Estero Americano Watershed Sediment Reduction Project, Phase II, Sonoma and Marin Counties, CA

Draft Quarterly Monitoring Report
Item B.4.2

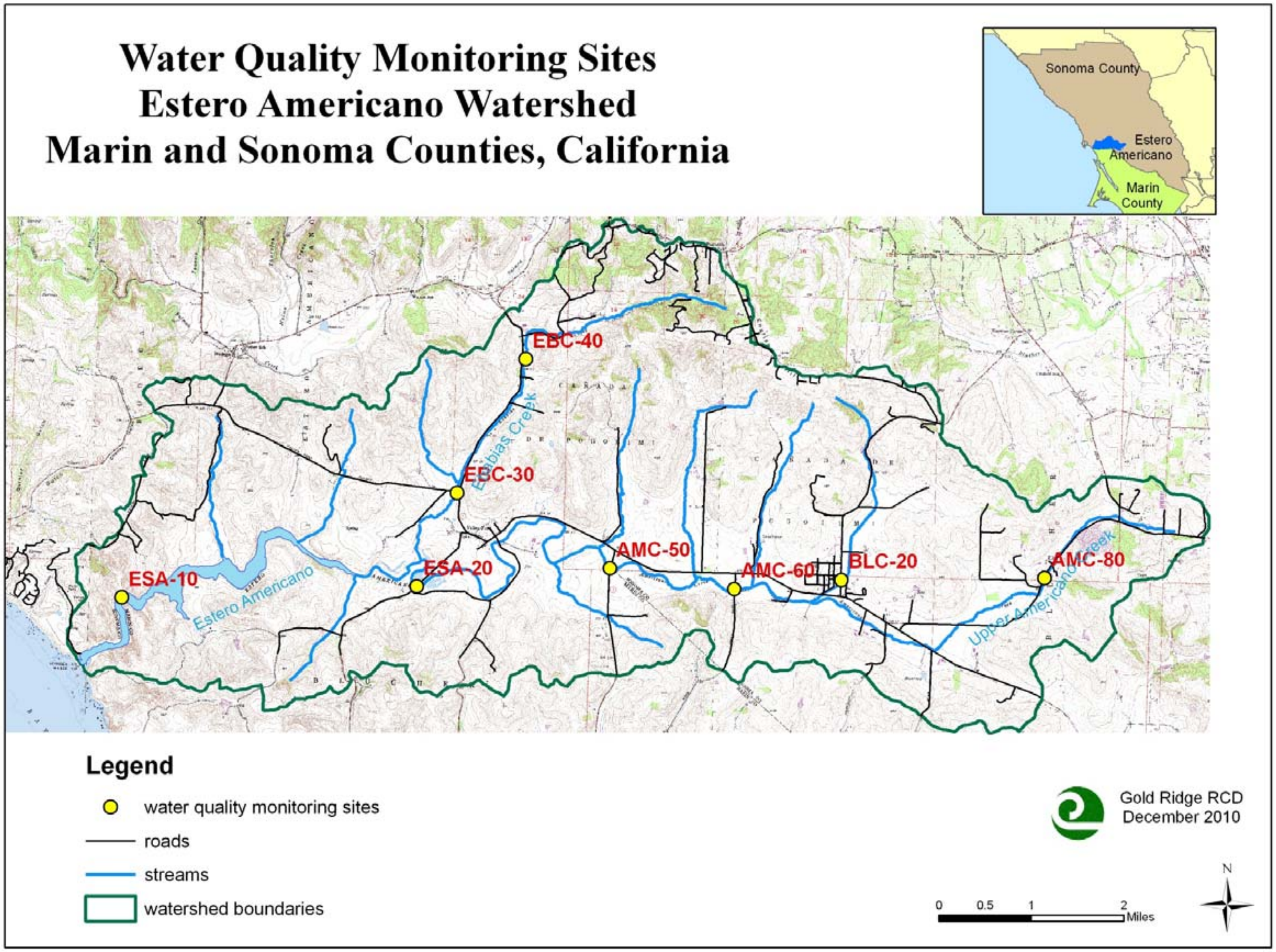
This quarterly report summarizes data collected from September 2012 through December 2012 under the SWRCB 319(h) funded Estero Americano Watershed Sediment Reduction Project, Phase II. The data period included a summer site assessment for monthly ambient sampling on August 29, 2012, when flow conditions were found to be isolated pools or dry channel throughout the watershed. No late summer ambient sampling event that included nutrient and TSS analysis was conducted due to dry channel conditions during the August 29, 2012 sampling attempt. Site assessments were completed after the first two significant rainfall events on October 23 and November 1, 2012, during which streamflow conditions continued to be isolated pools or dry channel throughout the watershed. Connected flow conditions occurred during the November 29 storm and storm sampling was conducted on November 30, 2012.

Since there are no public streamflow gauges deployed in the Estero Americano Watershed, the Salmon Creek streamflow gauge is used as a proxy for evaluating streamflow response to rainfall. Unfortunately, this gauge has been offline since September 2012 and no hydrograph data is available for the early 2012-13 water year storms.

All of the sampling sites had continuous surface flow during the November 30 sampling event. Prior to that storm cycle, since after the July 23 sampling event, streamflow conditions have been intermittent at several sampling sites (AMC-30, AMC-50 and AMC-60) resulting in either dry channel conditions or isolated pools that were not accessible from the sampling site.

A meeting to discuss the water quality results collected during this project was convened on January 12, 2012 and included representatives from local agricultural organizations (United Western Dairymen, Sonoma County Farm Bureau), the Gold Ridge and Marin County RCDs, UC Cooperative Extension and local agricultural producers. The goal of the meeting was to share the results, discuss potential sources of the high nutrient concentrations measured during 2010-11 storm sampling and discuss whether the Water Quality Objectives being used are appropriate for the Estero Americano watershed. Since most of Americano Creek and its tributaries (with the exception of Ebabias Creek) is not known to support the sensitive aquatic organisms for which many of the currently used WQOs were established, the objectives may be unrealistic for this watershed. It was discussed that due to the physical similarities (size, topography, land use, tidal influence, etc.) water quality data from neighboring Estero San Antonio might be more appropriate comparator than the Russian River objectives currently being used. A number of reports documenting water quality conditions in Estero San Antonio were provided by attendees and these are under review by GRRCD staff with consultation from John Largier of the Bodega Marine Laboratory.

