

California Regional Water Quality Control Board  
North Coast Region

**Laguna de Santa Rosa TMDL**

**Monitoring Plan**

June 2008

## 1.0 INTRODUCTION

The Laguna de Santa Rosa (Laguna) watershed was added to the 2002 California Section 303(d) list of impaired waterbodies for excessive nutrients (nitrogen and phosphorus), low dissolved oxygen (DO), high temperature and mercury in fish tissue. Staff of the North Coast Regional Water Quality Control Board's (Regional Water Board) Total Maximum Daily Load (TMDL) Development Unit are scheduled to complete the technical analyses for the Laguna TMDLs (excluding mercury) by 2011.

This Work Plan provides background information on TMDLs (Section 1) and presents Regional Water Board staff's planned approach for developing the Laguna TMDLs (Section 2). In addition, Regional Water Board staff's working hypotheses regarding conditions in the Laguna watershed are discussed (Section 3). Finally, a Monitoring Plan for the Laguna TMDL is presented (Section 4).

### *1.1 TMDL Background*

Section 303(d) of the federal Clean Water Act requires states to identify waterbodies that are impaired, to identify the particular pollutant(s) or stressor(s) that are causing impairment, and to develop a plan (the TMDL) to attain and maintain desired water quality conditions. An "impaired" waterbody is one that is not meeting water quality standards, which refers to the beneficial uses and water quality objectives of the waterbody, as stated in the North Coast Water Quality Control Plan (Basin Plan). A "beneficial use" refers to the designated uses of a waterbody, including municipal drinking water, agricultural supply, recreation, and habitat for cold water fish, to name a few. A "water quality objective" is a number or narrative description of the desired condition associated with a particular water quality parameter.

There are four steps to developing a TMDL. The first step is developing a Technical TMDL. The second step is developing an Implementation Plan, which outlines a strategy and schedule to achieve pollutant load reductions. The third step involves getting approval of the TMDL and Action Plan by the Regional Water Board, the State Water Resources Control Board, and the U.S. EPA, and thus incorporating the TMDL into the Basin Plan. The fourth step is implementing the TMDL Action Plan. Regional Water Board staff are now working on the first step of the Laguna TMDLs.

The Technical TMDL describes conditions in the watershed and includes a number of key elements.

- The **Problem Statement** characterizes water quality problem(s). It identifies water quality indicators and associated numeric targets, which are quantitative

or narrative measures of desired waterbody-specific conditions. Targets can vary from place-to-place and from season-to-season.

- The **Source Analysis** quantifies the natural and human-related sources of the pollutant(s) or stressor(s) that are causing impairment.
- The **Linkage Analysis** draws links between land use conditions and water quality conditions.
- The **TMDL Loading Capacity** determines how much of the pollutant(s) or stressor(s) the waterbody can handle while still supporting the beneficial uses.
- Finally, the **Load Allocations** determine how much, if any, the identified sources need to be reduced in order to achieve the target conditions.

## 2.0 SCOPE AND APPROACH

### 2.1 Scope of Laguna TMDLs

The overarching water quality goal for the Laguna de Santa Rosa watershed is to bring dissolved oxygen (DO) and other water quality constituents to environmentally appropriate, sustainable levels that support the beneficial uses of the Laguna channel and its tributaries. Dissolved oxygen levels are centrally important because they provide a direct limiting factor for many forms of aquatic life, and can shift the composition of the aquatic community. At the same time, low DO levels are a physical expression of other imbalances in the system, and are potentially affected by organic matter, suspended or re-mobilized sediment, nutrients, and water temperature.

