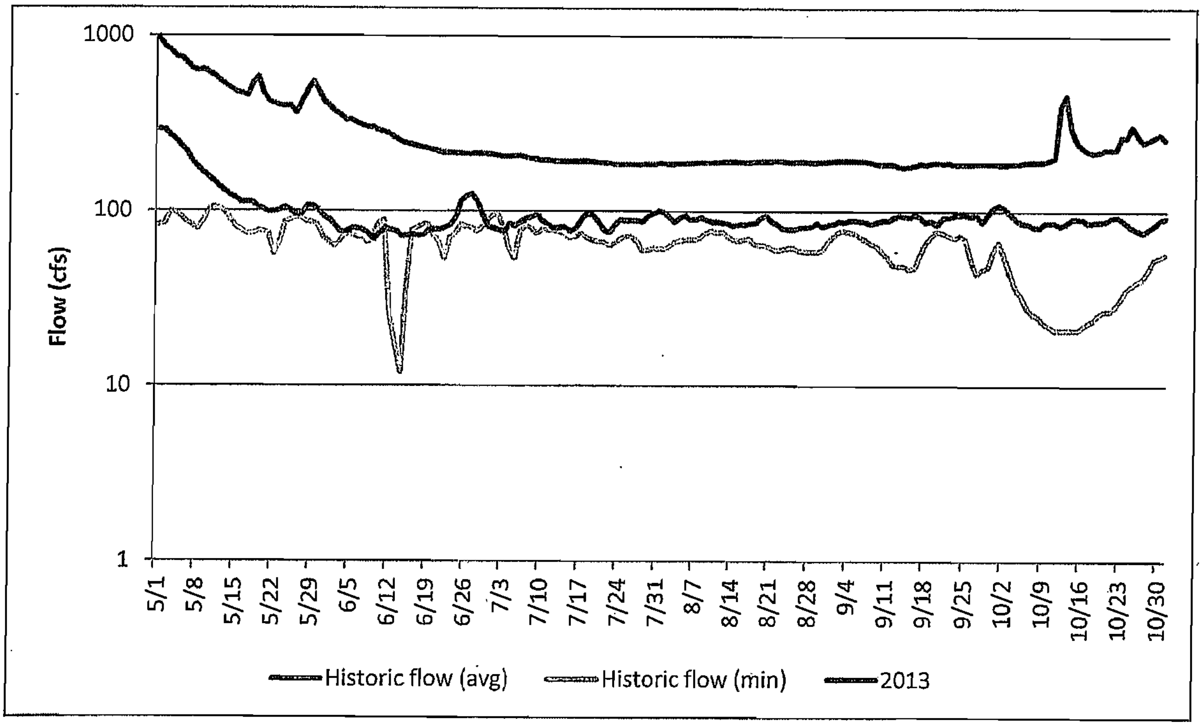


Figure 4-2. The 2013 Healdsburg average daily flow shown with the historic average flow at Healdsburg and the lowest flows recorded at Healdsburg (1960-2012)

Temperature

While the change in minimum instream flows under the Order is attempting to improve summer rearing steelhead habitat in the upper Russian River by lowering flows and thereby velocities with which fish must cope, it has an added benefit for summer rearing steelhead and adult Chinook of also reducing water temperatures in the upper Russian River during normal water years. Water releases from Lake Mendocino are made from near the bottom of the lake. In the summer the lake stratifies and water temperatures are much cooler at the bottom of the lake than at the surface. Water released from this cold water pool improves summer rearing steelhead habitat in the upper Russian River. However this cold water pool is generally not large enough to persist throughout the entire summer when making higher reservoir releases for D1610 flows. During consecutive dry years storage in Lake Mendocino can be so low that the cold water pool may be too small to persist throughout the summer even when making reservoir releases that are lower than D1610, as was the case in 2013.

When compared to water temperatures in the fall following implementation of minimum instream flows recommended by the Biological Opinion, 2013 water temperatures were warmer. This was largely due to 2013 drought conditions which led to low storage in Lake Mendocino and depletion of the cold water pool (the potion of cold water at the bottom of the lake below the thermocline). In 2013 vertical profiles in Lake Mendocino showed that the cold water pool was becoming depleted in August and became fully depleted by September 23 (Figure 4-3). Water temperatures at Hopland in fall 2013 were similar to water temperatures in years that had flows set by D1610 (Figure 4-4).

In other years the depletion of the cold water pool occurred during D1610 releases, but was preserved under temporary changes in minimum instream flows are described in the Biological Opinion. For example in August 2012, a year following implementation of TUC minimum instream flow changes described in the Biological Opinion, the daily maximum water temperatures in the upper Russian River was significantly lower than in recent normal water years following D1610 minimum instream flows (2002, 2003, 2005, 2006). On September 21, 2012, this difference became the most apparent as the maximum daily water temperature at Hopland was 4.5 °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 4-5).

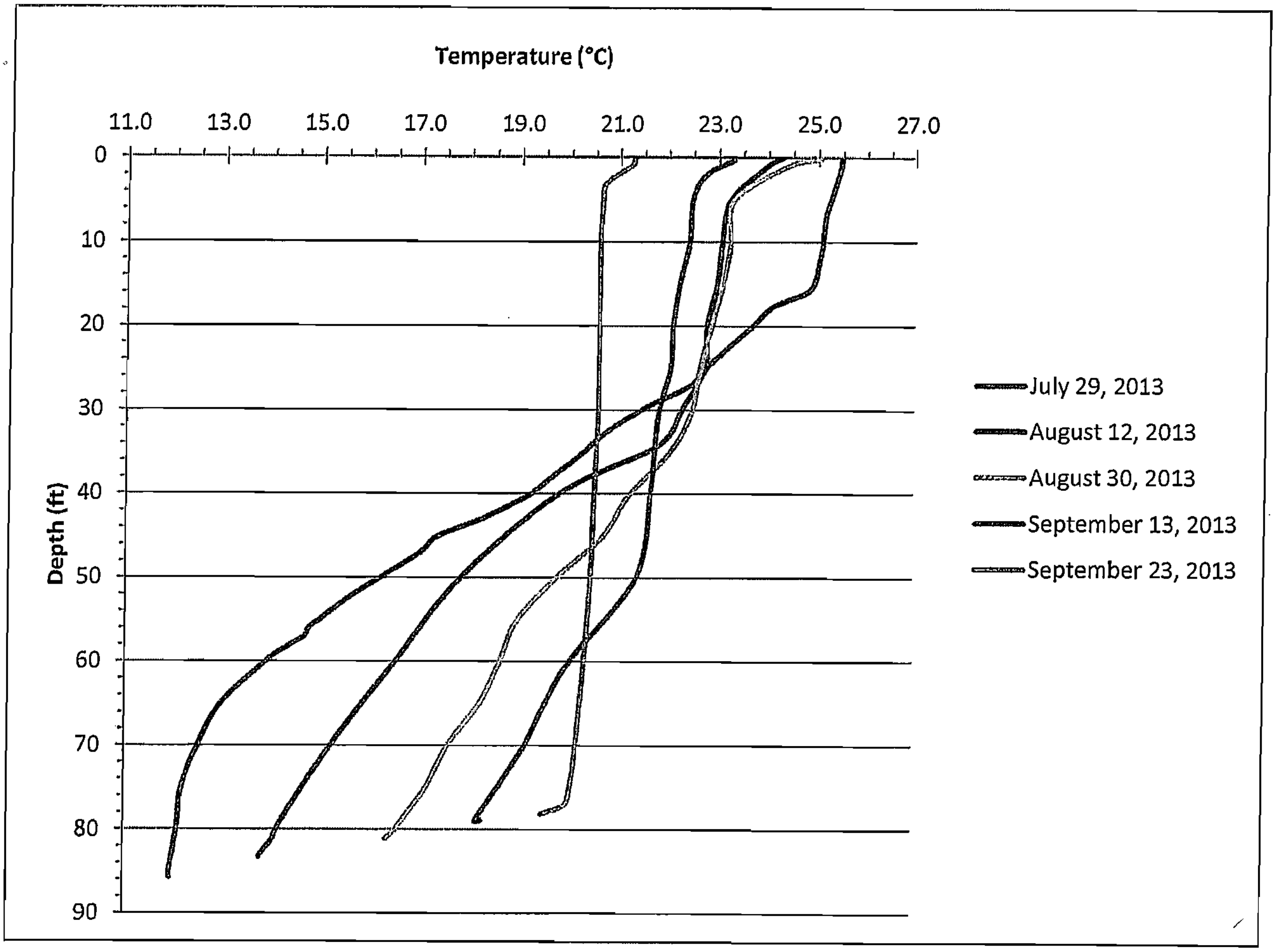


Figure 4-3. Vertical temperature profiles taken in Lake Mendocino in 2013.

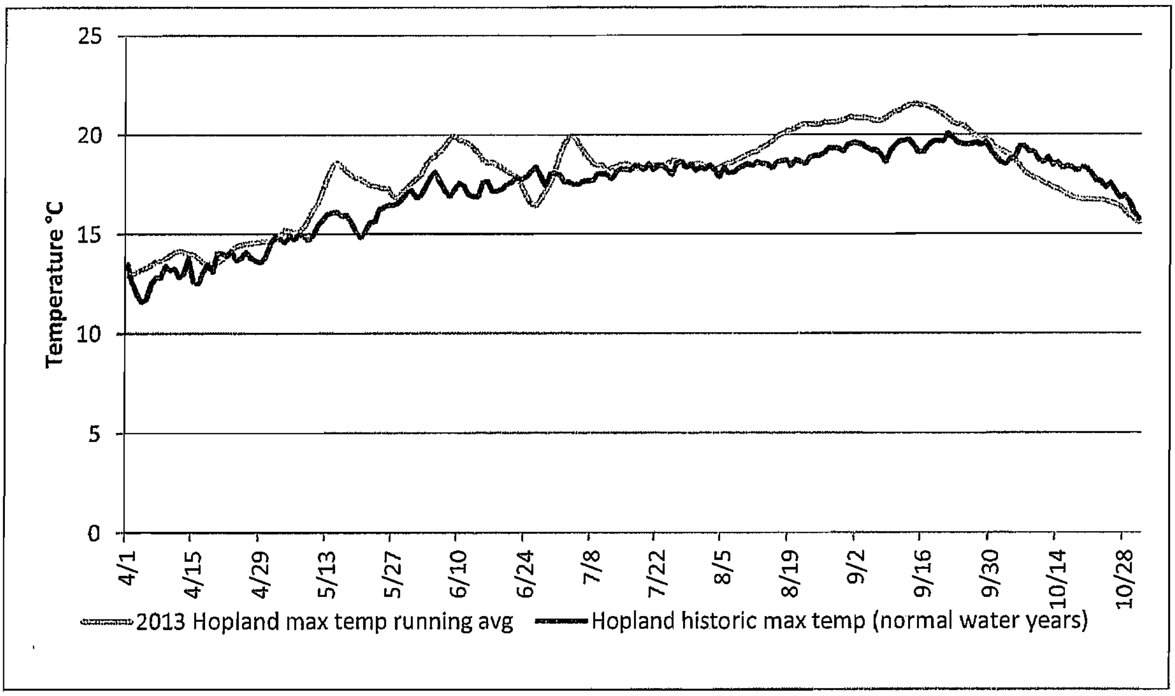


Figure 4-4. The 7 day running average of the daily maximum water temperature in 2013 at Hopland and the historic daily maximum water temperature (the average of the daily maximum water temperature from Decision 1610 normal water years (2002, 2003, 2005, 2006).

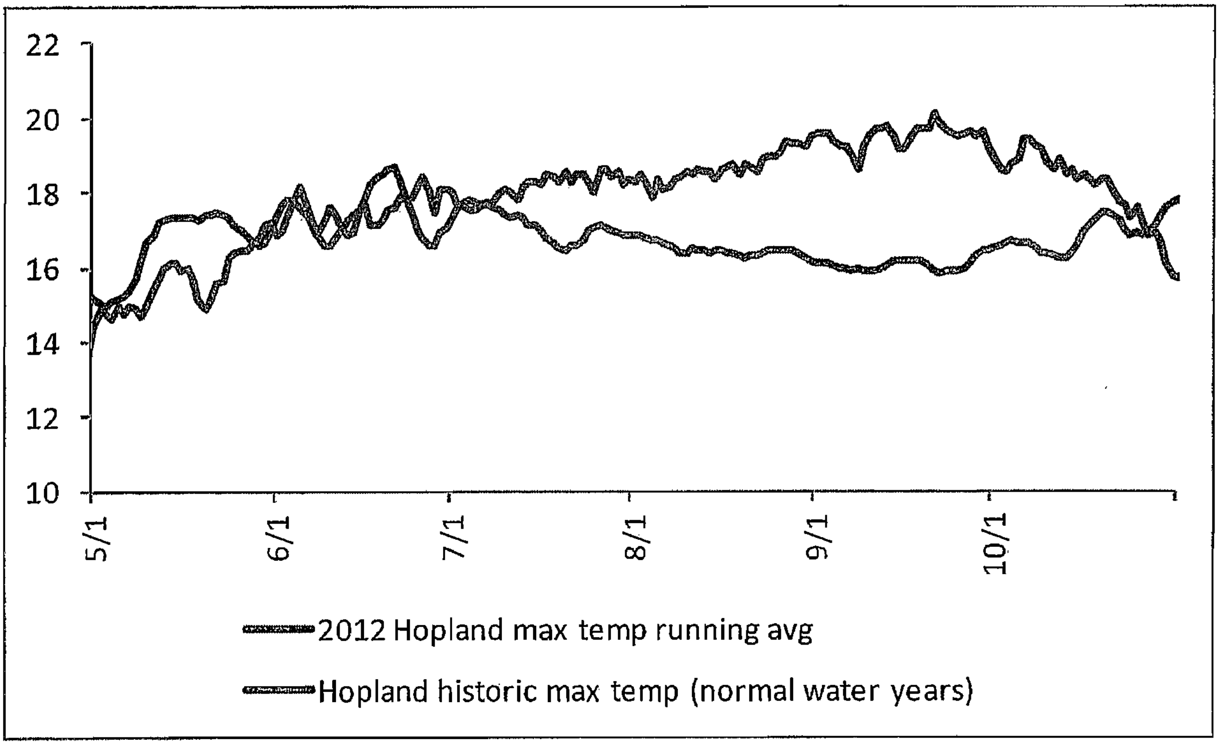


Figure 4-5. The 7-day running average of the daily maximum water temperature in 2013 at Hopland and the historic daily maximum water temperature (the average of the daily maximum water temperature from Decision 1610 normal water years (2002, 2003, 2005, 2006)

The preservation of the cold water 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. 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. However in some drought years (e.g., 2013) it may not be operationally possible to preserve the coldwater pool.