Figure 3: Map of sampling locations throughout the Estero Americano Watershed.



Water Quality Objectives/Targets

As with previous GRRCD evaluations of water quality in the Estero Americano Watershed, the Water Quality Objectives or comparative thresholds are listed in the table below. The North Coast Regional Water Quality Control Board (NCRWQCB) has not set numeric standard water quality objectives for the Estero Americano Watershed, which falls into the "Bodega Bay" water body description (NCRWQCB, 1994). Statewide criteria set by the US Environmental Protection Agency (EPA), Region 9(US Environmental Protection Agency, 2000) and/or the objectives for the nearby Russian River water body by the North Coast Regional Water Quality Control Board (NCRWQCB, 1994) have been used as targets and are outlined in Table 2 below.

Table 2: Water Quality Objectives.

Parameter (reporting units)	**Water Quality Objectives**	**Source of Objective**
Dissolved Oxygen (mg/l or ppm)	Not lower than 7	North Coast Region Basin Plan Objective for Cold Water Fish
pH (pH units)	Not less than 6.5 or more than 8.5	General Basin Plan objective
Water Temperature (°C)	Not to exceed 21.1	USEPA (1999) 20-22 range, supported by Sullivan (2000)
Conductivity (uS)	None established	N/A
Nitrate as N (mg/l)	Not to exceed 1.0	
Ammonia-Nitrogen (mg N/l)	Not to exceed 0.5	USEPA (2009)
Orthophosphate (mg/l)	Not to exceed 0.10 (for streams and flowing waters not discharging into lakes or reservoirs)	USEPA(2000)
Turbidity	1. Not to exceed 55 NTUs during low flow; 2. not to exceed 150 NTUs during storm events	GRRCD selected thresholds, 1. Supported by Sigler (1984); 2. supported by Newcombe (2003)

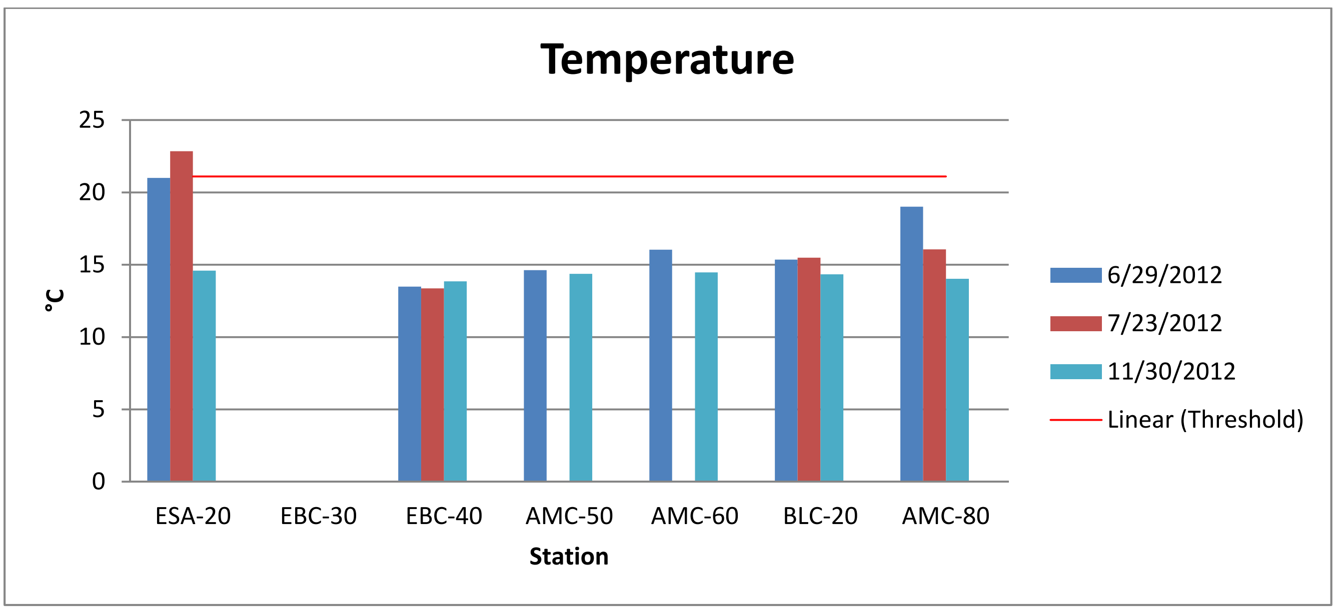
Results and Discussion

Temperature

Water temperature is important to fish and other aquatic species, as well as the function of the aquatic ecosystem. It influences the rate of metabolism for many organisms, including photosynthesis by algae and other aquatic plants, as well as the amount of dissolved oxygen that the water can hold.

Over the data period, temperature measurements were only taken during the November 30, 2012 storm sampling event. Water temperature is not generally of concern during the winter months, but the data is depicted alongside the last quarter data for comparison. Temperature data during 11/30 sampling event met water quality objectives.