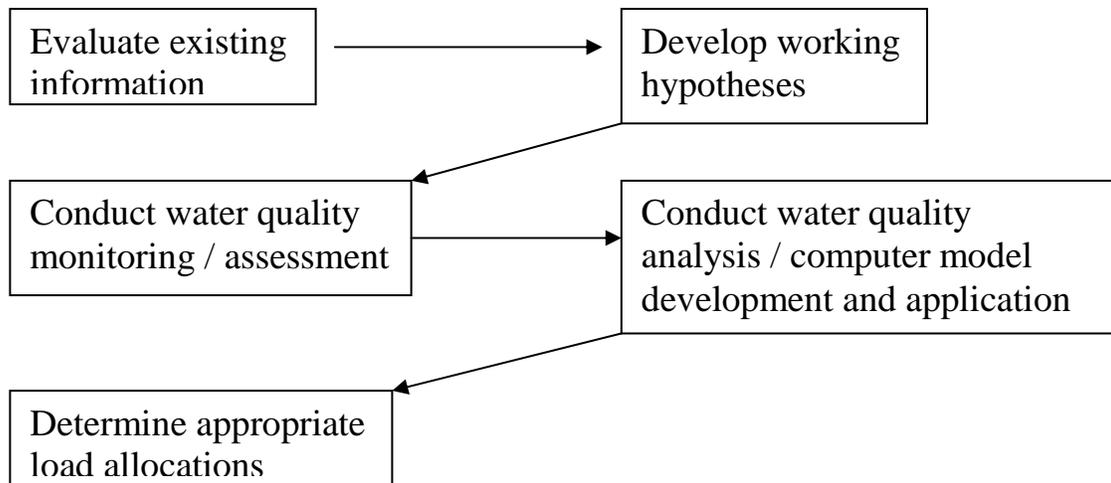
The listing of the Laguna for dissolved oxygen on the Section 303(d) list applies to the entire Laguna watershed, including the main Laguna channel and all surface waters that flow into it. This does not necessarily mean, however, that the entire Laguna watershed is impaired by low dissolved oxygen. Dissolved oxygen levels are known to vary wildly in the Laguna. Unlike other major surface waters on the north coast, the hydrology of the Laguna main channel has been compared to a series of basins or “bathtubs” connected by slow-moving rivers. Many of the deeper areas are highly stratified. Santa Rosa and Mark West Creeks appear to be well-mixed throughout the year down to their confluence with the Laguna channel. Other streams, especially those crossing long distances along the Santa Rosa Plain in the southern Laguna, have very low levels of dissolved oxygen during summer months.

A primary objective of the TMDL development process is to determine the areas within the Laguna watershed that are impaired – reach by reach. This way, restoration plans and regulations can be tailored to the areas of the watershed that are directly impaired and those areas that have been demonstrated to contribute to impaired conditions. Ultimately, the TMDL Implementation Plan will apply only to those areas of the Laguna watershed that are impaired and those areas that potentially contribute to the impaired conditions.

Priorities for dissolved oxygen studies in other North Coast watersheds have been based on the most sensitive beneficial uses. Salmonid spawning and rearing are the most sensitive beneficial uses to low DO levels. Laguna DO targets will be established based on assessment of natural conditions and conditions necessary to supporting sensitive salmonid uses. This means that we need to place attention both on the migratory corridor along the mainstem Laguna, and on the Laguna tributaries where spawning and rearing occur. We don't expect DO levels to be as low in the upper watershed, but these tributaries are the location of greatest salmonid DO requirements. Thus, an important initial phase of TMDL development will be to characterize the pattern of DO impairment, and how this correlates to salmonid distributions and other aspects of the biological community. Fisheries biologists do not believe that salmonids have ever used the mainstem Laguna channel during summer months; thus, other warm-water fish species or aquatic invertebrates must be chosen as indicator species.

## ***2.2 Conceptual Approach and Schedule for Developing Dissolved Oxygen TMDL***

The conceptual approach to developing the Laguna TMDLs is presented in the following flow chart.



The specific tasks for completing the key elements of the TMDLs are:

*Problem Statement*

- Review existing water quality, fisheries, and land use information
- Conduct literature review on various topics including dissolved oxygen requirements of salmonids, factors affecting dissolved oxygen levels in rivers, and water quality conditions associated with various land uses.

*Source Analysis*

- Conduct water quality and flow monitoring throughout Laguna watershed
- Estimate source loads from existing and newly collected information.

*Linkage Analysis*

- Analyze and interpret existing and newly collected water quality and flow monitoring data
- Calibrate and validate water quality model(s) as needed

*Loading Capacity*

- Apply computer model to assess natural conditions
- Compare modeling results to Water Quality Objectives

*Load Allocation*

- Apply computer model to evaluate possible management scenarios to achieve water quality objectives.

### **3.0 KEY QUESTIONS FOR TMDL DEVELOPEMENT**

The Regional Water Board has developed the following set of questions for developing the Laguna TMDLs.

#### **1. Are dissolved oxygen and temperature objectives being met in the Laguna de Santa Rosa watershed?**

*Hypothesis #1:*

DO and temperature levels vary spatially and temporally (seasonal and diurnal variation) in the Laguna watershed. Dissolved oxygen levels fall below the minimum Basin Plan objective in some reaches, especially in the early morning hours during the summer months. Temperature levels exceed Basin Plan Objectives in the late afternoon hours during the summer months.