In the lower river, 2013 water temperatures were generally similar to normal water years and showed less divergence from normal water years than did Hopland (Figure 4-6). It is important to note that while flow was lower in 2013 than in normal water years, water temperatures were similar between these two groups.

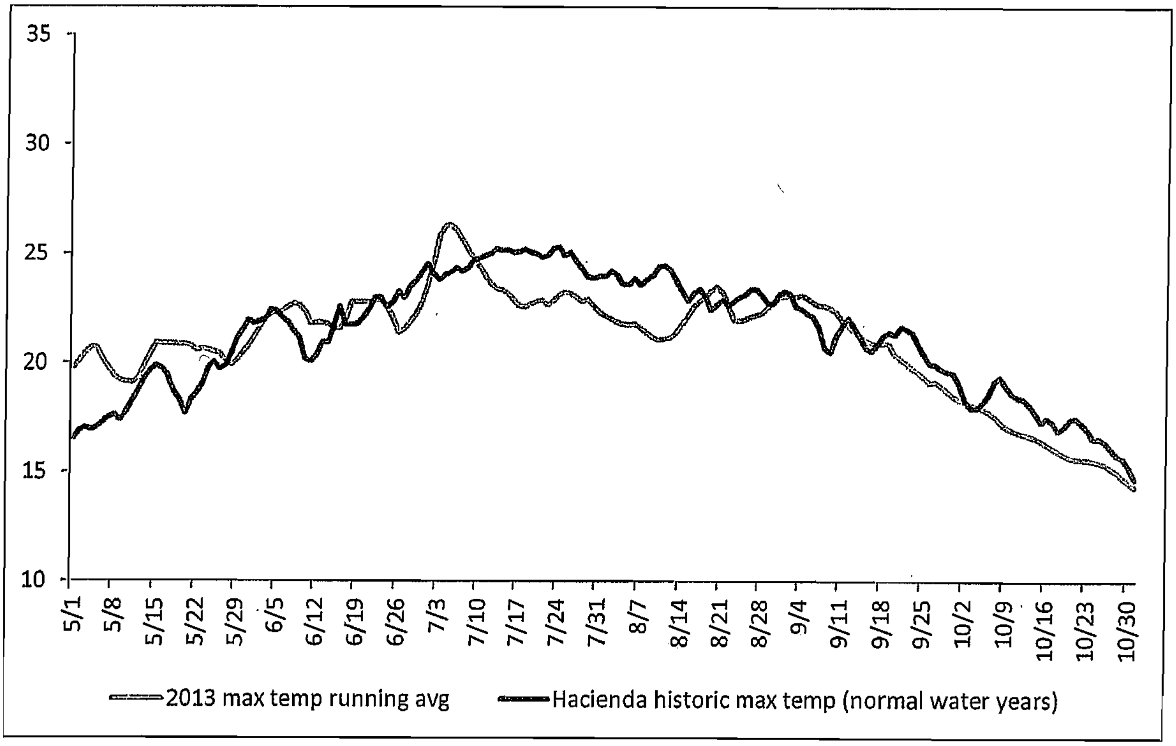


Figure 4-6. The 7-day running average of the daily maximum water temperature at Hacienda during the period of the Order in 2013 and historic daily maximum water temperature (the average of the daily maximum water temperature from Decision 1610 normal water years (2002, 2003, 2005, 2006).

Coho

Fish observed on the underwater video camera system at Mirabel that have coho characteristics are sent to a panel of biologists for a verification of species identification. At the time of this writing the panel has not reviewed all the video that was sent to them. Therefore the adult coho numbers reported here are preliminary and subject to change. During the Order two coho adults were observed on the underwater video camera system at Mirabel. Water temperatures at Hacienda ranged from 13.7 to 20.9 °C. At this time water temperatures at Hacienda for coho adults were in the zones of preference and resistance (Figure 4-7). However it is important to note that coho adults voluntarily leave the ocean and enter the Russian River, and that the bulk of the adult coho migration occurs in the winter when water temperatures are much cooler.

Coho smolts were migrating through the mainstem Russian River during the beginning portion of the Order. Based on downstream migrant trapping at Mirabel in 2013, coho smolts were present in the mainstem Russian River until at least June 29, 2013. At Mirabel, 283 coho smolts, representing 26 % of the season total catch were captured after the Order went into effect on May 1, 2013. During the time that coho smolts were captured at Mirabel water temperatures at Hacienda ranged from 16.3°C to 26.3 °C, which encompass the suitable temperature zone, the zones of tolerance, and resistance and upper lethal limit (Figure 4-8).

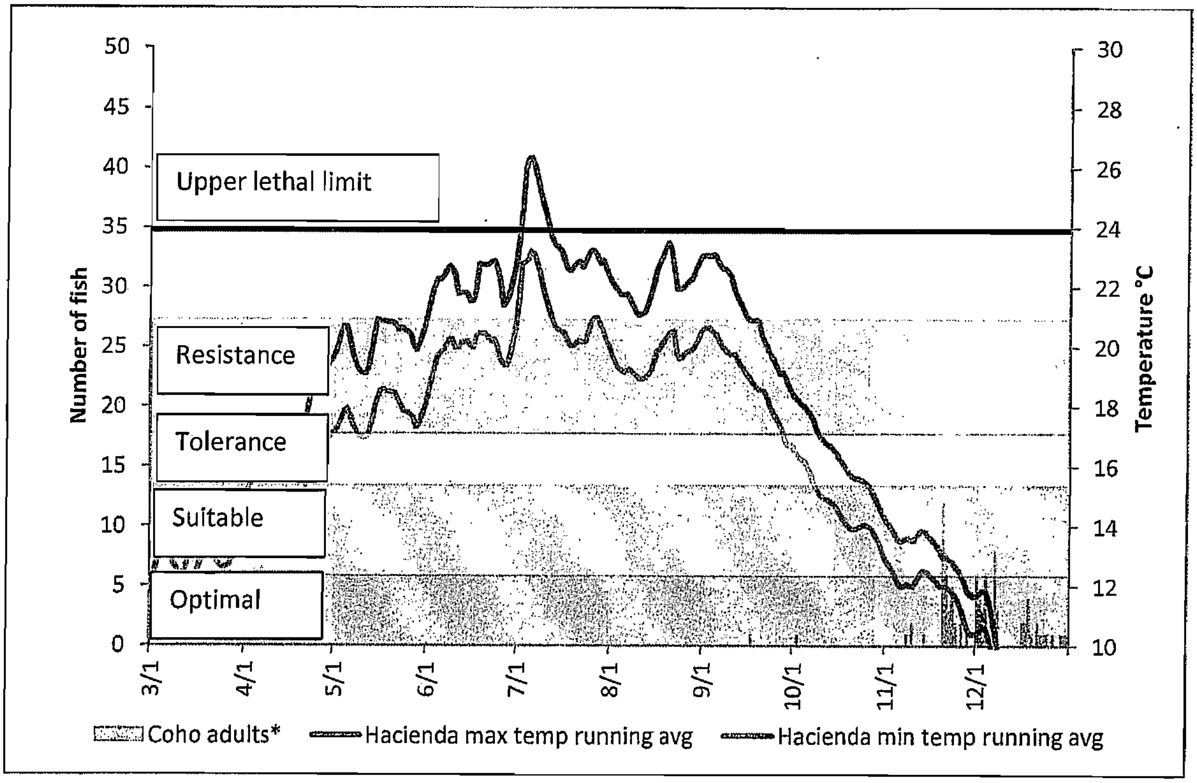


Figure 4-7. The number of coho adults observed on the Mirabel camera system (*preliminary data and subject to change) shown with the daily maximum and minimum water temperature 7-day running averages collected at Hacienda. Also shown are the temperature zones of optimal (<12.2 °C), suitable (12.2-15.6 °C), tolerance (15.6-16.9 °C), resistance (16.9-21.1 °C), and the upper critical lethal limit (>23.9 °C) for coho adults. The period of the Order 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 2013 video monitoring season was observed on September 15. A total of 5 adult steelhead were estimated to have passed the Inflatable dam during the 2013 Order (SCWA unpublished data). Water temperatures at Hacienda, ranged from 12.2 °C to 21.2 °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 suitability, tolerance, and resistance for adult steelhead (Figure 4-9). 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).

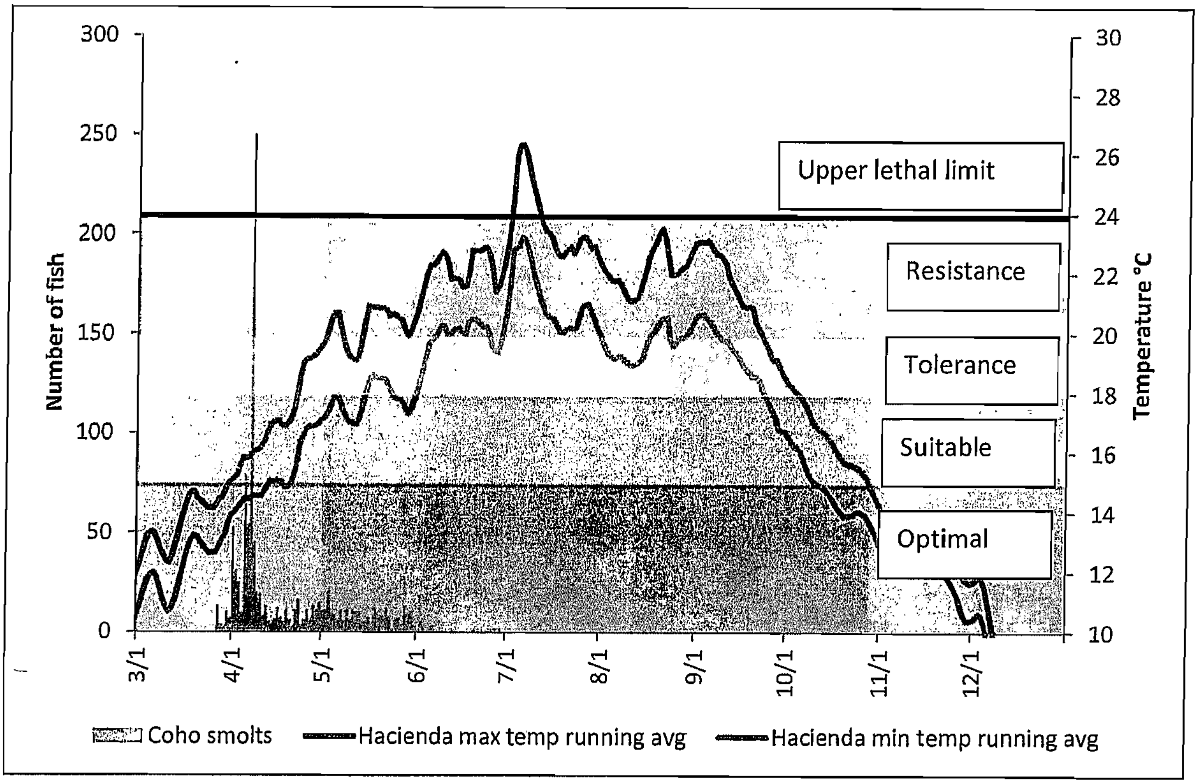


Figure 4-8. The number of coho smolts captured at Mirabel shown with the maximum and minimum daily water temperature 7-day running averages collected at Hacienda. Also shown are the temperature zones of optimal (<15 °C), suitable (15-17.8 °C), tolerance 17.8-20 °C), resistance (20-23.8 °C), and the upper critical lethal limit (>23.9 °C) for coho smolts. The period of the Order is shaded in grey.

In reaches that are considered steelhead rearing habitat, Ukiah to Cloverdale, water temperatures were often favorable for juvenile steelhead. Water temperatures downstream of Cloverdale are considered too high to support summer rearing steelhead (NMFS 2008 and Figure 4-10). During the time period that the Order was in effect, daily water temperatures measured at the USGS gauge (11462500) near Hopland ranged from 12.1 °C to 21.8 °C and were generally in the optimal and suitable temperature zones (Figure 4-11). At Cloverdale daily water temperatures ranged from 13.3 °C to 25.0 °C (during the period that temperature was collected; May 1 through October 20, 2013) and minimum temperatures were in the zones of optimum or suitability. While maximum water temperatures were generally in the zones of tolerance and resistance, it is important to note that the Cloverdale gage 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 (Figure 4-11). The maximum daily water temperature was above the upper critical limit at Cloverdale on July 4 and 5, 2013 (Figure 4-12).