Figure 4: Temperature Measurements

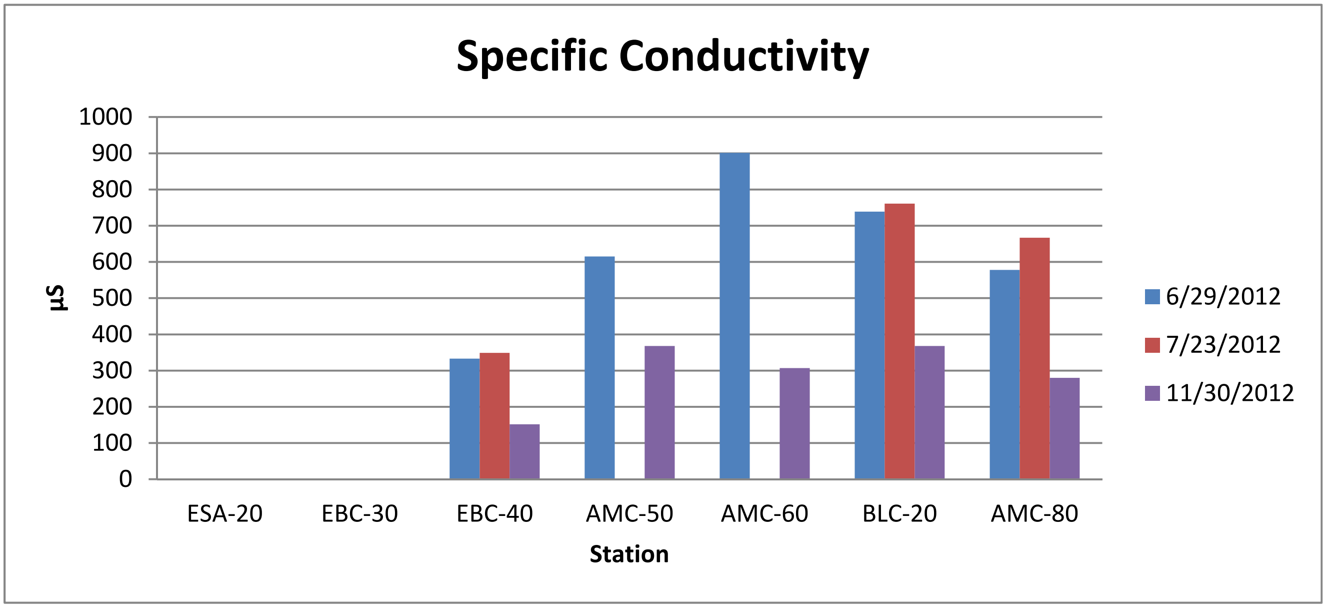


Conductivity

Conductivity is a measure of water's capacity for conducting electricity and is a measure of the ionic (dissolved) constituents present in the sample. While there is no specific water quality objective for conductivity, conductivity can be used as an indicator of pollutant levels.

The conductivity results from sampling station ESA-20 are not included in the graph below since high conductivity conditions are assumed to be a function of the tidal nature of this site, rather than an indicator of pollutant levels, and would have skewed the graph. As streamflow levels drop to summer baseflow conditions, specific conductivity results generally increase. The highest conductivity result was observed at station AMC-60 during the June 29 sampling event, this was the only measurement taken at this sampling site during this data period since the site dried up in early July. As is expected, specific conductivity results dropped significantly during the 11/30 storm event sampling due to the inflow of rainwater, which dilutes the conductivity levels that remain in the isolated pools.