*Information Needed to Test Hypothesis #1:*

DO and temperature sampling will be conducted to more completely characterize the spatial and temporal variability of dissolved oxygen levels in the Laguna and its tributaries. Measurement of DO concentrations should be conducted twice monthly at multiple locations in the Laguna and at significant tributaries. These DO measurements should be conducted in early morning hours to capture the lowest diel values. Temperature should also be conducted at multiple locations within the Laguna and tributaries. Continuous temperature monitoring instruments should be deployed at selected locations during the summer and early fall period.

#### **2. Do dissolved oxygen and temperature levels contribute to impairment of the beneficial uses of the Laguna watershed?**

*Hypothesis #2:*

The historic, current and future beneficial uses of the Laguna vary with environmental characteristics in different parts of the Laguna. DO and temperature levels currently do not meet water quality objectives. These objectives have been adopted as threshold criteria that infer impairment of beneficial uses.

*Information Needed to Test Hypothesis #2:*

Use available data and targeted field investigation to identify which beneficial uses may be impaired by DO levels in all locations within the Laguna and along tributaries in the watershed. Information collection should target the most sensitive beneficial use in each location and seasonal time period. In most locations within the watershed the most sensitive use will likely be impacts to

salmonids (e.g., COLD, MIGR, and SPAWN uses). A more complete assessment of salmonid distribution should be assembled, including maps identifying the distribution of various life stages of salmonids present in the Laguna watershed at different times of year. The salmonid distributional data should be assessed with data collected on DO and temperature.

### **3. What are the driving processes / factors affecting dissolved oxygen levels in the Laguna watershed?**

#### *Hypothesis #3:*

Low dissolved oxygen levels in the Laguna waterways are caused by oxygen consumption either by algae and macrophyte respiration, or by microbial decomposition of organic material in the water column and sediments. Sources of organic material include allochthonous terrestrial sources (including point source discharges) and autochthonous in-stream sources from vegetative senescence. Excessive nutrients (phosphorus and nitrogen) increase algal and macrophyte biomass impacting DO levels within the Laguna and watershed tributaries.

#### *Information Needed to Test Hypothesis #3:*

Information should be collected to support the calibration and validation of a predictive water quality model. The WASP model supported by the USEPA can be used to investigate the relationships between sources and processes within the Laguna. The WASP model allows evaluation of stratification effects. Data needed to develop a WASP model are:

- Sampling the Laguna and major tributaries for the constituents DO, nutrients, TSS and BOD. This information should be used for model boundary conditions, initial conditions, and model calibration/validation.
- Sampling the Laguna for chlorophyll, phaeophytin, and plankton speciation to assess productivity and biomass.
- Measuring the Laguna for DO and temperature to assess the spatial and temporal extent of stratification.
- Measuring the Laguna for DO and temperature to assess the spatial and temporal extent of diel variation.
- Measuring the Laguna and major tributaries for stream flow to provide data for the WASP model transport variable.
- Compile from other sources or conduct surveys for additional information needed by the WASP model including reach channel dimensions.

### **4. What are the driving processes / factors affecting temperature levels in the Laguna watershed?**

#### *Hypothesis #4:*

High temperature levels in the Laguna waterways are caused by altered riparian and channel habitat. Three major factors contribute to high temperature levels:

(1) Lack of riparian cover, (2) low channel width to depth ratio caused on excessive sediment deposition, and (3) nuisance flow originating from storm sewers and irrigation return discharges. The SSTEMP model supported by the USGS can be used to evaluate the relationship of these factors on stream reach temperature levels. The WASP model supported by the USEPA contains a heat module that can route heat between reaches within the Laguna watershed. Data needed to develop the SSTEMP and WASP models are:

*Information Needed to Test Hypothesis #4:*

- Sampling the Laguna and major tributaries for continuous temperature through summer and early fall.
- Measuring the Laguna and major tributaries for stream flow to provide data for the SSTEMP model.
- Compile from other sources or conduct surveys for additional information needed by the WASP model including reach riparian cover and watershed meteorological data.