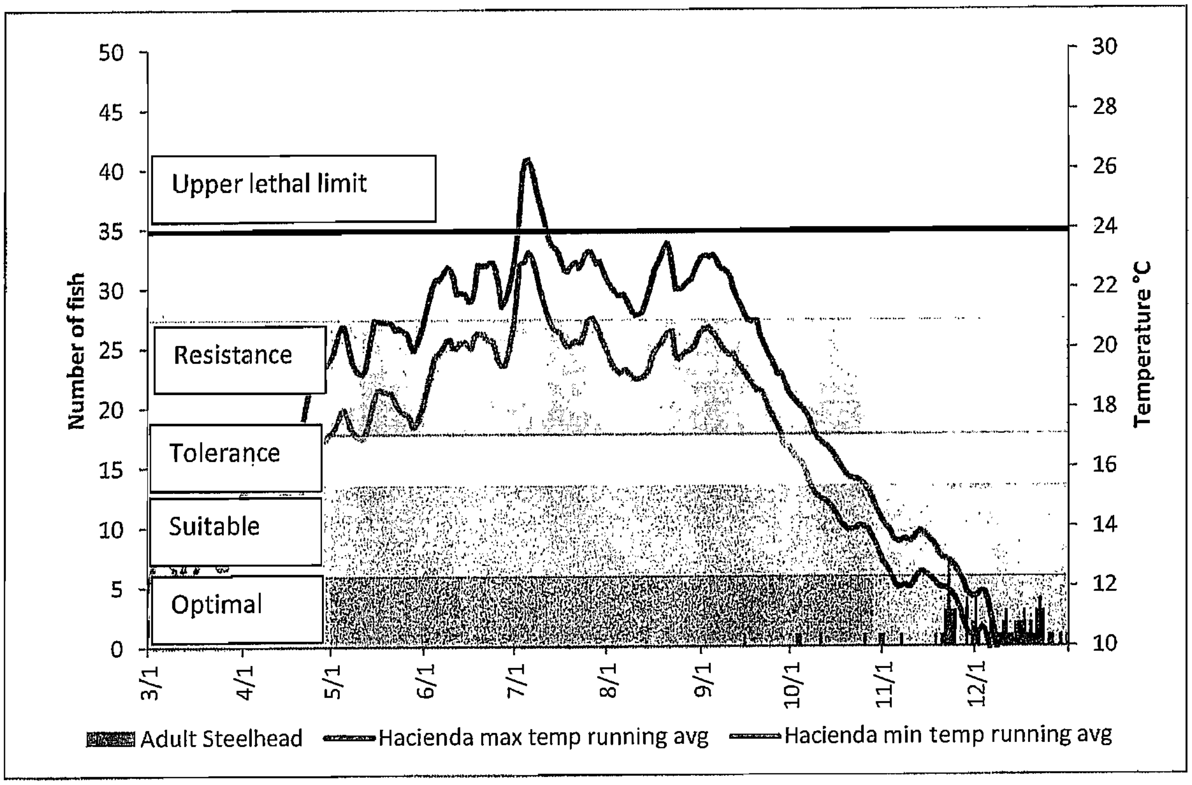


Figure 4-9. The number of steelhead adults observed on the Mirabel camera system shown with the daily maximum and minimum water temperature 7-day running averages collected at Hacienda. Also shown are the temperature zones of optimal (<12.2 °C), suitable (12.2-15.5 °C), tolerance (15.5-16.9 °C), resistance (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.

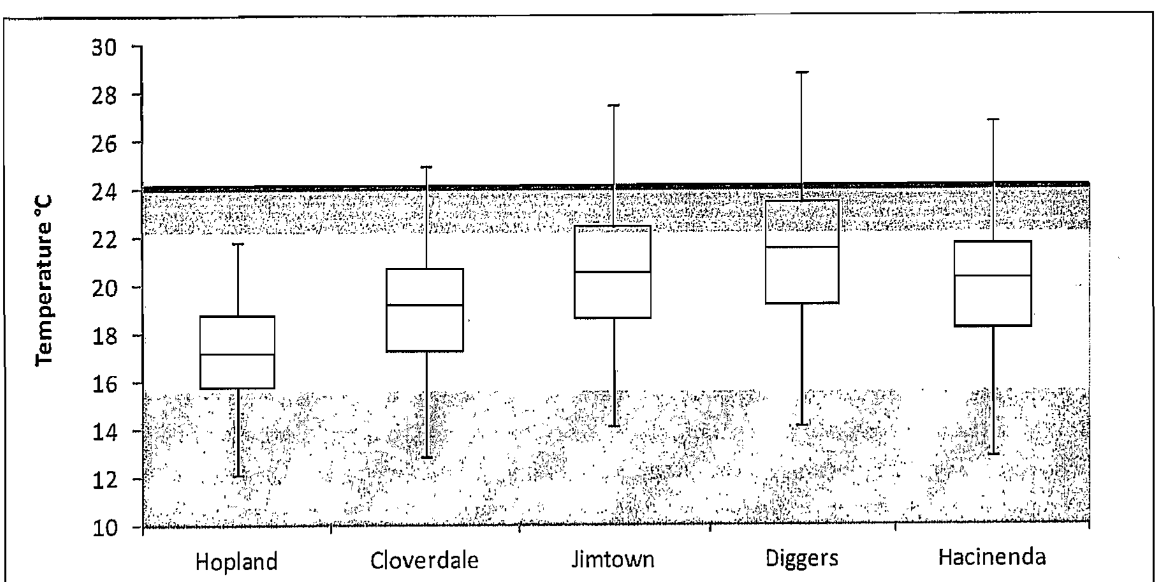


Figure 4-10. The minimum, 25 percentile, median, 75 percentile, and maximum water temperatures at Hopland, Cloverdale, Jimtown, Diggers Bend, and Hacienda for May 1 through October 28, 2013. Also shown are the zones of optimum (dark blue), suitability (light blue), tolerance (orange), and the upper lethal limit (red line) for summer rearing steelhead.

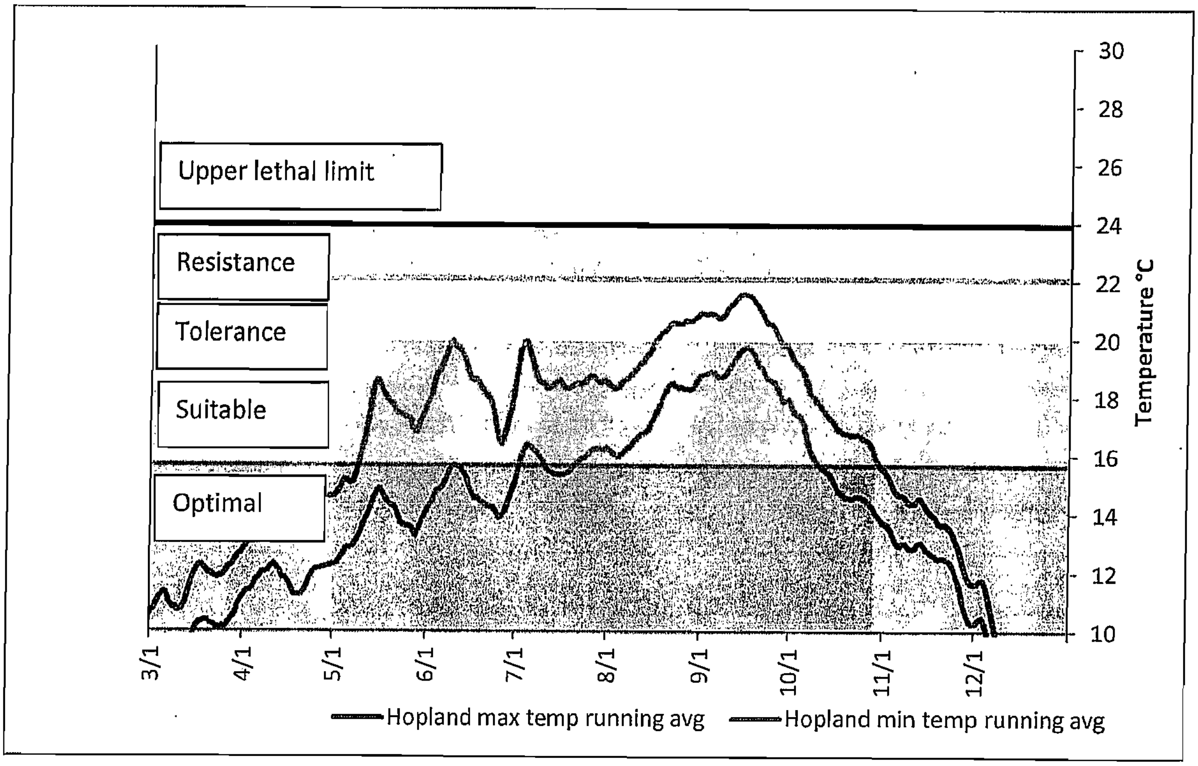


Figure 4-11. The maximum daily water temperature 7-day running average collected at Hopland shown with the temperature zones of optimal (>15.5 °C), suitable (15.5-20 °C), tolerance (20-21.1 °C), resistance (21.9-23.8 °C), and the upper critical lethal limit (>23.9 °C) for steelhead parr. The period of the Order is shaded in grey.

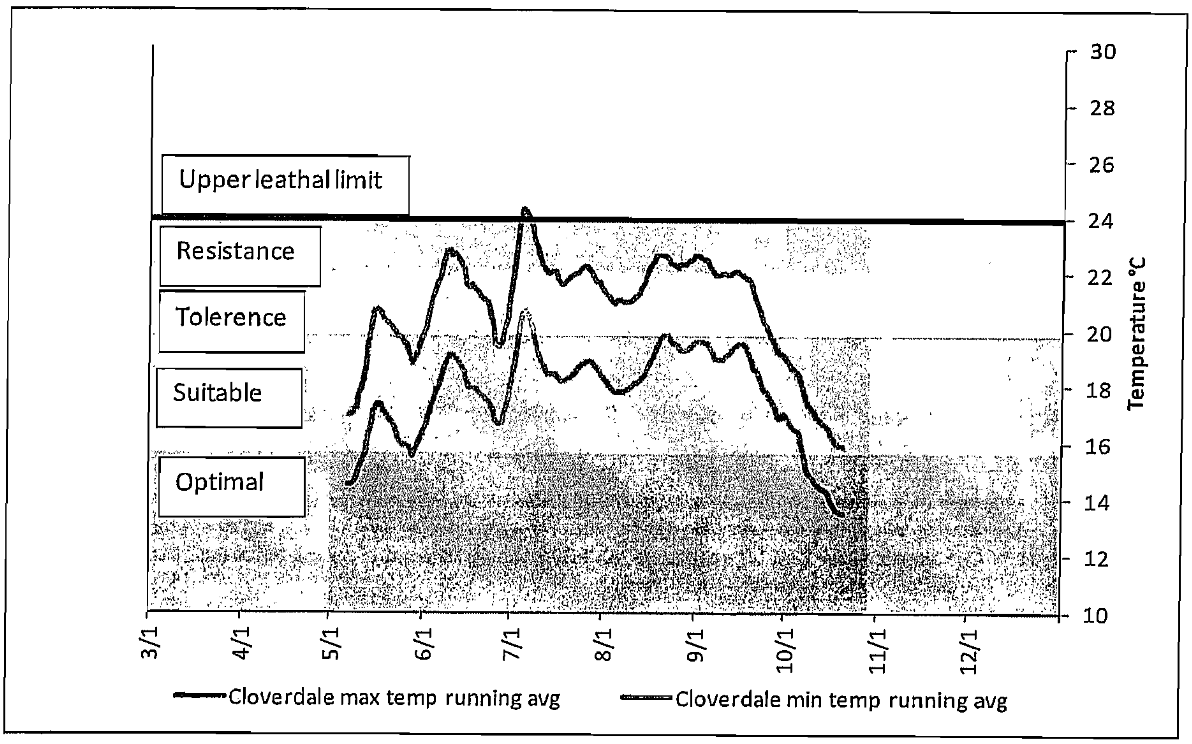


Figure 4-12. The maximum daily water temperature 7-day running average collected at Cloverdale shown with the temperature zones of optimal (>15.5 °C), suitable (15.5-20 °C), tolerance (20-21.1 °C), resistance (21.9-23.8 °C), and the upper critical lethal limit (>23.9 °C) for steelhead parr. The period 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 2013, 118 wild steelhead smolts were captured between May 1 and July 30 at Mirabel. The water temperatures at Hacienda ranged from 16.3 °C to 26.8 °C. During the portion of the Order where steelhead smolts were captured at Mirabel water temperatures at Hacienda were generally in the suitable and tolerable zones (Figure 4-13). Hopland, 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. It is important to note that the Water Agency installs downstream migrant traps as early as possible to monitor salmonid smolt outmigration, however because of high spring flows which limit trap installation and the early run timing of steelhead smolts it is likely that the majority of steelhead smolts emigrate from the Russian River before the Water Agency can install their fish traps.