Figure 5: Specific Conductivity Measurements

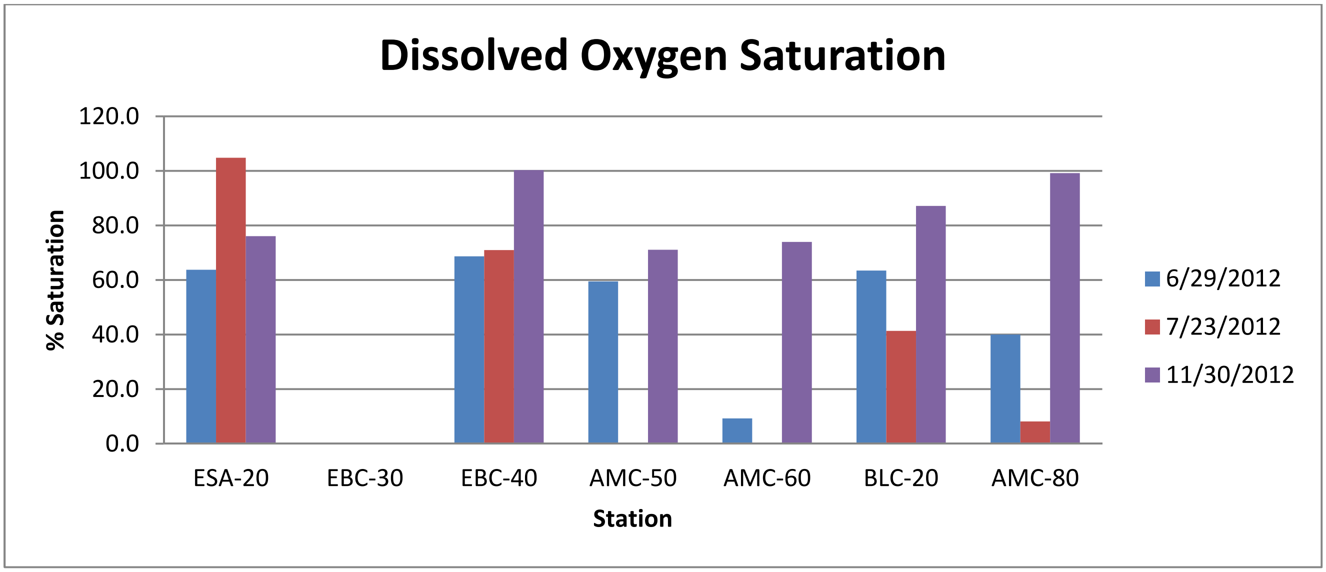


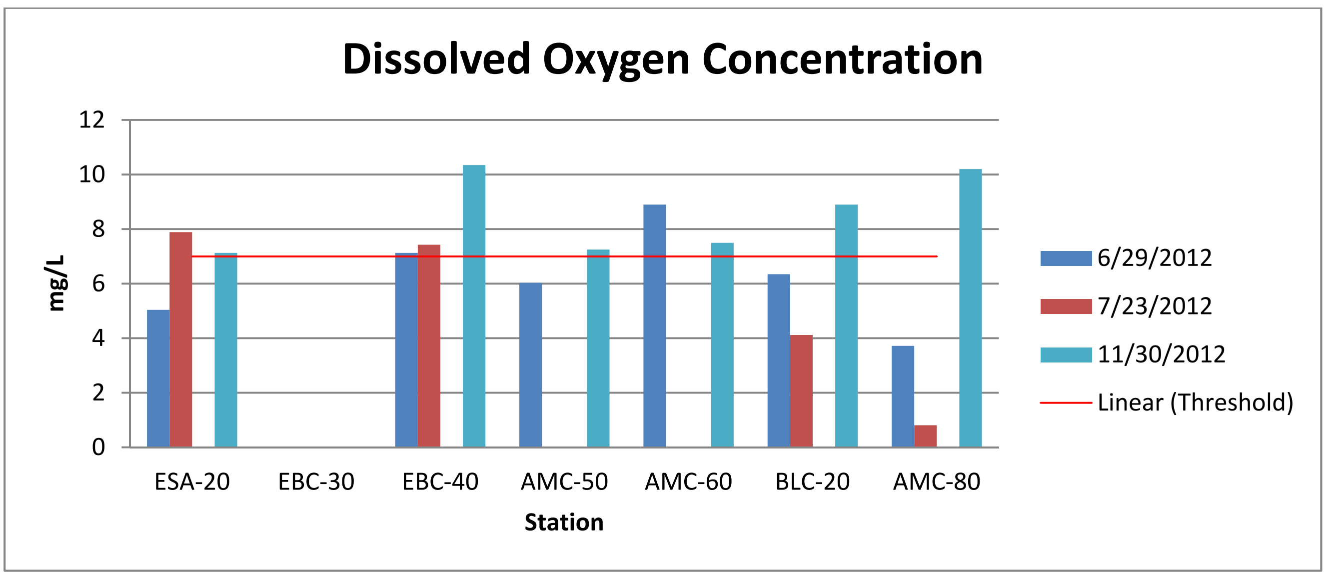
Dissolved oxygen

Dissolved oxygen (DO) refers to the amount of oxygen dissolved in water and available to aquatic organisms. Dissolved oxygen is added to water through diffusion from air, turbulence, and photosynthesis of aquatic plants, and removed through respiration of aquatic organisms, decomposition of organic material, and other chemical reactions that use oxygen.

Throughout the data period dissolved oxygen levels ranged from 9.3 to 71.0% saturation and 0.81 to 8.9 mg/l in Americano Creek at its freshwater tributaries. AMC-60 continued to have low dissolved oxygen conditions in June, and dried up in early July. This station should continue to be watched during subsequent sampling events to see if the condition persists. No super-saturated DO conditions were observed during this sampling period, which had been a concern at AMC-80 during the May 2012 sampling, and despite the presence of algae and aquatic plants. Since the collected measurements were grab samples, this information is not conclusive of the minimum dissolved oxygen conditions, a future monitoring recommendation would be to install continuous DO loggers to capture diurnal and seasonal variations.

Figures 6, 7: Dissolved Oxygen Measurements



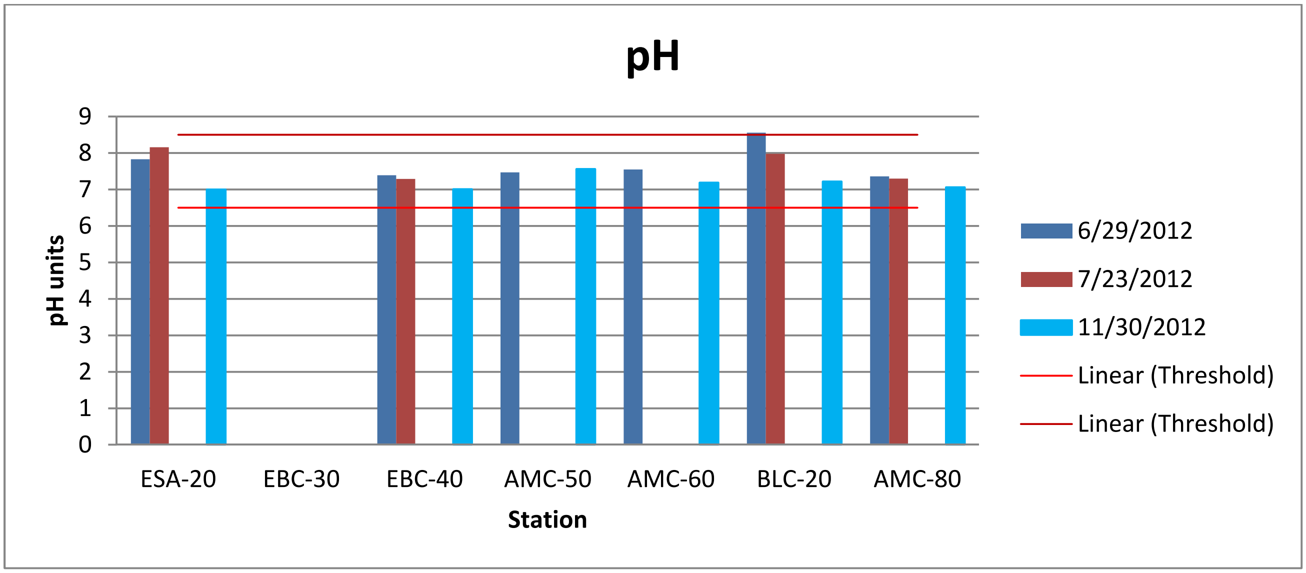


pH

pH refers to the concentration of hydrogen ions in water and determines the acidity or alkalinity of water. Natural pH levels are affected by geology, vegetation, and soil types in the streambed and surrounding the stream, and the availability of carbon dioxide. Changes in pH can have critical effects on water chemistry and the biological systems dependent on the aquatic environment. For example, the solubility and toxicity of metal compounds and nutrients changes greatly in relation with pH.

pH measurements ranged from 7.29 to 8.56 pH units for freshwater stations and 7.83 to 8.16 at the Estero station. All measurements, except the BLC-20 sample on 6/29/12, met water quality objectives. The most acidic measurement at BLC-20 just slightly exceeded the WQO of 8.5, and the acidic conditions had lowered by the 7/23/12 sampling event. Ebabias Creek, which has had acidic conditions in the past, showed conditions that fell within the WQO, which is important as it supports several sensitive aquatic organisms including California freshwater shrimp and steelhead trout.

Figure 8: pH Measurements



Nutrients

Nitrate-nitrogen, phosphate and phosphorous are not directly toxic to aquatic organisms but, where sunlight is available, these chemical nutrients act as biostimulatory substances that stimulate primary production (i.e. plant and algae growth). Excessive inputs of these nutrients, known as eutrophication, can result in abundant plant growth and resulting decay which depletes dissolved oxygen and can degrade habitat quality. This effect is particularly of concern during summer and fall low flow conditions.