*Sampling Location Selection:*

Existing water quality and flow data were compiled and reviewed to locate target sampling areas for water quality research that will support development of a computer model. Existing data vary in quality and in geographic coverage. To develop this Work Plan, several field reconnaissance surveys were conducted. Sampling locations have been initially selected. However, there are substantial physical and logistical barriers to addressing all of the monitoring questions. Access to the channel and many of the tributaries is a problem, as many areas run through private property. Maps and data sets often do not adequately describe variation water depth, and locations that look promising on paper may become completely dry later during the summer sampling season.

## **4.0 MONITORING PLAN**

This Monitoring Plan outlines the monitoring that Regional Water Board staff plan to complete to develop the Laguna TMDLs. Rationale for the specific monitoring tasks is presented in the previous sections.

### ***4.1 Quality Assurance Project Plan***

Regional Water Board staff have developed a *Laguna de Santa Rosa TMDLs Quality Assurance Project Plan* (QAPP). The QAPP outlines data quality objectives, sampling procedures, equipment calibration and reporting, quality control procedures, and documentation. Water quality monitoring conducted by Regional Water Board staff will be done according to this QAPP.

### ***4.2 Tasks***

Outlined in the following pages:

## **Task 1: Dissolved Oxygen (DO) Measurements**

### ***Objectives:***

- To test Working Hypothesis #1, 2 and 3.
- To characterize the temporal and spatial variation of dissolved oxygen levels and ancillary constituents throughout the Laguna watershed.

### **What:**

- Instream instantaneous measurements of DO, temperature, pH, and DO saturation.

### **Where:**

- Initial measurements will concentrate on the locations identified in Section 5.0 of this plan. (28 Sites Total).
- Locations may be moved upstream or downstream (where possible) to track spatial movement of low DO values over time. The focus will be to locate the reaches where the DO water quality objective is not being achieved (i.e., 7.0 mg/L)

### **When:**

- Once every 2 weeks from June – November 2008

### **How:**

- Instream YSI 6600 Sonde measurement with air calibration

## **Task 2: Temperature Measurements**

### ***Objectives:***

- To test Working Hypothesis #1, 2, 3 and 4.
- To characterize the temporal and spatial variation of instream water temperature levels in the Laguna watershed.

### **What:**

- Instream continuous measurements of temperature.

### **Where:**

- Temperature measurements will be collected at the 28 Sites identified in Section 5.0 of this plan.

### **When:**

- Once every 30 minutes from June – November 2008

### **How:**

- Hobo temperature probes will be deployed following the *Forest Science Project Stream Temperature Protocols*

### **Task 3: Stratification Measurements**

#### ***Objectives:***

- To test Working Hypothesis #2, 3 and 4.
- To characterize the temporal and spatial variation of stratification in the Laguna watershed.

#### **What:**

- Instream instantaneous measurements of temperature and DO.

#### **Where:**

Profile measurements will be collected from the Laguna at the following bridges:

1. Laguna at Sebastapol Pond
2. Laguna downstream of Occidental Road (USGS 11465750 Gage and CDFG WQ site)

#### **When:**

- Once every 2 weeks from June – November 2008

#### **How:**

- Instream YSI 6600 Sonde measurement with air calibration

#### **Task 4: Diel Measurements**

##### ***Objectives:***

- To test Working Hypothesis #2, 3 and 4.
- To characterize the temporal and spatial variation of diel patterns in dissolved oxygen and temperature levels in the Laguna watershed.

##### **What:**

- Instream continuous measurements of DO and temperature collected over several 24-hr periods

##### **Where:**

- DO, temperature and pH measurements will be collected at the 28 Sites identified in Section 5.0 of this plan.

##### **When:**

- Once every 2 weeks from June – November 2008
- Scheduling of measurements for each site for Task 1 will be staggered throughout the sampling season to be taken BOTH in the early morning hours (before 10:00) to assess maximum DO level depression AND in late afternoon hours (after 13:00) to assess maximum thermal stratification.

##### **How:**

- Instream YSI 6600 Sonde measurement with air calibration

## **Task 5: Stream Flow Measurements**

### ***Objectives:***

- To test Working Hypothesis # 3.
- To characterize the temporal and spatial variation of stream flow levels in the Laguna watershed.

### **What:**

- Instream instantaneous measurements of stream flow.

### **Where:**

- Measurements will be collected at all sites.
- Flow measurement will not be collected at the 3 sites with USGS continuous flow gaging stations (LSPR, LOR1, and SRWR).
- Additional tributary stream flow measurements will be collected upstream or downstream (where possible) to track spatial movement of flowing water over time. The focus will be to locate the reaches where surface flow is perennial and those that are ephemeral.