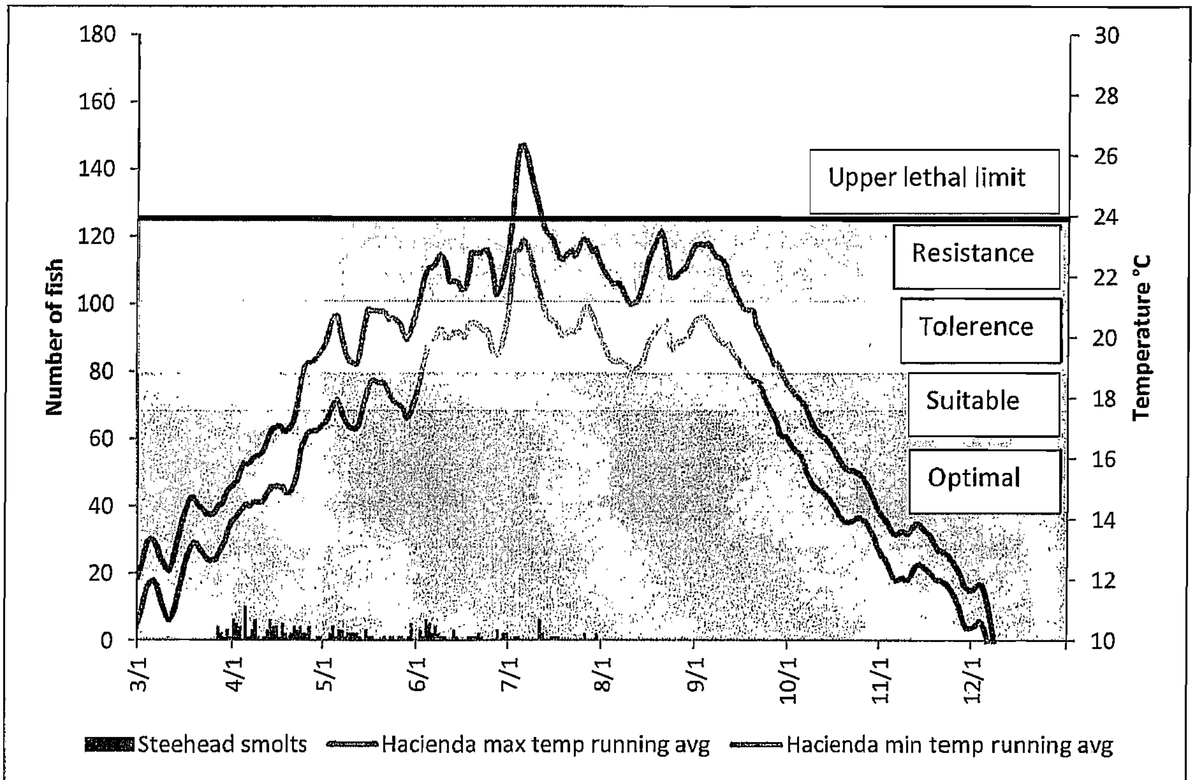


Figure 4-13. The number of steelhead smolts captured at Mirabel shown with the maximum and minimum daily water temperature 7-day running averages collected at Hacienda. Also shown are the temperature zones of optimal (<17 °C), suitable (17.5-18.9 °C), tolerance 18.9-21.1 °C), resistance (21.1-23.8 °C), 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 2013 was observed on September 2. By October 28, a total of 93 Chinook were estimated to have passed the dam, or 3 % of the Chinook adults detected at the inflatable dam. During this time period daily water temperatures at Hacienda were generally in the zones of tolerance and resistance for the portion of the Chinook run that took place during the Order (Figure 4-

14). 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.

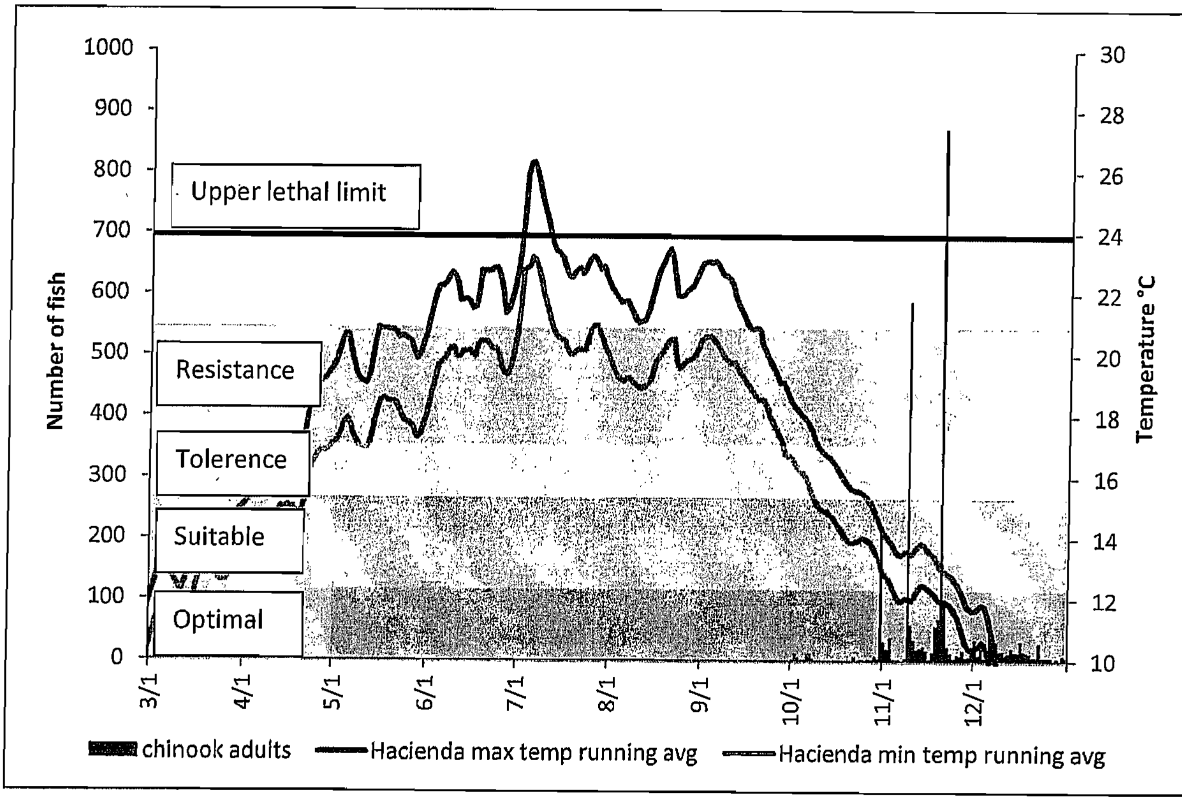


Figure 4-14. The number of Chinook adults detected at Mirabel shown with the maximum daily water temperature 7-day running average collected at Hacienda. Also shown are the temperature zones of optimal (<12.2 °C), suitable (12.2-15.5 °C), tolerance (15. 5-16.9 °C), resistance (16.9-21.1 °C), and the upper critical lethal limit (>23.9) for Chinook adults. The period of the Order is shaded in grey.

Between May 1, 2013 and when the traps were removed on July 31, 2013, a total of 5,084 Chinook smolts were captured at Mirabel. During the period of the Order water temperatures at Hacienda were in the zones of optimal, suitable, tolerance, and resistance temperature conditions, with the tolerance, resistance and the upper lethal limit temperature conditions occurring during the tail of the Chinook smolt run (Figure 4-15). While water temperatures entered the zones of tolerance, resistance and the upper lethal limit 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.

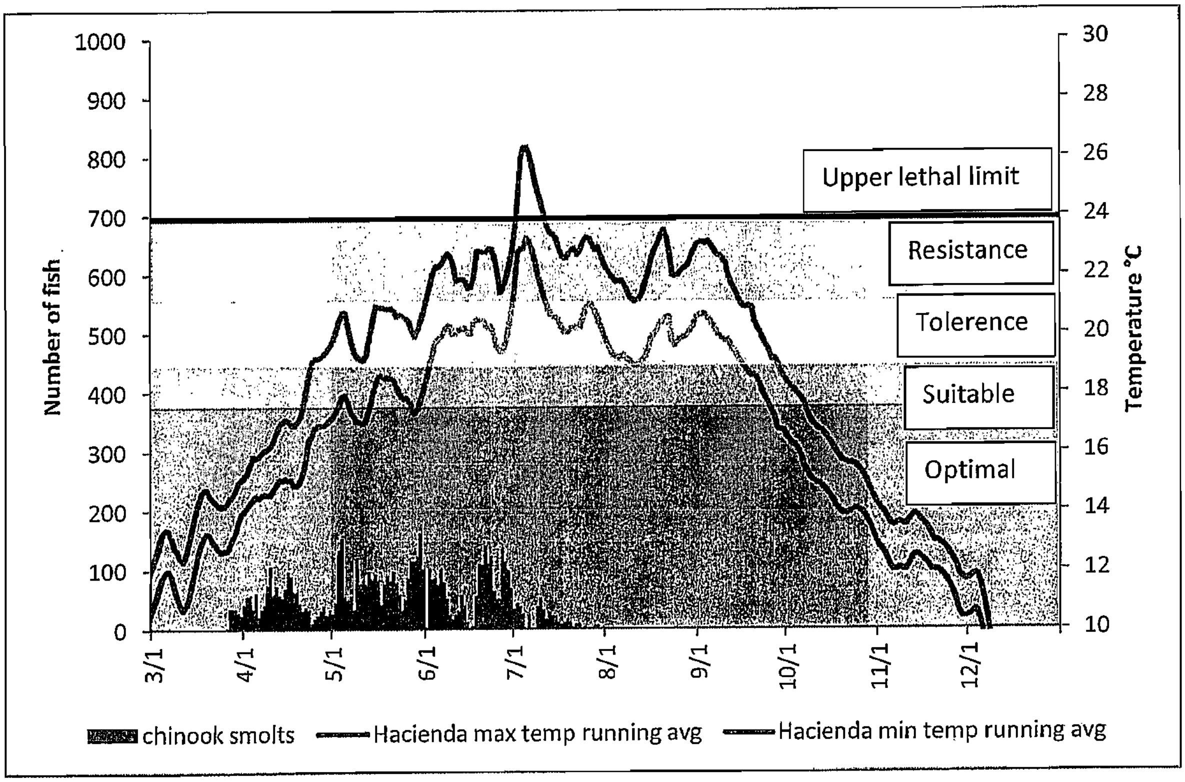


Figure 4-15. The number of Chinook smolts detected at Mirabel shown with the maximum daily water temperature 7-day running average collected at Hacienda. Also shown are the zones of optimal (<17 °C), suitable (17.5-18.9 °C), tolerance 18.9-21.1 °C), resistance (21.1-23.8 °C), and the upper critical lethal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

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. The first adult salmonid observed in 2013 at the Inflatable dam was a Chinook on September 2. A total of 93 adult Chinook were observed passing the Inflatable dam before October 28, 2013. The first steelhead observed on the camera system was on September 15 and by October 28, 2013, a total of 5 steelhead were counted as they passed the Inflatable dam (SCWA unpublished data). The first adult coho was observed on September 17, 2013. During the Order two adult coho were observed on the Mirabel camera system. From September 2 to October 28, 2013, the lowest minimum DO readings at Hacienda was 7.7 mg/L. Both daily minimum and maximum levels of DO were typically within the suitable zone for adult salmonids at Hacienda during the time that adult salmonids were observed (Figure 4-16).

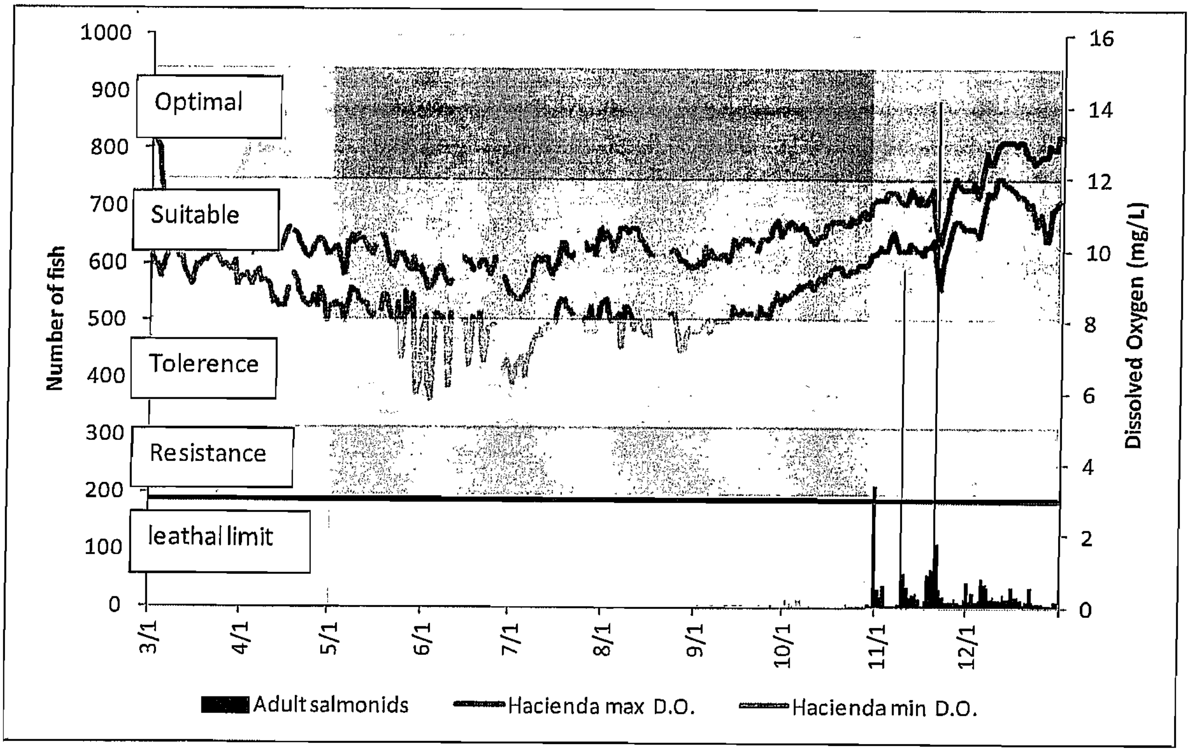


Figure 4-16. The number of adult salmonids observed at Mirabel shown with the daily minimum and daily maximum levels of DO at Hacienda. Also show are the DO zones of optimal (≥ 12 mg/L), suitable (8 to <12 mg/l), tolerance (5 to <8 mg/L), resistance (3.1 to <5 mg/L), and the lower lethal limit (≤3 mg/L) of DO for adult salmonids.