As per the Monitoring Plan for this project, nutrients are to be measured several times a year to characterize seasonal conditions when they may have water quality impacts. The next nutrient sampling event, to capture late summer nutrient levels during low flow conditions, was scheduled to occur during the August 2012 sampling event. Unfortunately, all but two stations were dry on 8/29/12 when sampling was scheduled.

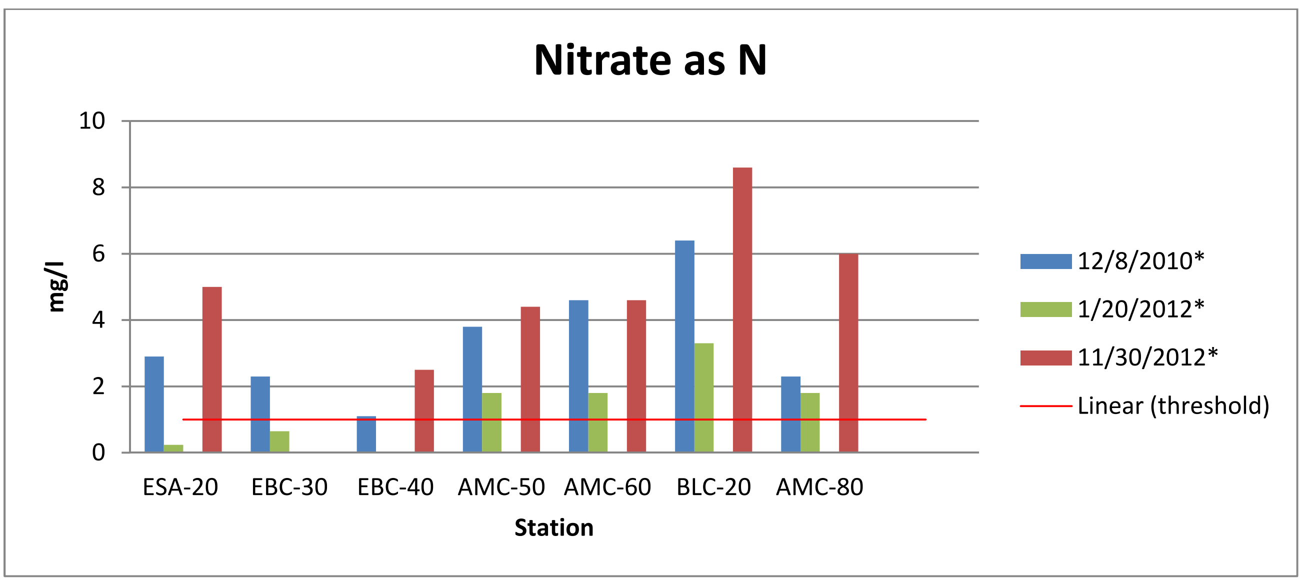
While nutrient levels generally have the greatest impact to water quality both directly (through toxicity) and indirectly (through decreased dissolved oxygen levels due to the biological oxygen demand of decaying plants and algae) during the low flow summer months, the highest concentrations are observed during storm runoff. Since this was a relatively dry winter/spring and baseflow conditions have been low, high concentration nutrient runoff can have a significant water quality impact.

Again, as mentioned in previous reports, based on the large amount of algae and aquatic macrophytes observed throughout the Americano Creek system, particularly during the summer and fall months, it would be a good future monitoring priority to collect continuous dissolved oxygen data to see if the aquatic vegetation is causing the assumed diurnal and seasonal dissolved oxygen concentration fluctuations and associated impacts. Access to deploy a multi-parameter probe in summer 2012 was thwarted by the mainstem Americano Creek sites drying up by early July. Access will be requested earlier next year.

Nitrate

Nitrate (NO_3) is an inorganic form of nitrogen that is soluble and therefore subject to leaching and biological uptake. For the 11/30/12 storm sampling event, Nitrate results at freshwater stations ranged from 2.5 to 8.6 mg/l for freshwater stations, with all stations exceeding the 1.0 mg/l Water Quality Objective. As with most years, the first significant storm tends to show the highest nutrient concentrations, with resulting storms showing a decrease in nutrient concentrations over time.

Figure 9: Nitrate Measurements



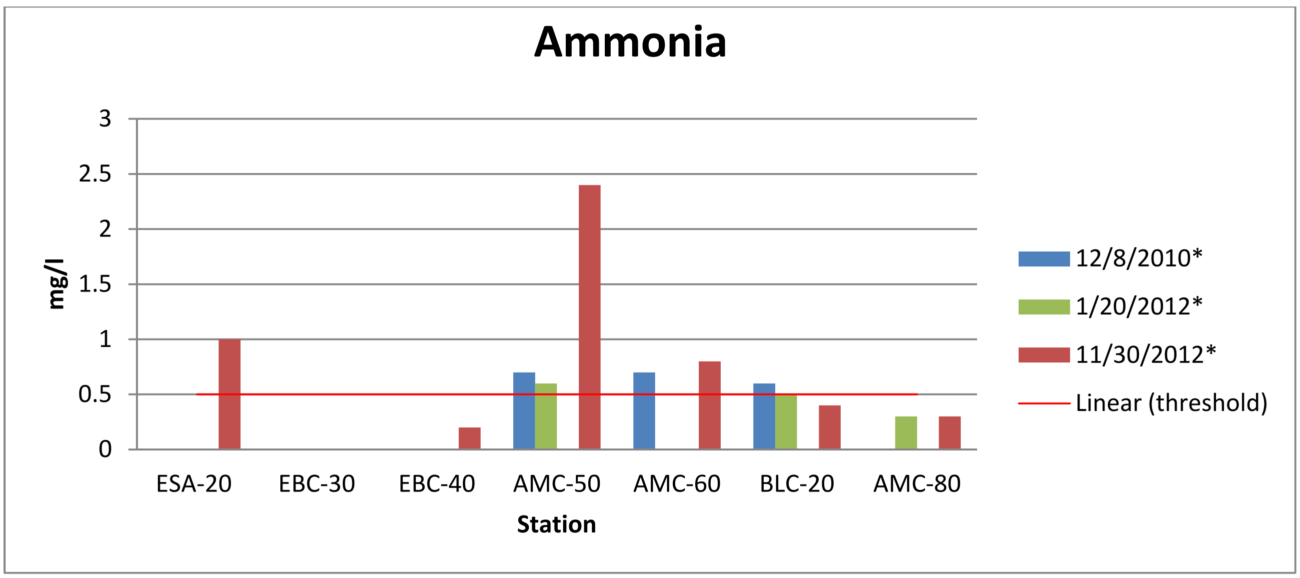
Ammonia

Total ammonia is composed of two forms; ionized ammonia (NH_4^+), and un-ionized ammonia (NH_3).Un-ionized ammonia, which primarily results from decomposition of manure and other organic debris by microbes, can be toxic to aquatic organisms in small concentrations. The percent of total ammonia in the harmful un-ionized form increase with higher temperatures and pH values.