### **When:**

- Once every 2 weeks from June – November 2008

### **How:**

- USGS protocol (Rantz, 1982) using 2 methods depending on site conditions:
  1. SonTek Acoustic Doppler Velocimeter (ADV) for wadable streams
  2. Float method for low sheet flows

## **Task 6: Pollutant Sampling**

### ***Objectives:***

- To test Working Hypothesis # 3.
- To characterize the temporal and spatial variation of pollutant levels in the Laguna watershed.

### **What:**

- Grab water samples for these pollutants: TSS, BOD<sub>5</sub>, NH<sub>3</sub>, NO<sub>3</sub>, TKN, SRP, TP, Total Hg
- Note that Mercury sampling is being conducted for a future TMDL Project.

### **Where:**

- Samples will be collected from all 28 Sites identified in Section 5.0 of this plan.
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### **When:**

- Tributary sites will be sampled three (3) times during June 2008 (except for Total Hg)
- Nine sites on the mainstem Laguna and Santa Rosa Creeks will be sampled only one (1) time during June 2008. The reduced sample frequency for these sites is due to an end of fiscal year budget constraint.
- Total Hg will be sampled at each site only one (1) time during June 2008.
- All sites will be sampled three (3) times during September 2008 if flowing water exists.
- All sites will be sampled three (3) times during late fall or early winter after base flows have returned. However, samples will not be collected within 72-hours after a storm event.

### **How:**

- Grabs samples sent to *Basic Labs* for analysis.
- Triplicate samples will be collected once for each pollutant at a randomly selected site.
- Field blanks will be submitted to the lab for each pollutant at a randomly selected site.

## **Task 7: Productivity Measurements**

### ***Objectives:***

- To test Working Hypothesis # 3.
- To characterize the temporal and spatial variation of phytoplankton levels in the Laguna watershed.

### **What:**

- Grab samples of chlorophyll and phaeophytin concentrations with accompanying instream measurements of fluorescence.

### **Where:**

- Collect a longitudinal profile of near surface fluorescence measurements of along the thalweg of the 2 Laguna lentic areas (LSEB & LOR1 Occidental Road Pond), and 3 lotic areas (LTOD, SRWR, and LTHR).
- Collect grab samples for chlorophyll and phaeophytin analysis at 5 locations along the LOR1 thalweg, 3 locations along the LSEB thalweg, and each of the 3 lotic areas. The grab samples will be used to produce a calibration curve for converting the fluorescence measurements into chlorophyll measurements.

### **When:**

- Fluorescence measurements twice-monthly from August – November 2008
- Chlorophyll and phaeophytin concentrations will be collected monthly. New calibration curves will be derived monthly.

### **How:**

- Turner Design Fluorometer using EPA Method 445.0
- Grabs samples sent to *Basic Labs* for chlorophyll and phaeophytin analysis.
- Triplicate grab samples will be collected once each month at a randomly selected site.

## **Task 8: Phytoplankton Composition Sampling**

### ***Objectives:***

- To test Working Hypothesis # 3.
- To characterize the temporal and spatial variation of phytoplankton composition in the mainstem Laguna.

### **What:**

- Sample the phytoplankton community composition of the mainstem Laguna

### **Where:**

- Collect spaced samples along a longitudinal profile of the mainstem Laguna thalweg during Fluorometric measurements.

### **When:**

- Monthly from August - November 2008

### **How:**

- Olympus Compound Microscope using dichotomous key qualitatively identify the most abundant phytoplankton species to the lowest taxa possible using an Sedwick-Rafter counting cell aliquot (Lind, 1974)

## 5.0 SAMPLING LOCATIONS

- Samples and field measurements will be collected at 18 tributary locations, 7 Laguna mainstem locations and 3 Santa Rosa Creek mainstem locations (28 Sites Total - see table below).
- Locations in the Upper Laguna watershed will be monitored during one week and locations in the Lower Laguna Watershed will be monitored the subsequent week. The cycle will be repeated through the summer.