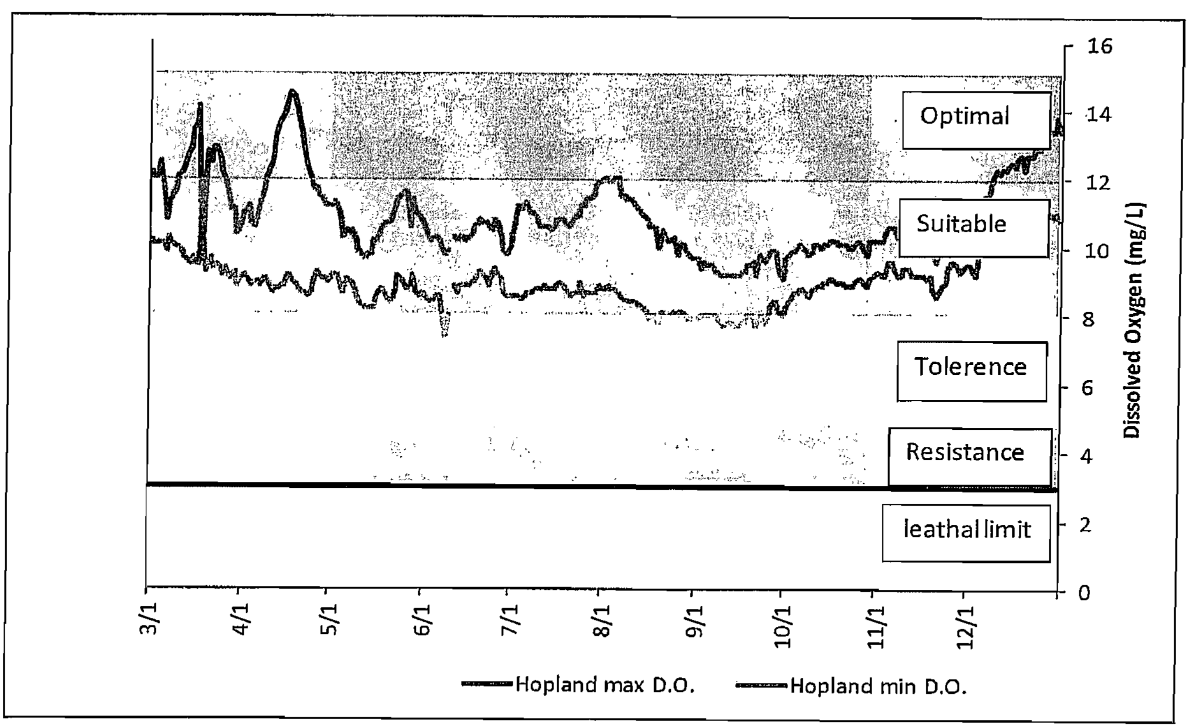


Figure 4-17. The daily minimum and daily maximum levels of DO at Hopland. Also show are the DO zones of optimal (≥ 12 mg/L), suitable (8 to <12 mg/l), tolerance (5 to <8 mg/L), resistance (3.1 to <5 mg/L), and the lower lethal limit (≤3 mg/L) of DO for salmonids.

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 was 7.4 mg/L and 6.6 mg/l in Cloverdale. At Hopland daily minimum DO levels occasionally entered the zone of tolerance, but were typically in the suitable zone (Figure 4-17). Daily minimum DO levels at Cloverdale were typically in the zone of tolerance while daily maximum DO levels at Cloverdale remained in the suitable or optimal zones throughout the duration of the Order (Figure 4-18)..

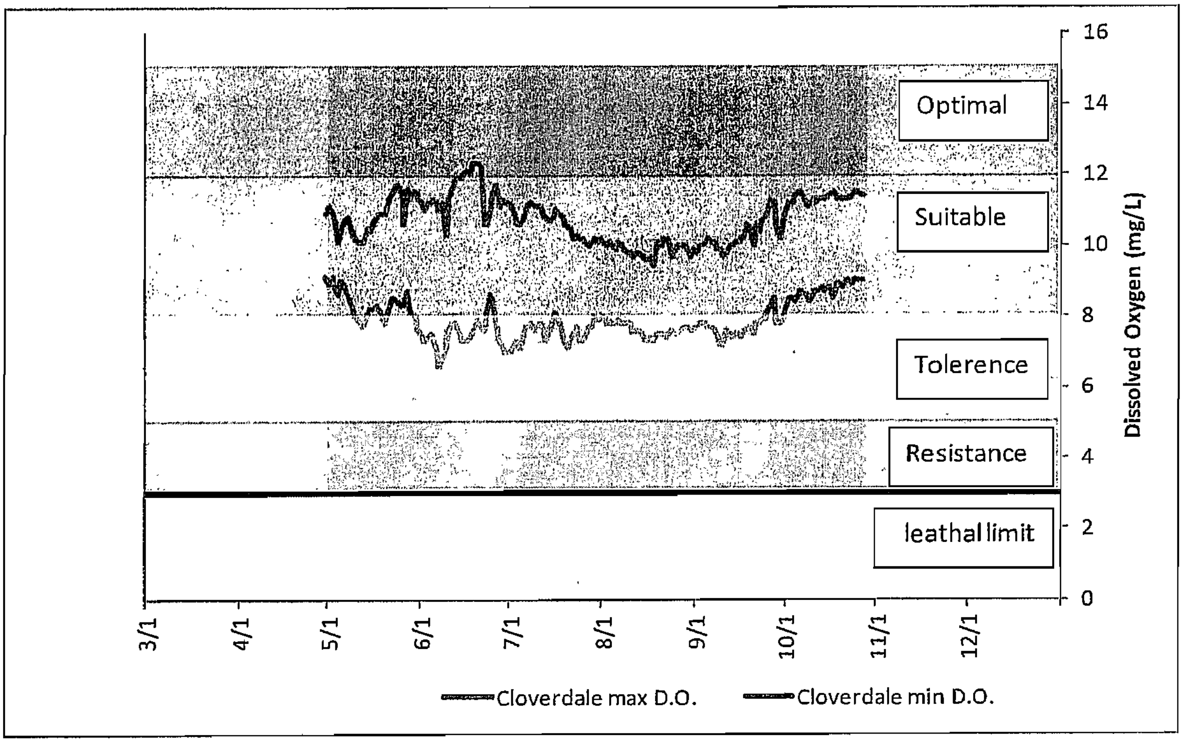


Figure 4-18. The daily minimum and daily maximum levels of DO at Cloverdale. Also show are the DO zones of optimal (≥ 12 mg/L), suitable (8 to <12 mg/l), tolerance (5 to <8 mg/L), resistance (3.1 to <5 mg/L), and the lower lethal limit (≤3 mg/L) of DO for salmonids.

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 2013 before the Order went into effect and were operated until July 31, 2013. The traps were ultimately removed because the daily catch of salmonids was diminishing. In total 5,084 Chinook smolts, 40 hatchery and wild coho smolts, and 118 wild steelhead smolts were captured in the downstream migrant traps from May 1 to July 31, 2013. During the time period that salmonid smolts were captured at the inflatable dam daily minimum and maximum DO readings at Hacienda were 5.8 mg/L and 10.6 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 4-19).

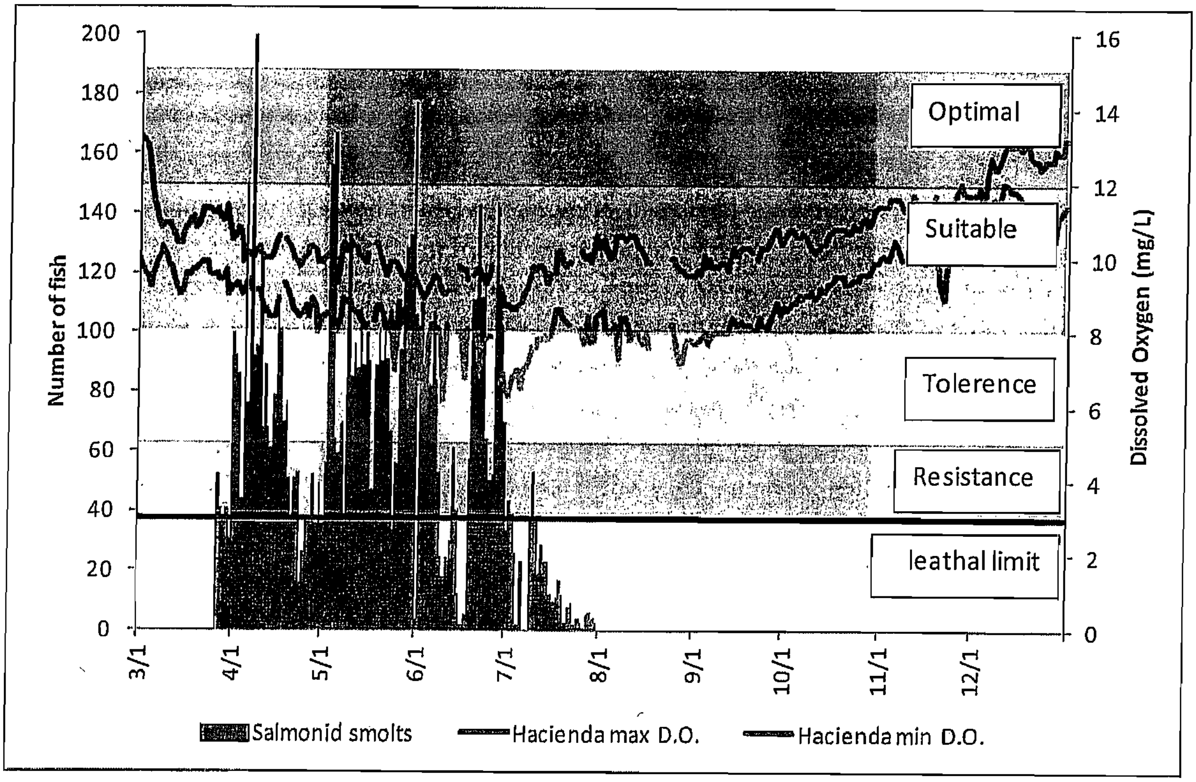


Figure 4-19. The number of salmonid smolts observed at Mirabel shown with the daily minimum and daily maximum levels of DO at Hacienda. Also show are the DO zones of optimal (≥ 12 mg/L), suitable (8 to <12 mg/l), tolerance (5 to <8 mg/L), resistance (3.1 to <5 mg/L), and the lower lethal limit (≤3 mg/L) 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 in the Russian River near Healdsburg were lower than usual due to the drought experienced in 2012-13. For much of the duration of the 2013 Order, flows in the upper Russian River were closer to the historic minimum flow than to the historic average (Figure 4-2). This is due to the region experiencing a drought that required adjustments to reservoir releases in order to ensure reservoir reliability.

Temperature

At Hopland water temperatures in the fall of 2013 were warmer than when compared to 2012. Hopland water temperatures in 2012 were cooler than in either 2013 or 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 2012 flow regime, but depleting the cold water pool during D1610 flows. Because of the low rainfall experienced in 2013 the storage in Lake Mendocino was lower than in 2012. As a result there was likely a smaller volume in the cold water pool and that cold water pool was depleted in 2013 even with the flow reductions made to preserve storage in Lake Mendocino.

Coho

Few adult coho where observed in the Russian River during the Order; however coho smolts were regularly encountered at the fish trap during the early portion of the Order. A total of 2 adult coho were observed on the Mirabel underwater video camera during the Order. Based on counts at the Mirabel inflatable dam most of the adult coho run took place well after the Order expired (SCWA unpublished data). Coho smolts migrate through the mainstem Russian River and were in the river during the beginning portion of the Order. During the Order, daily maximum water temperatures for coho at Hacienda were in the zone of suitability and the zone of tolerance with a few individuals emigrating during the tail of the run when maximum daily water temperatures reached the upper lethal limit. The elevated water temperatures during the coho smolt migration were likely related to rising air temperatures.

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 zones of tolerance and resistance and the maximum daily water temperature exceeded the upper lethal limit. While water temperatures at Hacienda were in the zone of tolerance and resistance water temperatures at Hacienda in 2013 were similar to water temperatures during normal water years (2002, 2003, 2005, 2006) when flows were above D1610 minimum flows (Figure 4-6). It is important to note that adult steelhead voluntarily leave the ocean and enter the Russian River.

Steelhead parr rear throughout the summer in a section of the upper Russian River near Ukiah and Hopland. During most of the Order the maximum water temperature at Hopland remained in the suitable temperature zone, but did enter the zone of tolerance during the late summer. This was due to the cold water pool in Lake Mendocino being depleted in 2013. Due to the low amount of rainfall in 2013 the cold water pool was likely much smaller in 2013 than in previous years and became depleted despite the lower reservoir releases. The daily minimum water temperature remained in the optimal and suitable temperature zones for the duration of the Order.

Steelhead smolts were in the mainstem Russian River during the beginning portion of the Order. 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 a period of time where the maximum daily water temperature exceeded the upper lethal limit. The elevated water temperatures during the steelhead smolt migration were likely related to rising air temperatures in June.

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 2013 were similar to water temperatures during normal water years (2002, 2003, 2005, 2006) when flows were above D1610 minimum flows (Figure 4-6). Furthermore Chinook passing Mirabel have the option of taking thermal refuge in Dry Creek which is cooler than the mainstem Russian River.

Chinook smolts were captured in mainstem Russian River traps during portions of the Order when water temperatures were in the zones of suitability, tolerance, and resistance. However, despite lower flow in 2013, the water temperatures were similar to water temperatures during normal water years (2002, 2003, 2005, 2006) when flows were above D1610 minimum flows. The water temperatures observed during the smolt migration were likely a result of the ambient air temperatures.

Dissolved oxygen

Dissolved oxygen levels were generally favorable for salmonids in the Russian River. For the adult life stage, Hacienda daily minimum and maximum DO remained in the zone of suitability for all but the very beginning of the adult run. 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 except for a short period where the daily minimum DO dropped into the zone of tolerance. At Cloverdale the daily minimum DO generally in the zone of tolerance while the daily maximum DO remained in the zone of suitability for the duration of the order. For the smolt life stage 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. During the order DO levels were typically favorable for all salmonid species and life stages at the locations where water quality data was summarized.

References

Bell, M. C. 1986. Fisheries handbook of engineering requirements and biological criteria. Fisheries Engineering and Research Program, U.S. Army Corps of Engineers Division, Portland, Oregon.

Baker, P. F., T. P. Speed, and F. K. Ligon. 1995. Estimating the influence of temperature on the survival of Chinook salmon smolts (Oncorhynchus tshawytscha) migrating through the Sacramento-San Joaquin River Delta of California. Journal of Fisheries and Aquatic Sciences 52: 855-863.

Barnhart, R. A. 1986. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Pacific Southwest) -- steelhead. U.S. Fish and Wildlife Service report 82(11.60). U.S. Army Corps of Engineers, TR EL-82-4. 21 pp.