Ammonia concentrations ranged from 0.2 to 2.4 mg/L during the 11/30/12 sampling event. Ammonia concentrations exceeded the water quality objective at all stations, though only slightly at EBC-30. Also, as with most years, the first significant storm tends to show the highest nutrient concentrations, with resulting storms showing a decrease in nutrient concentrations.

Due to the low water temperatures and generally neutral pH values during the sampling period, toxicity due to unionized ammonia concentration is not likely a threat to aquatic organisms. Ammonia concentration becomes more potentially toxic as water volumes decrease and water temperatures increase under summer conditions. BMPs that target reducing nutrient sources for surface runoff should continue to be employed throughout the watershed.

Figure 10: Ammonia Measurements



Orthophosphate

Phosphorus is a natural element found in rocks, soils and organic material and is a nutrient required by all organisms for basic biological function. Phosphorus clings to soil particles and is readily used by plants, so in natural conditions, phosphate concentrations are very low. Phosphorus is considered the growth-limiting nutrient in freshwater systems, meaning that when it is present and available in freshwater systems, it is readily absorbed and utilized by algae and aquatic plants for their growth. Orthophosphate is a dissolved and readily bioavailable form of Phosphorus. When Orthophosphate is present in measurable concentrations under conditions that allow algal and aquatic plant growth, it is considered excessive since it can result in algal blooms and eutrophication.

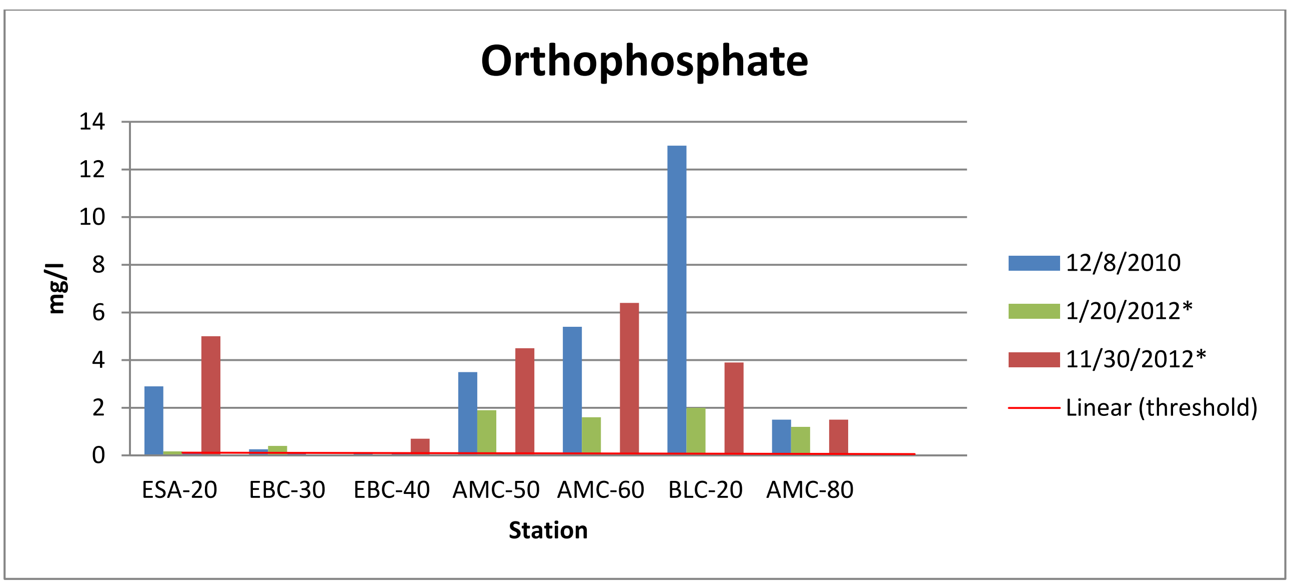
For the 11/30/12 storm sampling event, Orthophophate results ranged from 0.7 to 6.4 mg/l for freshwater stations, with all stations exceeding the 0.1 mg/l Water Quality Objective. This was the first storm the reestablished continuous flow conditions throughout the watershed and phosphate levels uniformly exceeded the WQOs. As with most years, the first significant storm tends to show the highest nutrient concentrations, with resulting storms showing a decrease in nutrient concentrations.

It is likely that there may be several pathways of Phosphate entering Americano Creek and its tributaries, but based on past soil sampling conducted at selected locations in the Estero Americano watershed (see Table below), the Phosphorus concentrations stored in the soil are rated "VH" which stands for "very high". Since Phosphorus readily binds to soil particles that settle out in the stream channel, BMPs that target reducing nutrient sources and soil erosion for surface runoff should continue to be employed throughout the watershed.

Table 3. Soil Analysis Report taken from agricultural lands in Estero Americano Watershed

Sample ID	Organic Matter		Phosphorus	Potassium	Magnesium	Calcium	Sulfur
	% Rating	*ENR (lbs/A)	P ppm	K ppm	Mg ppm	Ca ppm	SO_4-S ppm
Field A	5.5VH	140	48VH	156M	359M	1746M	11M
Field B	4.4H	118	95VH	250M	441VH	1341L	8L
* Estimated Nitrogen Release (ENR) in lbs per acre is derived from % organic matter and represents the "potential" amount of organic nitrogen that will be mineralized by soil microbes during the growing season.							