Site Name	Site ID	Replicate	Blanks
Wilfred Creek	WIL1	TP	
Laguna at Stony Point Rd	LSPR	TSS	
Hinebaugh Creek	HIN1		TP
Copeland Creek	COP1		
Laguna Headwater	LHW1		TKN
Cotati Creek	COT1		
Washoe Creek	WAS1		
Gossage Creek	GOS1		TSS
Colgon Creek	COL1		
Turner Creek	TUR1		NO3
Blucher Creek	BLU1		
Laguna at Todd Rd	LTOD	SRP	
Laguna at JR Trail	LJRT		
Laguna at Sebastapol Pond	LSEB		
Laguna at Occidental Pond	LOR1	NO3	
Brush Creek	BRU1	BOD5	
Santa Rosa Creek Headwater	SRHW	TKN	
Mantanzas Creek	MAN1		
Santa Rosa Creek at Fulton Rd	SRFU		
Piner Creek	PIN1		
Peterson Creek	PET1		
Abramson Creek	ABR1		
Santa Rosa Creek at Willowside Rd	SRWR	NH3	
Vine Hill Creek	VIN1		NH3
Mark West Creek	MWC1		SRP
Laguna at River Rd	LRR1		THg
Laguna at Trenton-Healdsburg Rd	LTHR	THg	
Windsor Creek	WIN1		BOD5

Wilfred Creek (Bellevue Flood Control Channel)

Map 424 C4 @ Stony Point Rd

- Sample at USGS Gage Site
- Park on SW corner of Bridge
- Mouth just past USGS Gaging House
- Sample the small low flow channel.



Approach on North Bank



Site down hill

Laguna at Stony Point

Map 424 C4 @ Stony Point Rd

- Same as Above
- Continuous USGS Gage Site
- Park on SW corner of Bridge
- Collect samples from bridge shoulder with a bucket or along the bank next to Gage House



Downstream



Upstream

## **Hinebaugh Creek**

Map 424 E4 @ Labath Ave

- Good on-street parking.
- Good access SE side of bridge next to CHP office
- Confined channel with grass bank upstream good for flow measurement



Downstream

Upstream

## Copeland Creek

Map 404 F5 @ Commerce Blvd

- Park at the City Admin Office on the cross street Avram Ave
- Best direct access is on NE corner of bridge. Small trail under bridge. Some flow seen.
- Better access with some pruning 100' upstream on North side of Creek behind KFC
- Good confined channel with grassy bank for flow measurement at upstream site.



Upream Access location



Upstream Site



Upstream of Bridge

### Laguna Headwaters

Map 444 G1 @ Benson Rd

- South on Old Redwood Hwy in Cotati, just east of Veterans Park
- Park on the Benson Rd Bridge
- Good access and some flow observed



Downstream



Upstream

### Cotati Creek

Map 444 F1 @ Page Street

- South on Old Redwood Hwy just past downtown Cotati.
- Right on Page Street and Park at Delano Park
- Access is on SE side of the Pedestrian bridge down a steep brick stepped bulkhead
- Concrete channel
- Visible sheet flow over concrete. Need to use float method at low flow.



Upstream



Downstream

## Washoe Creek

Map 424 D6 @ Derby Lane

- Park at SCWA gate.
- Easy access down bridge bulkhead
- Flowing water seen on concrete. Need to use float method at low flow.



Upstream



Downstream

## Gossage Creek

Map 424 C6 @ Hwy 116

- Good parking on North side of Hwy 116 just across from large Red Barn
- Access down bank at NE side of bridge
- Flow visible on concrete spill. Need to use float method at low flow.



Downstream

Colgan Creek

Map 423 J1 at Llano Rd

- Park of shoulder NW side of bridge
- Access down bank
- Seasonal USGS Gage site
- Good channel for flow measurement



Downstream



Upstream

Turner Creek

Map 423 J4 @ Daywalt Rd

- Park on shoulder
- Access NW side of bridge.
- May need additional pruning for access.
- Measure flow 50' downstream along West bank.



Downstream



Upstream

**Blucher Creek**

Map 423 G2 @ Lone Pine Road

- Park NW side of bridge
- Access NE side of Bridge
- Good place for Flow measurement.
- Need to modify channel by moving rip rap around for a constricted channel



Downstream

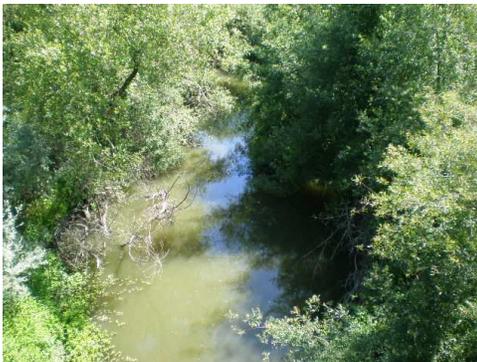


Upstream

**Laguna at Todd Road**

Map423 H1 @ Todd Rd

- Safe to work from Bridge
- Access to water on SW side of Bridge
- Flow measurement at flow constriction just upstream of bridge



