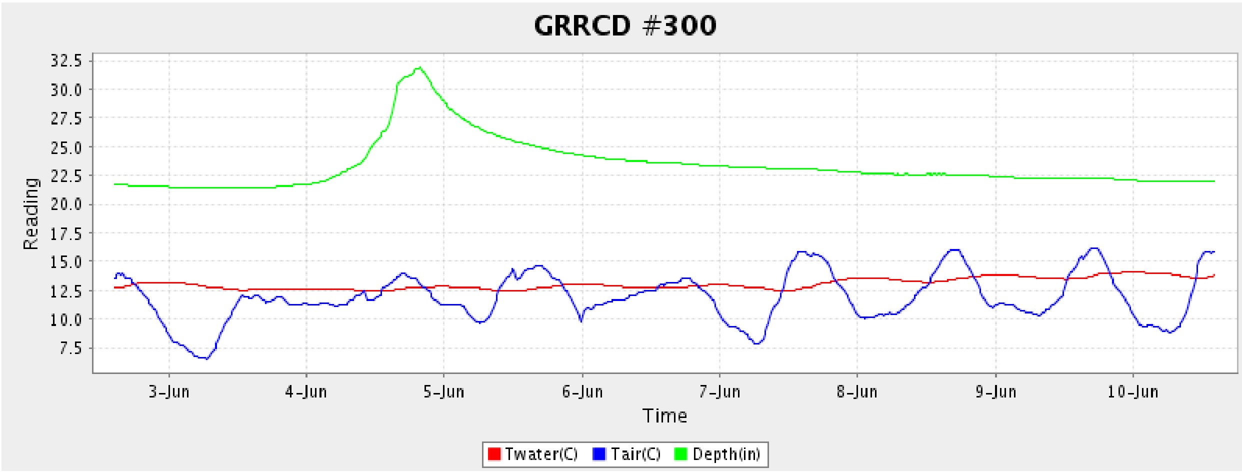
Estero Americano Watershed Sediment Reduction Project, Phase II, Sonoma and Marin Counties, CA

Draft Quarterly Monitoring Report
Item B.4.2

This quarterly report summarizes data collected from June to August 2011 under the SWRCB 319(h) funded Estero Americano Watershed Sediment Reduction Project, Phase II. The data period included the spring ambient water quality sampling (June 8) and two monthly sampling events (July 12 and August 17).

There were two significant (>1.0 inch in 24 hours) rainfall events during the sampling period, on June 4 and June 28. 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. Below are the two hydrographs associated with the June 4 storm event and June 8 sampling.