Figure 11: Orthophosphate Measurements



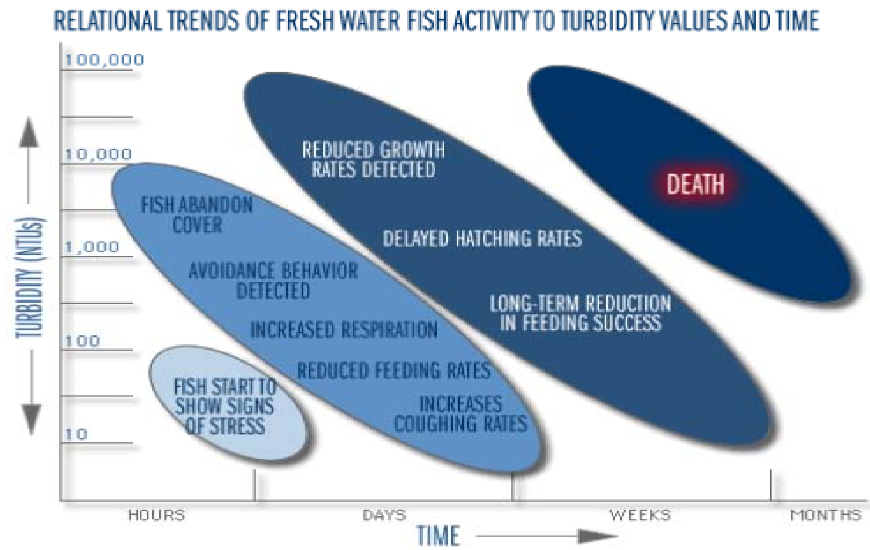
Turbidity and Total Suspended Solids

Turbidity, which can make water appear cloudy or muddy, is caused by the presence of suspended and dissolved matter, such as clay, silt, finely divided organic matter, plankton and other microscopic organisms. Sources of turbidity include soil erosion, streambank erosion, animal waste, road and urban runoff, and excessive algal growth.

Excess turbidity reduces light, thereby reducing benthic organisms and ultimately fish populations. High turbidity level can increase water temperatures due to suspended particles absorbing heat. High turbidity levels also affect aquatic organisms by causing reduced feeding rates, reduced growth rates, damage to gills, and fatality.

Water quality objectives for turbidity and Total Suspended Solids (TSS) are not definitively established for the Estero Americano Watershed. While the North Coast Regional Water Quality Control Board mandates that turbidity levels not be increased more than 20% above naturally occurring background levels (NCRWQCB, 2007), when a background level has not been established (as is the case with the Estero), this objective is difficult to use. Since at least part of the watershed sustains anadromous fish, clear water fishery objectives have been employed as water quality targets. Newcombe (Newcombe, 2003) described the detrimental impacts to clear water fishes at several turbidity levels. Newcombe states that turbidity levels of 55 NTUs caused significant impairment to fish after one day and severe impairment after four months, while turbidity levels of 150 NTUs caused significant impairment after three hours and severe impairment after two weeks. For summer baseflow conditions, when turbidity is generally expected to be low, a threshold of 25 NTUs has been used.

Figures 12, 13: Representations of impairment relationships between turbidity and fresh water fish



"Figure 10: Idealized model of fish response to increased suspended sediments. Schematic source of above figure is unknown; it is a generic, un-calibrated impact assessment model based on Newcombe, C. P., and J. O. T. Jensen. 1996. Channel suspended sediment and fisheries: a synthesis for quantitative assessment of risk and impact. North American Journal of Fisheries Management. 16: 693-727. Reprinted, with permission, from: http://wow.nrri.umn.edu/wow/under/parameters/turbidity.html" (Berry, 2003).

Impact Assessment Model for Clear Water Fishes Exposed to Conditions of Reduced Water Clarity

Visual clarity of water (yBD) and related variables: alternate		preferred		Duration of exposure to conditions of reduced VISUAL CLARITY ($\log_e$ hours): 0	1	2	3	4	5	6	7	8	9	10	Fish reactive distance: calibrated for trout		
NTU ($\Delta ntu_{\Sigma,\Lambda}$)	zSD (m)	BA (m^{-1})	yBD (m)	Severity-of-ill-effect Scores (SEV) -- Potential: SEV = - 4.49 + 0.92($\log_e$ h) - 2.59($\log_e$ yBD)											ψBD (cm)	xRD (cm)	
1100	0.01	500	0.010	7	8	9	10	11	12	13	14				1		O
			0.014	7	7	8	9	10	11	12	13	14			1		N
400	0.03	225	0.02	p6*	7	7	8	9	10	11	12	13	14		2		M
			0.03	4	5	6	7	8	9	10	11	12	13	14	3		L
150	0.07	100	0.05	3	p4*	p5*	6	7	8	9	10	11	12	13	5		K
			0.07	2	3	4	5	6	7	8	9	10	11	11	7		J
55	0.15	45	0.11	p1*	2	3	4	5	6	7	8	9	10	10	11	6	I
			0.16	0	1	2	3	4	5	6	7	8	9	9	16	17	H
20	0.34	20	0.24	0	p0*	p1*	2	3	4	5	6	7	8	8	24	30	G
			0.36	0	0	0	1	2	3	4	5	6	6	7	36	42	F
7	0.77	9	0.55	0	p0*	0	0	1	2	3	4	4	5	6	55	55	E
			0.77	0	p0*	p0*	0	0	1	2	3	4	4	5	77	66	D
3	1.53	4	1.09	0	p0*	0	0	0	0	1	2	3	4	5	109	77	C
			1.69	0	0	0	0	0	0	0	1	2	2	3	169	90	B
1	3.68	2	2.63	p0*	p0*	p0*	0	0	0	0	0	0	1	2	263	104	A
				1	3	7	1	2	6	2	7	4	11	30			
				Hours			Days			Weeks		Months					
				a	b	c	d	e	f	g	h	i	j	k			

"Figure 11: Matrix of impairment levels by turbidity level and duration. Yellow indicates slight impairment with changes in feeding and other behaviors, orange indicates significant impairment with altered fish growth and habitat quality, and red indicates severe impairment with physiological condition changes and habitat alienation (Newcombe 2001, 2003)" (Gold Ridge RCD, 2010).