Bell, M. C. 1991. Fisheries handbook of engineering requirements and biological criteria. Fisheries Engineering and Research Program, U.S. Army Corps of Engineers Division, Portland, Oregon.

Bisson, P. A. and J. L. Nielsen, and J. W. Ward. 1988. Summer production of coho salmon stocked in Mount St. Helens streams 3-6 years after the 1980 eruption. Transactions of the American Fisheries Society 117: 322-335.

Bovee, K. D. 1978. Probability of Use Criteria for the Family Salmonidae. U.S. Fish and Wildlife Service.(FWS/OBS-78/07.): 53.

Brett, J. R. 1952. Temperature tolerance in young Pacific salmon, genus Oncorhynchus. Journal of the Fisheries Research Board of Canada 9(6): 265-309.

Brett, J. R., M Hollands, and D. F. Alderdice. 1958. The effects of temperature on the cruising speed of young sockeye and coho salmon. Journal of the Fisheries Research Board of Canada. 15(4):587-605.

Brett, J. R., W. C. Clar, and J. E. Shelbourn. 1982. Experiments on the thermal requirements for growth and food conversion efficiency of juvenile Chinook salmon. Canadian Technical Report of Fisheries and Agricultural Science. 1127. Pacific Biological Station, Nanaimo, BC. 29 pp.

Carter, K. 2005. The Effects of Temperature on Steelhead Trout, Coho Salmon, and Chinook Salmon Biology and Function by Life Stage: Implication for the Klamath Basin TMDLs. Regional Water Quality Control Board North Coast Region.

CDPH (California Department of Public Health). 2011. Draft Guidance for Freshwater Beaches. Division of Drinking Water and Environmental Management. http://www.cdph.ca.gov/HealthInfo/environhealth/water/Documents/Beaches/DraftGuidanceforFreshWaterBeaches.pdf. Last update: January 2011.

Chase, S. D., R. C. Benkert, D. J. Manning, and S. K. White. 2004. Results of the Sonoma County Water Agency's Mirabel Rubber Dam/Wohler Pool Fish Sampling Program – Year 4 Results: 2003.

Chase, S.D., D. Manning, D. Cook, S. White. 2007. Historic accounts, recent abundance, and current distribution of threatened Chinook salmon in the Russian River, California. California Fish and Game 93(3):130-148. California Dept. Fish and Game, Sacramento California.

Chase, S.D., R.Benkert, D.Manning, and S. White. 2005. Sonoma County Water Agency's Mirabel Dam/ Wohler pool fish sampling program: year 5 results 2004. Sonoma County Water Agency, Santa Rosa, CA.

Clarke, W. C. and J. E. Shelbourn, and J. Brett. 1981. Effects if artificial photoperiod cycles, temperature, and salinity on growth and smolting in underyearling coho (Oncorhynchus kisutch), Chinook (O. tshawytscha), and sockeye (O. nerka) salmon. Aquaculture 22:105-116.

Clarke, W. C. and J. E. Shelbourn. 1985. Growth and development of seawater adaptability by juvenile fall Chinook salmon (Oncorhynchus tshawytscha) in relation to temperature. Aquaculture 45:21-31.

Cook, D. 2004. Chinook salmon spawning study: Russian River – Fall 2002-2003. Sonoma County Water Agency.

Cook, D. 2003. Upper Russian River Steelhead Distribution Study. Sonoma County Water Agency, Santa Rosa, CA.

Crader, P. 2012. Order approving Sonoma County Water Agency's petition for temporary urgency change of permits 12947A, 12949, 12950, and 16596 (applications 12919a, 15736, 15736, 15737, 19351). Division of Water Rights, Permitting and Licensing Section. Sacramento, C A.

EPA (U.S. Environmental Protection Agency). 1977. Temperature criteria for freshwater fish: protocol and procedures. U.S. Environmental Protection Agency, Office of Research and Development, Environmental Research Laboratory, Duluth, MN. EPA-600/3-77-061.

EPA (U.S. Environmental Protection Agency). 2000. Ambient Water Quality Criteria Recommendations. Information Supporting the Development of State and Tribal Nutrient Criteria for Rivers and Streams in Nutrient Ecoregion III. Office of Water. 4304. EPA-822-B-00-016. December 2000. http://water.epa.gov/scitech/swguidance/standards/upload/2007_09_27_criteria_nutrient_ecoregions_rivers_rivers_3.pdf.

EPA (U.S. Environmental Protection Agency). 2012. Recreational Water Quality Criteria. Office of Water. 820-F-12-058. http://water.epa.gov/scitech/swguidance/standards/criteria/health/recreation/upload/RWQC2012.pdf.

Griffiths, J. S. and D. F. Alderice. 1972. Effects of acclimation and acute temperature experience on the swimming speed of juvenile coho salmon. Journal of the Fisheries Research Board of Canada 29: 251-264.

Hallock, R. J., R. T. Elwell, and D. H. Tory. 1970. Migrations of adult king salmon (Oncorhynchus tshawytscha) in the San Joaquin Delta, as demonstrated by the use of sonic tags. Cal. Dept. Fish and Game, Fish Bull. 151.

Hinze, J. A. 1959. Annual report. Nimbus salmon and steelhead hatchery. Fiscal Year 1957-58. CDFG. Inland fish. Admin. Rept. 56-25.

Holt, R. A., J. E. Sanders, J. L. Zinn, J. L. Fryer, K. S. Pilche. 1975. Relation of water temperature to Flexibacter columnaris infection in steelhead trout (Salmo gairdneri), coho (Oncorhynchus kisutch) and Chinook (O. tshawytscha) salmon. Journal of the Fisheries Research Board of Canada 32: 1553-1559.

Jackson, T.A. 2007. California steelhead report-restoration card; a report to the legislature. Department of Fish and Game. Sacramento CA.

Klamt, R. et al. 2000. Review of Russian River Water Quality Objectives for Protection of Salmonid Species Listed Under the Federal Endangered Species Act. Regional Water Quality Control Board North Coast Region. Santa Rosa, CA.

Marine, K. R. 1997. Effects of elevated water temperature on some aspects of the physiology and ecological performance of juvenile Chinook salmon (Oncorhynchus tshawytscha): implications for management of California's Central Valley salmon stocks. Masters Thesis. University of California, Davis.

Martini Lamb, J. and D.J. Manning, editors. 2011. Russian River Biological Opinion status and data report year 2010-11. Sonoma County Water Agency, Santa Rosa, CA. P.208

McMahon, T. E. 1983. Habitat suitability index models: coho salmon. U.S. Department of Int., Fish and Wildlife Service FWS/OBS-82/10.49. 29 pp.

Moyle, P.. 2002. Inland Fishes of California. University of California Press. Berkeley and Los Angeles, CA.

Myrick, C. A. and J. J. Cech, Jr. 2000. Bay-Delta modeling forum technical publication 01-1

Nielsen, J., T. E. Lisle and V. Ozaki. 1994. Thermally stratified pools and their use by steelhead in northern California streams. Transactions of the American Fisheries Society 123: 613-626.

Obedzinski, M. 2012. Personal communication. University of California Cooperative Extension and Sea Grant Program; Russian River coho salmon monitoring program. Santa Rosa, CA.

Obedzinski, M., Pecharich J., Lewis, D., and Olin, P. 2007. Russian River Coho Salmon Captive Broodstock Program Monitoring Activates Annual report July 2006 to June 2007. University of California Cooperative Extension and Sea Grant Program Santa Rosa, CA.

Obedzinski, M., Pecharich, J., Vogeazopoulos, G., Davis, J., Lewis, D., and Olin, P. 2006. Monitoring the Russian River Coho Salmon Captive Broodstock Program: Annual Report July 2005 to June 2006

Ràleigh, R. F., W. J. Miller, and P. C. Nelson. 1986. Habitat suitability index models and instream flow suitability curves: Chinook salmon. U.S. Fish and Wildlife Service Biological Report 82(10.022). 64 pp.

Reese, C. D., and B. C. Harvey. 2002. Temperature-dependent interactions between juvenile steelhead and Sacramento pikeminnow in laboratory streams. Transactions of the American Fisheries Society. 131:599-606.

Rich, A. A. 1987. Report on studies conducted by Sacramento County to determine the temperatures which optimize growth and survival in juvenile Chinook salmon (Oncorhynchus tshawytscha): McDonough, Holland & Allen, 555 Capitol Mall Sacramento.

Roelofs, T. D. W. Trush, and J. Clancy. 1993. Evaluation of juvenile salmonid passage through Benbow Lake State Recreation Area. Fisheries Department, Humboldt State University, Arcata, California. Santa Rosa, CA.

Stein, R. A., P. E. Reimers, and J. H. Hall. 1972. Social interaction between juvenile coho (Oncorhynchus kisutch) and fall Chinook salmon (O. tshawytscha) in Sixes River, Oregon. Journal of Fisheries Research Board of Canada 29: 1737-1748.

Sullivan, K. D J. Martin, R. D. Cardwell, J. E. Toll, and S. Duke. 2002. An analysis on the effects of temperature on salmonids of the Pacific Northwest with implications for selecting temperature criteria. Sustainable Ecosystems Institue.

Thomas, R. E., J. A. Gharrett, M. G. Carls, S. D. Rice, A. Moles, S. Korn. 1986. Effects of fluctuating temperature on mortality, stress, and energy reserves of juvenile coho salmon. Transactions of the American Fisheries Society 115: 52-59.

Welsh, H. H. Jr., G. R. Hodgson, B. C. Harvey, and M. F. Roche. 2001. Distribution of juvenile coho salmon in relation to water temperatures in tributaries of the Mattole River, California. North American Journal of Fisheries Management. 21:464-470.

Werner, I, T. B. Smith, J. Feliciano, and M. Johnson. 2005. Heat shock proteins in juvenile steelhead reflect thermal conditions in the Navarro River Watershed, California. 134:399-410. Transactions of the American Fisheries Society.

Wurtzbaugh, W. A. and G. E. Davis. 1977. Effects of temperature and ration level on the growth and food conversion efficiency of Salmo gairdneri Richardson.

State Water Resources Control Board
Order 5/1/2013

Provision 16 – Water Loss and Water Use Efficiency

March 31, 2014

Prepared by

Sonoma County Water Agency
404 Aviation Blvd
Santa Rosa, CA 95403

1 Introduction

This report has been prepared by the Sonoma County Water Agency (Water Agency) to fulfill the requirements of Term 16 of the State Water Resources Control Board (State Board) Order dated May 1, 2013 (Order).

Term 16 of the Order directs the Water Agency to take the following actions:

> SCWA shall provide a written update to the Deputy Director by March 31, 2014, regarding activities and programs being implemented by SCWA and its water contractors to assess and reduce water loss, promote increasing water use efficiency and conservation, and improve regional water supply reliability. The written update shall include a report regarding the actual maximum applied water allowance (MAWA) achieved by each of SCWA's contractors during May through November 2013.

2 Water Loss and Water Use Efficiency

In response to the dry spring conditions of 2013, the Water Agency launched a public education campaign to encourage residents to voluntarily reduce water consumption. The Water Agency launched the "20-Gallon Challenge" campaign to increase awareness of the water supply situation and as a call to action.

The campaign features a pledge to save 20 gallons per person per day. As an incentive to pledge, monthly prize drawings were held from May to October. The prizes included two high-efficiency toilets, two high efficiency clothes washers, a rainwater catchment or graywater system, and custom water-wise landscape design. The prizes were awarded to residents throughout the region including Santa Rosa, Forestville, Windsor, Cotati and Novato.

The 20-Gallon Challenge website also contained a page for residents to report water waste. When water waste reports were received, the Water Agency sent a postcard to the identified address providing education and resources to the resident about how to save water.

Pledges and contest entries were accepted from the entire Russian River Watershed to encourage both upper and lower Russian River water users to participate in the Challenge. Outreach was conducted through print media, radio ads in English and Spanish, water bill stuffers, social media, newsletters, and outreach events like the Sonoma County Fair, farmers markets and the Santa Rosa Wednesday Night Market.

3 Sonoma-Marin Saving Water Partnership Annual Report

The Cities of Santa Rosa, Rohnert Park, Sonoma, Cotati, Petaluma, Town of Windsor and North Marin, Marin Municipal and Valley of the Moon Water Districts and the Water Agency formed the Sonoma-Marin Saving Water Partnership in 2010. The purpose of the Sonoma-Marin Saving Water Partnership is to establish the financial obligation for the eight local water utilities, Marin Municipal Water District and

Sonoma County Water Agency, identify and recommend implementation of water conservation projects and to maximize the cost-effective projects for the Partnership.

The Partners are committed to remain as members in good standing of the California Urban Water Conservation Council (CUWCC) and implement the Best Management Practices (BMPs) for water conservation. The Partners will implement or use best efforts to secure the implementation of any water conservation requirements and will publish an Annual Report to track progress. The Annual Report will track program implementation, highlight program milestones, and reinforce the importance of protecting and preserving water resources for future generations. The 2012/2013 Annual Report for the Partnership is attached in Appendix A.

4 Maximum Applied Water Allowance (MAWA)

The Maximum Applied Water Allowance (MAWA) is the upper limit of annual water use for a specific landscaped area based on the square footage of the area, an evapotranspiration (ET) adjustment factor, reference ETo and effective rainfall. MAWA is commonly referred to as a water budget. The Water contractors[1] used an ET adjustment factor of 60% for calculating the reported water budgets.

Water contractors submitted information on calculated water budgets and water use to the Water Agency. The water use reported was through November 2013 as required by the Order. The average actual MAWA achieved by the Water Agency water contractors was 63%.

Below is the report regarding the actual maximum applied water allowance achieved by each of the Water Agency's contractors during May through November 2013.