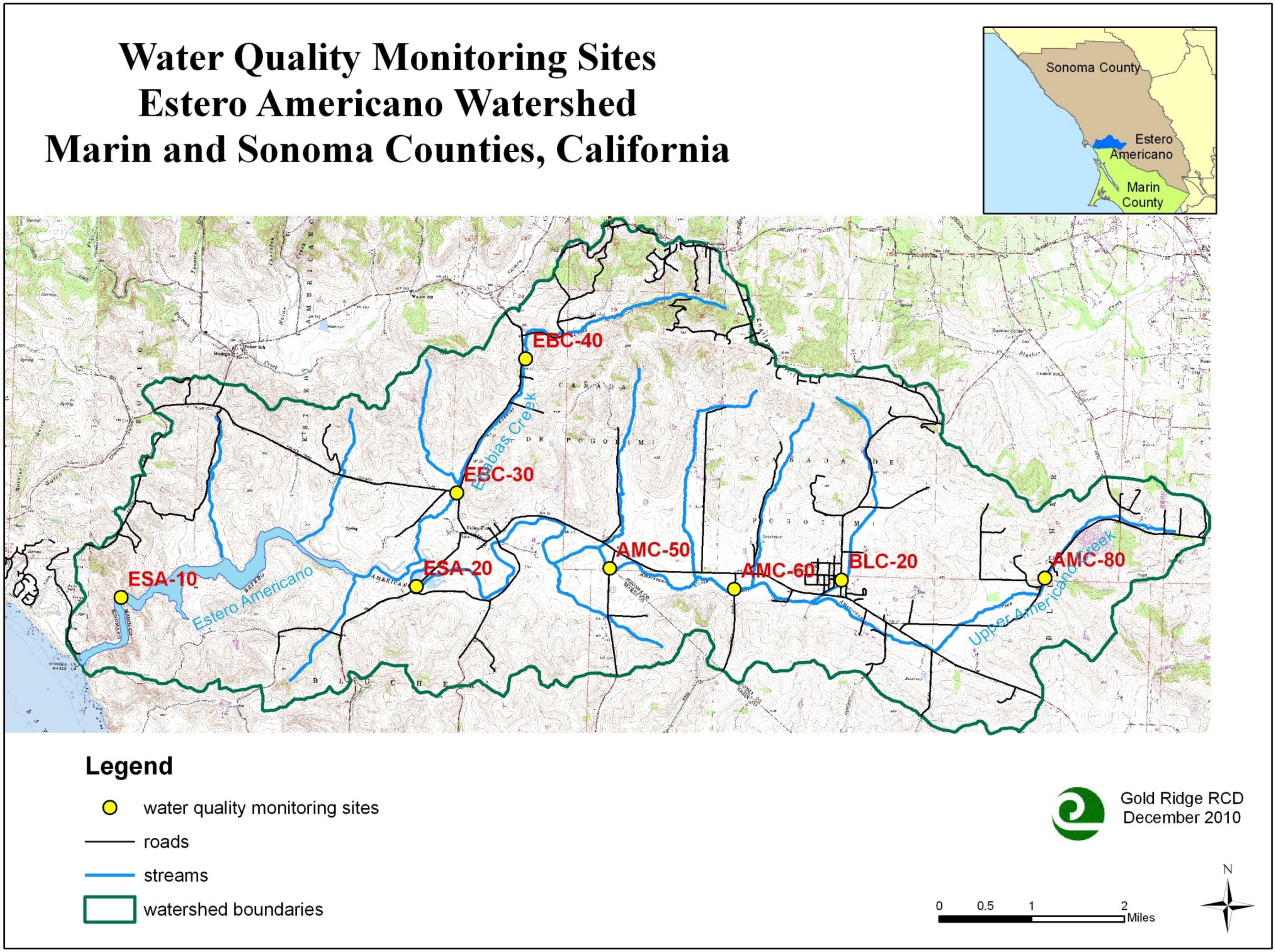
Figure 1: Hydrograph of Salmon Creek from June 2 to June 10, 2011



All of the sampling sites had surface water throughout the sampling period, though several of the mainstem Americano Creek sites had isolated pool conditions during the 8/12/11 sampling event, trending towards dry channel conditions. The Bloomfield Creek site was not sampled during the August 17 monitoring event because the channel had been altered during construction of a flood capacity project.

August 12, 2011 trickle of streamflow over the culvert at Station EBC-30

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)