The turbidity levels during the 7/23/12 monthly ambient sampling event showed the highest result at AMC-80. This was due to a recent disturbance in the channel and was not reflected in turbidity conditions downstream of this site. During the 11/30/12 storm sampling event, turbid conditions were present throughout the watershed. One recently tilled property that was not adequately storm-proofed downstream of AMC-80 acted as point source of sediment and resulted in an increase in turbidity from station AMC-80 to AMC-60. Much of the fine sediment had settled out by the time flows reached ESA-20.

Figures 14: Turbidity Measurements

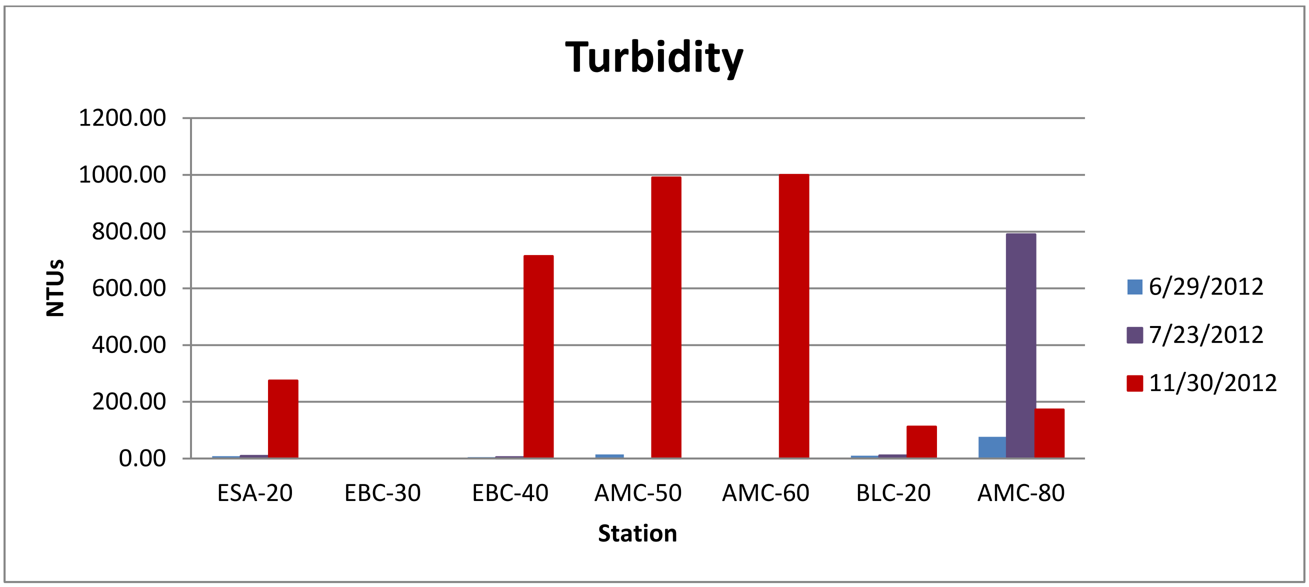
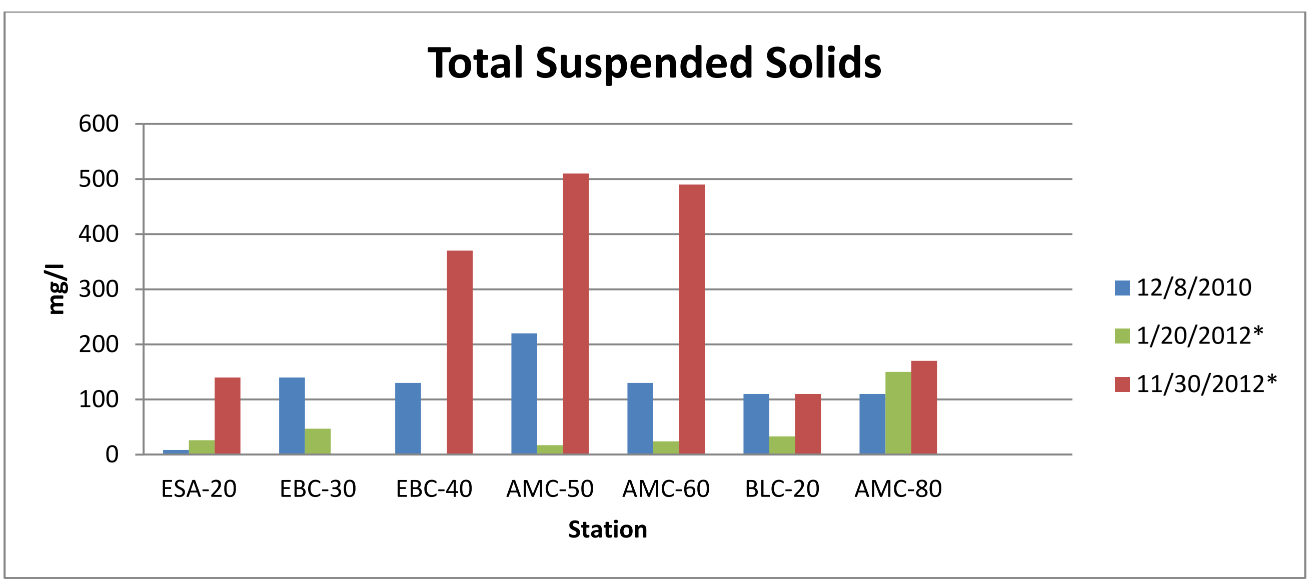


Figure 15: Total Suspended Solids Measurements



List of Works Cited

Berry, W. N. (2003). *The Biological Effects of Suspended and Bedded Sediment (SABS) in Aquatic Systems: A Reivew.* Narraganset, RI: US Environmental Protection Agency.

Gold Ridge RCD. (2010). *Salmon Creek Integrated Coastal Watershed Management Plan.* Occidental, California: Gold Ridge Resource Conservation District.

Newcombe, C. (2003). *Impact assessment model for clear water fishes exposed to excessively cloudy water.* Journal of the American Water Resources Association (JAWRA) 39(3):529-544.