	Water Budget (AF)	Dedicated Irrigation Metered Sales (AF)	Actual MAWA Achieved (%)
City of Cotati	178	129	43%
City of Petaluma	723	693	58%
City of Rohnert Park	275	329	72%
City of Santa Rosa	1,837	1,993	65%
City of Sonoma	34	76	135%
North Marin Water District	939	874	56%

[1] Under the 2006 Restructured Agreement for Water Supply, the Water Agency's "water contractors" are the Cities of Santa Rosa, Rohnert Park, Sonoma, Cotati, Petaluma, the Town of Windsor and the North Marin and Valley of the Moon Water Districts.

Town of Windsor	156	208	80%
Valley of the Moon Water District	25	44	106%
Regional Average	4,167	4,316	63%

SONOMA - MARIN
SAVING WATER
PARTNERSHIP

Annual Report

SAVING WATER

SONOMA-MARIN PARTNERSHIP

City of Santa Rosa

ROHNERT PARK CALIFORNIA

CITY COTATI

NORTH MARIN WATER DISTRICT

About the Partnership

The Sonoma-Marin Saving Water Partnership (Partnership) represents 10 water utilities in Sonoma and Marin counties that have joined together to provide regional solutions for water use efficiency.

The utilities include the Cities of Santa Rosa, Rohnert Park, Petaluma, Sonoma, Cotati; North Marin, Valley of the Moon and Marin Municipal Water Districts; Town of Windsor and Sonoma County Water Agency (Partners). Each of the Partners have water conservation programs that can assist you in reducing your water use.

The Partnership was formed to identify and recommend implementation of water use efficiency projects, and maximize the cost-effectiveness of water use efficiency programs in our region.

The Partners are committed to remain members in good standing of the California Urban Water Conservation Council (CUWCC) and implement the Best Management Practices (BMPs) for water conservation.

Contents

Our Service Area

More than 600,000 residents in Sonoma and Marin counties rely on the water delivered from the Russian River by the Sonoma County Water Agency (Water Agency) to the nine cities and districts in the Partnership. Supplementing the water provided by the Water Agency are local supplies including recycled water, groundwater from underground aquifers and surface water reservoirs.

Recreation, agriculture and wildlife, including threatened and endangered steelhead and coho and Chinook salmon also rely on these same natural resources in order to thrive.

Realizing the importance of protecting and preserving water resources for future generations, the members of the Partnership have taken a proactive role in helping fund, maintain and implement an array of water supply, water use efficiency and fishery recovery programs.

VALLEY OF THE MOON Water District | MARIN MUNICIPAL WATER DISTRICT | SEAL OF THE CITY OF SONOMA CALIFORNIA | TOWN OF WINDSOR | PETALUMA 1858 | SONOMA COUNTY WATER AGENCY

Working Together

Every day we wake up and turn on the tap to draw water and begin our daily routine. It's a marvel that fresh water appears instantly and this marvel is a testament to the men and women of the Sonoma County Water Agency and area retail water providers working together to insure a safe, reliable water supply is available for the residents of Sonoma and Marin Counties. Whether the water is naturally filtered from the Russian River, local ground water or surface water from local lakes, the coordinated effort to extract, treat and deliver water is often taken for granted. Conservation of precious water resources is critical as we strive to make the water available for our communities while preserving natural resources.

The Sonoma-Marin Saving Water Partnership (Partnership), through its many water efficiency programs, educational seminars and outreach campaigns, is working to educate our communities about the importance of conserving water resources and curbing water-wasting behaviors.

This year the "20-Gallon Challenge" was embraced by community members who pledged to reduce water use by 20 gallons per person per day. The 20-Gallon Challenge was promoted throughout the Russian River Watershed expanding the Partnership reach into Mendocino County. Working together in Sonoma, Marin and Mendocino counties, the 20-Gallon Challenge resulted in a positive response to the 2013 dry spring conditions.

The Partnership received a 2013 WaterSense Excellence award from the U.S. Environmental Protection Agency (EPA) for promoting water efficient irrigation practices through implementation of the Qualified Water Efficient Landscaper Program (QWEL). QWEL educates landscape professionals and their customers on the benefits of sound landscape design, management and irrigation practices. The award was one of only five issued by the EPA nationally.

The time and energy invested in the Partnership has benefitted our region. Water use during Fiscal Year 2012/13 remains down from prior years and the region has avoided water use restriction, even during an extremely dry spring. The Partnership will continue to offer educational resources, programs and incentives to aid our communities in meeting water use efficiency requirements as we work together in response to variable water year conditions and maintain supplies for beneficial use and instream needs.

Sincerely,

Jake Mackenzie, Chair
Water Advisory Committee
Council Member
City of Rohnert Park

David Rabbitt
Chair, Sonoma County Water Agency
Supervisor, County of Sonoma

SONOMA - MARIN
SAVING WATER
PARTNERSHIP

Partnership Achievements By the Numbers

Fiscal Year 2012/2013

122 rebates were issued to businesses for installing high-efficiency toilets.

501 guests visited the nine gardens that participated in the Second Annual Eco Friendly Garden Tour.

607 students graduated from the Qualified Water Efficient Landscaper (QWEL) and Spanish QWEL programs.

4,888 students received direct instruction; 2,679 in the classroom only program and 2,209 in the classroom and Field Study program.

8 businesses were certified through the Sonoma County Green Business Program sponsored by the Water Agency.

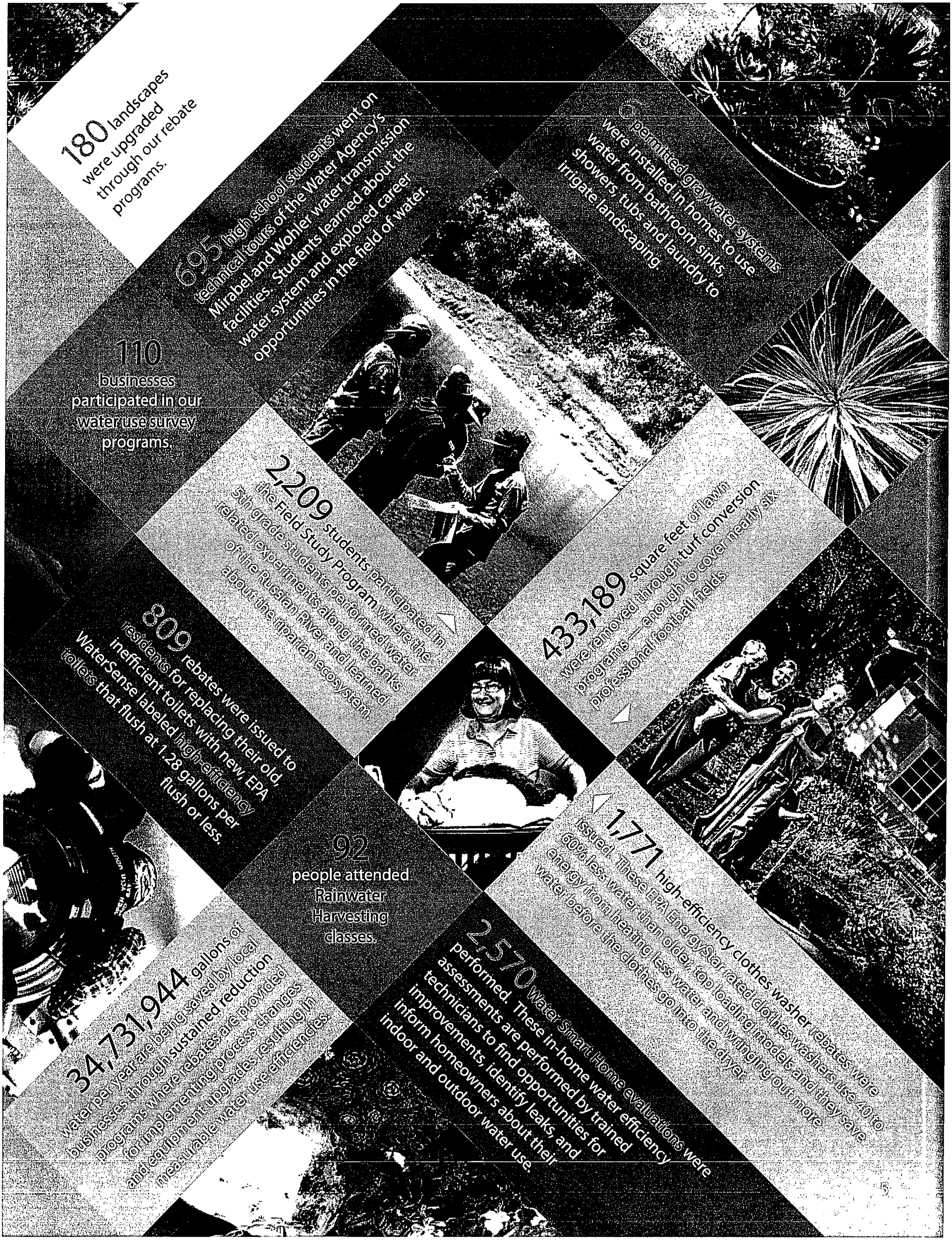
356 parents volunteered to chaperone their child's class during their field study visit to the Water Agency's Russian River Field Study Site near Forestville. The parents participated along with the students allowing the Field Study Program to reach adults as well as children.

8,777 students experienced "The Musical Watershed" performed by the ZunZun performing arts group in 37 shows at 25 different elementary schools.

16 laundry to landscape graywater systems were installed.

3,558 actions were inspired by the 350 Home & Garden Challenge.

26,962 students in 1,133 different classrooms received curriculum materials provided by the Water Education Program.



180 landscapes were upgraded through our rebate programs.

695 high school students went on technical tours of the Water Agency's Mirabel and Wohler water transmission facilities. Students learned about the water system and explored career opportunities in the field of water.

9 permitted graywater systems were installed in homes to use water from bathroom sinks, showers, tubs and laundry to irrigate landscaping.

110 businesses participated in our water use survey programs.

2,209 students participated in the Field Study Program where the 5th grade students performed water related experiments along the banks of the Russian River and learned about the riparian ecosystem.

433,189 square feet of lawn were removed through turf conversion programs — enough to cover nearly six professional football fields.

809 rebates were issued to residents for replacing their old, inefficient toilets with new, EPA WaterSense labeled high-efficiency toilets that flush at 1.28 gallons per flush or less.

92 people attended Rainwater Harvesting classes.

1,771 high-efficiency clothes washer rebates were issued. These EPA EnergyStar rated clothes washers use 40 to 60% less water than older, top loading models and they save energy from heating less water and wringing out more water before the clothes go into the dryer.

34,731,944 gallons of water per year are being saved by local businesses through sustained reduction programs where rebates are provided for implementing process changes and equipment upgrades resulting in measurable water use efficiencies.

2,570 Water Smart Home evaluations were performed. These in-home water efficiency assessments are performed by trained technicians to find opportunities for improvements, identify leaks, and inform homeowners about their indoor and outdoor water use.

Partnership Highlights

PROGRAM EXPENDTURES

Partners have pledged to fund water use efficiency programs. The baseline funding is established in the Memorandum of Understanding (MOU) and is based on historic water deliveries through the Water Agency's water transmission system, ensuring that programs will always be available to help residents use our water resources efficiently.

Minimum funding levels are presented in the orange bar in the table below along with Fiscal Year 12/13 expenditures.

For the Town of Windsor, additional required funding paid through a direct diversion water conservation sub-charge is not included with their MOU minimum. These additional funds are designated for the Town's water use efficiency programs and are included in their annual program expenditures.

The Water Agency's Water Use Efficiency Program is funded by the water contractors through the Water Conservation Sub-Charge as part of the Water Agency wholesale water rates. The amount of money deposited into the fund is calculated based on an estimate of the total costs for all regional Water Conservation Projects for each fiscal year.

The Sonoma-Marin Saving Water Partnership does not specify a minimum amount that should be utilized for regional programs.

Program Expenditures (in thousands of dollars)

	City of Cotati	Marin Municipal Water District	North Marin Water District	City of Petaluma	City of Rohnert Park	City of Santa Rosa	City of Sonoma	Valley of the Moon Water District	Town of Windsor	Sonoma County Water Agency	Regional Total
FY 12-13	$60	$1,279	$263	$461	$16	$965	$173	$180	$269	$1,510	$5,176
Minimum	$25	$177	$241	$242	$120	$557	$55	$72	$10	N/A	$1,500

ANNUAL MULTI-MEDIA PUBLIC EDUCATION CAMPAIGN

In response to the dry spring conditions, the Partnership doubled its annual public education campaign to encourage residents to voluntarily reduce water consumption. The Partnership launched the "20-Gallon Challenge" campaign to increase awareness of the water supply situation and as a call to action.

The campaign features a pledge to save 20 gallons per person per day. As an incentive to pledge, an entry for monthly prize drawings for high-efficiency toilets and clothes washers, rainwater catchment and graywater systems, and custom water-wise landscape designs were provided.

Pledges and contest entries were accepted from the entire Russian River Watershed to encourage both upper and lower Russian River water users to participate in the challenge.

2012 TEMPORARY URGENCY CHANGE PETITION

On March 29, 2013, the Water Agency submitted a report to the State Water Resources Control Board (SWRCB) in response to an Order approving a Water Agency request to modify in-stream flow requirements for the Russian River. The report highlighted two pilot projects focused on unaccounted water loss through residential meters and water use efficiency through customer awareness in addition to the Partnership's water use efficiency efforts.

The Temporary Urgency Change Petition, submitted on April 9, 2012, was needed to improve conditions for juvenile coho and Chinook salmon and steelhead rearing in the river.

On May 2, 2012 the SWRCB issued an Order approving the petition. Included as part of the Order, the SWRCB requested that the Water Agency provide a written update regarding activities and programs being implemented by the Partnership to assess and reduce water loss and promote increasing water use efficiency. The order acknowledged the Partnership's work to date with assigning landscape water budgets to dedicated irrigation accounts and the continued work on compiling with SBx7-7 targets.

PARTNERSHIP JOINS EPA WATERSENSE

In April of 2012, the Partnership became a Promotional Partner to the U.S. Environmental Protection Agency's WaterSense program. Both the Partnership and WaterSense share the goal of promoting efficient water use both indoors and out.