Downstream



Upstream

**Laguna at Joe Rodata Trail**

Map 403 D4 off Joe Rodata Trail @ Petaluma Ave

- Park at Public Lot in Sebastopol off Petaluma Drive next to Hop Monk Brewery
- Hike trail ¼ mile to pedestrian bridge.
- Access down trail on NW side of bridge



Downstream

Upstream

**Brush Creek and Santa Rosa Creek headwaters confluence**

Map 385 A4 @ Hwy 12

- East on Hwy 12 make right just past Brush Creek Rd onto Streamside Drive
- Work through the neighborhood to the SW corner
- Park near the Pedestrian Bridge over Brush Creek
- Follow the Trail south along the east bank of Brush Creek to area with flat boulders
- Sample BOTH Brush Creek and Santa Rosa Creek upstream of the confluence
- Many good locations for flow measurements on both Creeks.
- Seasonal USGS Gage house upstream of confluence on North side of Hwy 12



Brush Creek near mouth



Santa Rosa Creek Upstream

Downstream

### **Mantanzas Creek**

Map 384 G6 @ Brookwood Road

- Park on shoulder right on bridge.
- Easy trail access on SE bridge corner
- Caution with homeless people living under bridge
- Best flow measurement under bridge on the downstream side



### **Santa Rosa Creek**

Map 383 J5 @ Fulton Rd

- Park in trailhead access SE side of bridge.
- Good access down SE side of bridge.
- Measure flow North side of bridge pier



Piner Ck

Map 383 J5 @ Fulton Rd

- Park in neighborhood NE side of bridge (Cadence Way)
- Access on SE corner of Bridge



Upstream

Downstream

Peterson Creek

Map 383 H4 @ Guerneville Rd

- Access through SCWA gate off of Guerneville Rd
- Drive to mouth along Creek levy.
- Access under pedestrian Bridge to concrete area at the mouth.



Mouth at Santa Rosa Creek



Pedestrian Bridge

Abramson Creek

383 F4 @ Guerneville Rd.

- Paved Shoulder Parking on North side
- Downstream access over fence to the right of SDWA “No Trespass” Sign
- Clear area under bridge good for flow measurement



Upstream



Downstream



Downstream access to right of fence

Santa Rosa Creek

Map 383 E5 @ Willowside Rd

- Easy parking along side the road. This is a trailhead.
- Easy access under south side of bridge.
- Good flow measurement location just downstream of bridge.
- Continuous USGS Gage site



Downstream

Looking Upstream

Laguna at Occidental Road

Map 383 C7 @ Occidental

- Park in area 150' east of bridge
- Follow path along fence (not the road shoulder)
- Continuous USGS gage site
- **NOT Safe to work from bridge due to small shoulder and heavy traffic**



Upstream

Downstream

Vine Hill Creek

Map 383 A3 @ Laguna Rd

- Park on shoulder near driveway on east side of Laguna Rd
- Site access 50' up private driveway ... We have access permission. (see Address sign below).
- Measure flow inside culvert with float method.



Upstream Access Point

Downstream



Private drive sign post

Mark West Creek

Map 363 C6 @ Slusser Rd

- Park at turnout 100' NE from Bridge
- Access only at NE side through some berry brush
- Best flow measurement directly below bridge



Downstream

Upstream

## Laguna at River Road

Map 363 A6 @ River Road

- Park under the River Road Bridge at the end of Trenton Rd
- Trail down to Laguna.
- Pruned berry plants on 23 May. Trail may need future pruning for continued access.
- Good site for flow measurement 50' downstream of trail access off of small rip rap area.



Access trail going east to the Laguna



Upstream



Downstream

### **Laguna at Trenton-Healdsburg Road**

Map 362 J5 @ Trenton –Healdsburg Rd

- USGS Gaging station discontinued (Why?)
- Park on shoulder NW side of bridge
- Access to stream on NW side of bridge



### **Windsor Creek**

Map 363 B3 @ Mark West Station Rd

- Park in SW turnout
- Easy access both sides of the bridge
- Best flow measurement location just upstream of bridge, Next best is 50 yards downstream.



Upstream



Downstream

## 6.0 REFERENCES CITED

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