As a Promotional Partner, the Partnership is able to collaborate with and leverage the WaterSense program's national campaigns such as Fix-A-Leak Week and Sprinkler Spruce-Up while helping to get the word out about WaterSense labeled products and services.

The Partnership has a history of working with WaterSense since the program began, actively participating in the development of WaterSense labeling specifications to ensure that the WaterSense label only appears on high-performance, water efficient products that work. In 2008, the Partnership's Qualified Water Efficient Landscaper Program (QWEL) became one of the nation's first WaterSense Labeled professional certification programs. The Partnership continues to actively support and participate with WaterSense.

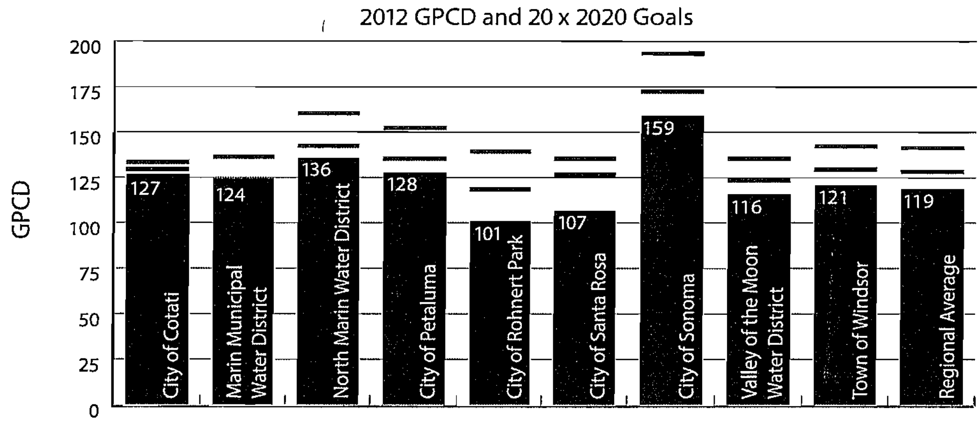
20 X 2020 GOALS

In 2009, SBx7-7 established a statewide goal, known as 20 x 2020, to reduce per capita water use 20% by the year 2020 with an interim goal of a 10% reduction by 2015.

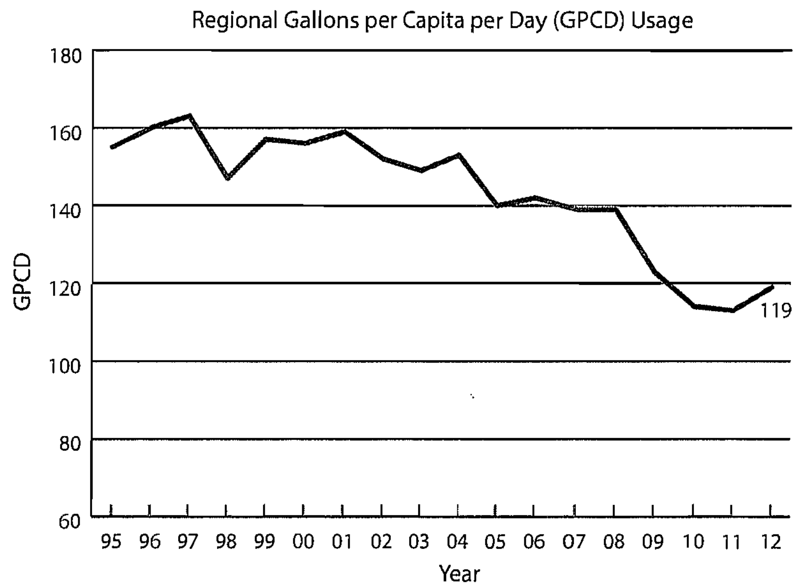
The chart to the right displays 2012 per capita water use in each Partner service area and the region as a whole. The 2015 and 2020 goals are indicated by the green and red lines, respectively.

While the chart shows that all Partners are currently meeting the 2020 targets, we recognize that water use efficiency must continue. Many factors can affect water use patterns as has been seen in recent years. The overall downward trend is a result of many factors including the California drought, economy, changes in weather conditions, and active water conservation programs.

It is important to continue the work on water use efficiency to maintain the savings already achieved and make sure the region captures all the benefits of future water savings.



2015 Target	134	137	161	153	140	136	194	136	143	142
2020 Target	130	124	143	136	119	127	173	124	130	129



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State Water Resources Control Board
Order 5/1/2013

Provision 18 – Progress of Santa Rosa Plain Groundwater Management Planning Program

March 31, 2014

Prepared by

Sonoma County Water Agency
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Santa Rosa, CA 95403

1 Introduction

This report has been prepared by the Sonoma County Water Agency (Water Agency) to fulfill the requirements of Provision 18 of the State Water Resources Control Board (State Board) Order dated May 1, 2013 (Order).

Provision 18 of the Order directs the Water Agency to take the following actions:

> SCWA shall provide a written update to the Deputy Director regarding the progress of the Santa Rosa Plain Groundwater Management Planning Program by March 31, 2014. The update shall include a discussion of: (1) progress being made toward implementation of groundwater recharge in the Santa Rosa basin; and (2) efforts by SCWA and its water contractors to conjunctively manage surface water and groundwater resources within SCWA's service area. Such management should emphasize the conservation and replenishment of groundwater resources and utilization of available surface water supplies to the extent feasible.

2 Santa Rosa Plain Groundwater Management Planning

In October 2011, the Water Agency's Board of Directors approved a workplan and a Cooperative Agreement with the Sonoma County Water Agency, County of Sonoma, City of Santa Rosa, City of Rohnert Park, City of Sebastopol, City of Cotati, Town of Windsor, and California-American Water Company to fund the preparation of a non-regulatory, voluntary groundwater management plan for the Santa Rosa Plain.

A Basin Advisory Panel (Panel) was convened in December 2011 and will guide the development and implementation of the groundwater management plan. The Panel is comprised of 30 members representing key groundwater interests: Agriculture (Dairies, Farmers & Grape Growers and Wineries); Business / Developers; Environmental; Government (Tribal, State, County, and Cities); Public Health; Rural Residential Well Owners; and Water Supply & Groundwater Technical Expertise. The Panel has met 19 times between December 2011 and March 2014 and has undertaken several actions including development of a charter, governance proposal, draft basin management objectives and components, recommended actions, prioritized an implementation schedule and formation of a Technical Advisory Committee, as well as funding and community forum subcommittees. In addition, the Panel has received presentations on different topics including groundwater basin conditions by United States Geological Survey scientists, regional and local water resource management strategies, enhanced recharge studies and programs, land use planning, and water quality programs. The Panel selected the Water Agency as the lead agency for developing the groundwater management plan and the Water Agency's Board of Directors, following a public hearing on October 23, 2012, adopted a Resolution of Intention to Prepare a Groundwater Management Plan for the Santa Rosa Plain of Sonoma County.

The Panel and Technical Advisory Committee will continue to meet on an approximate monthly basis to finalize elements of the groundwater management plan and integrate the results and findings of a numerical modeling of surface water and groundwater flow performed by the U.S. Geological Survey.

Panel members will continue briefing their constituencies and other interested organizations on the groundwater management plan development and four public forums are planned for May 2014 to present the overall content of the groundwater management plan and results of the U.S. Geological Survey modeling to the public. The groundwater management plan is projected to be completed in summer 2014 and will be considered by the Water Agency's Board of Directors for adoption at a publically noticed hearing. Should the plan be adopted, implementation of the plan would begin in fall 2014. Further information regarding the Santa Rosa Plain Groundwater Management Planning Program can be found on the program website www.scwa.ca.gov/srgroundwater/.

3 Groundwater Recharge and Conjunctive Management Efforts

Among other strategies, the Water Agency and its local partners, including many of its Water Contractors, are evaluating opportunities to enhance the existing conjunctive use of the region's surface water and groundwater resources. The Water Agency's Water Supply Strategies Action Plan identifies enhancing groundwater recharge through groundwater banking and stormwater recharge as primary strategies that emphasize the conservation and replenishment of groundwater resources and utilization of available surface water supplies to the extent feasible. Updates on the status of two studies the Water Agency and its local partners are conducting to pursue these strategies are summarized below:

Groundwater Banking Feasibility Study: To improve the reliability of future water supplies (both surface water and groundwater), the Water Agency partnered with the Cities of Cotati, Rohnert Park and Sonoma, the Town of Windsor and the Valley of the Moon Water District to conduct a feasibility study for a regional groundwater banking program. The feasibility study investigated the viability of enhancing the conjunctive management of surface water and groundwater resources. Conceptually, the groundwater banking program would involve the diversion and transmission of surplus Russian River water produced at existing drinking water production facilities during wet weather conditions (i.e., the winter and spring seasons) for storage in aquifers beneath the Santa Rosa Plain and/or Sonoma Valley . The stored water would then be available for subsequent recovery and use during dry weather conditions (i.e., the summer and fall seasons) or emergency situations. The Water Agency and the study participants are exploring groundwater banking in a systematic and phased approach utilizing information obtained from completed and ongoing scientific studies and groundwater management activities sponsored by the Water Agency and its partners.

A regional feasibility study report was completed in June 2013. The following primary findings from the study will provide a framework for developing a groundwater banking program:

- The groundwater banking program would provide enhanced reliability of the regional water supply during droughts, natural hazard events (e.g., earthquakes), and periods of peak seasonal water demands.

- Additional potential benefits include improved habitat conditions by enhancing tributary base flows by reducing groundwater pumping, or in the case of Dry Creek, reducing summer releases from Warm Springs Dam (due to reduced peak demands) thus improving flow conditions for ESA-listed salmonids.

- Facilities owned and operated by the study participants, including drinking water production facilities along the Russian River and groundwater supply-wells within the two groundwater basins, are well-suited for further testing and developing a groundwater banking program in an incremental and phased manner.

- There appears to be adequate wintertime Russian River water supplies, transmission system capacity, and aquifer storage space to meet preliminary conceptual storage targets through a combination of in-lieu and direct groundwater recharge.

- The quality of drinking water from the Water Agency and Town of Windsor's drinking water facilities and conveyance piping indicate that the potential source water represents an excellent candidate for direct recharge and Aquifer Storage and Recovery (ASR) operations.

- Evaluation of regional hydrogeologic and geochemical conditions has identified 14 potential groundwater banking alternatives in the Santa Rosa Plain and Sonoma Valley, which include a combination of indirect (in lieu) and direct (surface spreading and ASR) recharge methods. Of the two direct recharge methods, ASR is deemed to be the most practical to implement in the near term based on: (1) the ability to incrementally establish an ASR program; (2) the ability to pilot test ASR alternatives in a phased manner; (3) the relatively lower costs associated with ASR; and (4) uncertainties related to the ability of surface spreading alternatives to convey water to aquifers suitable for storage and subsequent recovery.

Based on the above summary of findings, several recommended next steps for establishing a groundwater banking program have been identified and initiated:

- Suitable locations for performing pilot-scale ASR demonstration testing consisting of existing active and inactive municipal supply wells are being evaluated.

- Site-specific groundwater quality data from existing wells deemed suitable for pilot-scale ASR testing have been collected, analyzed, and incorporated into a geochemical model, along with the source water quality data, to assess the potential interaction between the source water and native groundwaters.

- Work plans for performing pilot-scale demonstration testing are being developed for each of the study participants. The work plans will incorporate site-specific hydrogeologic, engineering, and water quality information and form the basis for designing and permitting a pilot-scale ASR demonstration test.

- Briefing of local stakeholders has been accomplished through sharing information on this study at regular Sonoma Valley and Santa Rosa Plain Basin Advisory Panel meetings.

- Briefings and discussions with representatives of the San Francisco Bay and North Coast Regional Water Quality Control Boards (RWQCBs) have occurred to identify permitting requirements for pilot-scale ASR demonstration testing.

- Identifying funding sources for performing pilot-scale demonstration testing. Potential funding sources include grants through the California Department of Water Resources Integrated Regional Water Management program and recent Drought-Relief funding.

- Initiating preparation of permit applications for performing the pilot-scale ASR testing from applicable regulatory entities, including Regional Water Quality Control Boards, the State Water Resources Control Board and the California Department of Public Health.

Based on the results of pilot-scale demonstration testing, full-scale groundwater banking programs and facilities would be designed and developed.

<u>Stormwater Management & Groundwater Recharge Scoping Studies:</u> In three of its flood zones, the Sonoma County Water Agency is identifying opportunities to alleviate flooding, while recharging groundwater aquifers and providing other benefits. The "Stormwater Management-Groundwater Recharge" studies are currently assessing the feasibility of projects in Laguna-Mark West watershed, the Sonoma Valley watershed and the Upper Petaluma River watershed.

The goal of the initial scoping studies (one in each watershed) is to establish the project objectives, identify potential project concepts, and determine, at a preliminary level, the technical and practical feasibility of projects that would reduce flooding while providing additional community benefits. These benefits could include groundwater recharge, water quality improvements, water supply improvements, improved ecosystem functions, preservation of agricultural land use, preservation or enhancement of open spaces, system sustainability or benefits like recreation, public access or education.

To accomplish this goal, consultants in each watershed are collecting and assessing technical data and information about the watersheds, and have met with active stakeholders to discuss project objectives and goals and to solicit ideas on potential projects. The second phase of the studies is to identify possible project opportunities and evaluate at a more detailed level the feasibility of implementing those projects, as indicated by the following process timeline.

- **Phase 1 –** Initiated in December 2010. Draft studies were submitted in Spring 2011. Stakeholder input was provided in Spring-Summer 2011.
- **Phase 2 –** Based on comments received in Phase 1, consultant teams updated the studies and identified possible project areas. Meetings were held in fall and winter 2011-2012 to discuss findings with stakeholders, community members, and regulators.
- **Phase 3 –** For those projects where partners and potential partners express interest, the Water Agency is moving forward with engineering and other supporting studies. The goal is to be positioned to take advantage of potential grant and other funding sources. Where grant funds have already been secured, project designs are proceeding.