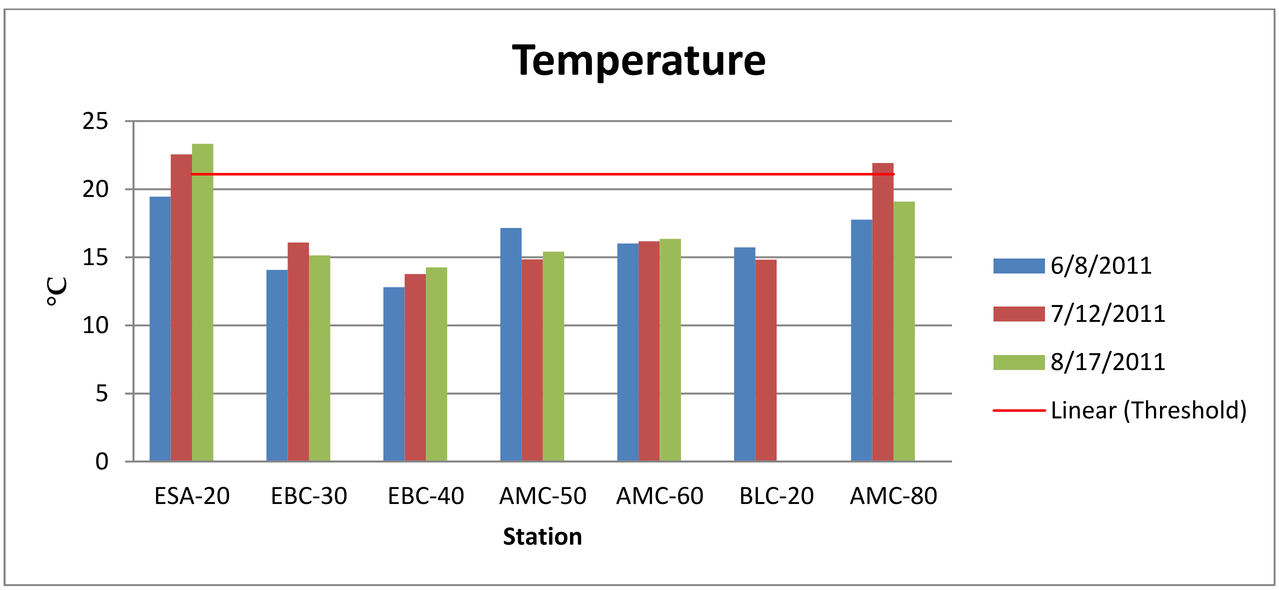
Results and Discussion

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 varied from 12.81 to 21.93 °C for the freshwater stations and 19.46 to 23.33 for the Estero (ESA-20) station. The July 12 measurement for AMC-80 exceeded the threshold of 21 °C by nearly a degree (21.93°C at 12:12 pm), but all of the other freshwater Americano Creek stations met temperature objectives during the sampling events during the data period. Considering that AMC-80 is the upstream-most sampling station, it is of concern that this site is exceeding temperature objectives, but it appears that these temperatures are not persisting downstream. Since the collected measurements were grab samples, this information is not conclusive, a future monitoring recommendation would be to install continuous temperature loggers to capture diurnal and seasonal variations.

Figure 4: Temperature Measurements

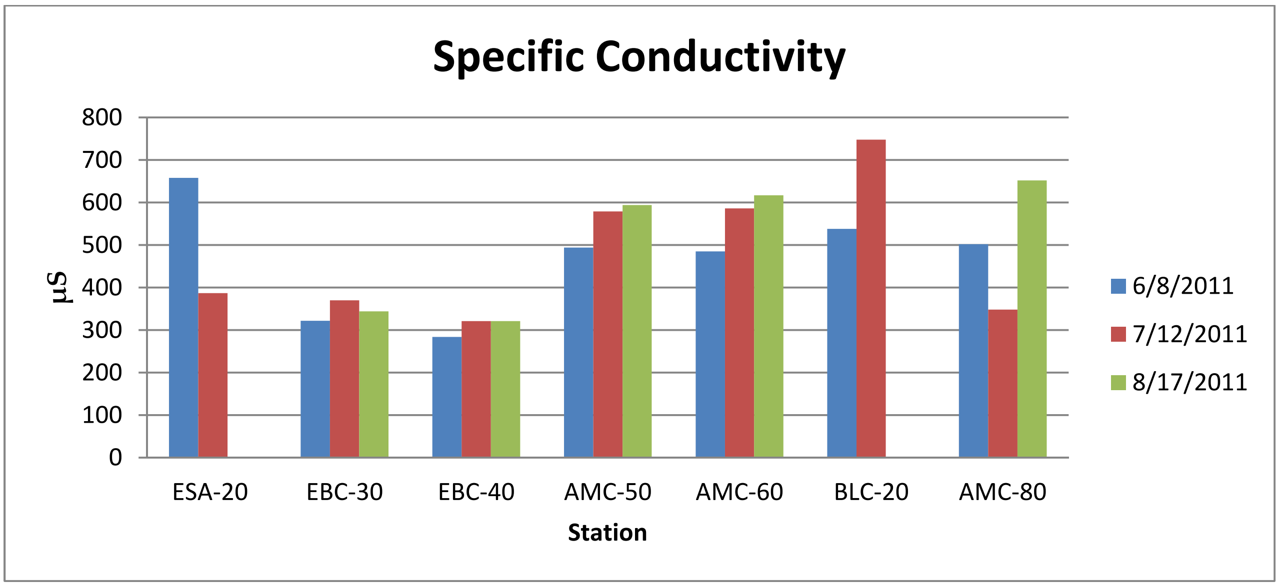


Conductivity

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.

Over the data period, specific conductivity measurements in Americano Creek ranged from 284 to 748 µS and from 387 to 43,720 µS in the Estero Americano (the 43,720 µS result at ESA-20 during 5/31/11 sampling was removed from the graph below since it is assumed to be a function of the tidal nature of this site and would have skewed the graph). As expected, specific conductivity levels generally increased throughout the summer as streamflow levels dropped. With the exception of Ebabias Creek stations (and excluding the tidal effects of salinity fluctuation at ESA-20), the conductivity results remained relatively high (>325 uS) throughout the sampling period.

Figure 5: Specific Conductivity Measurements



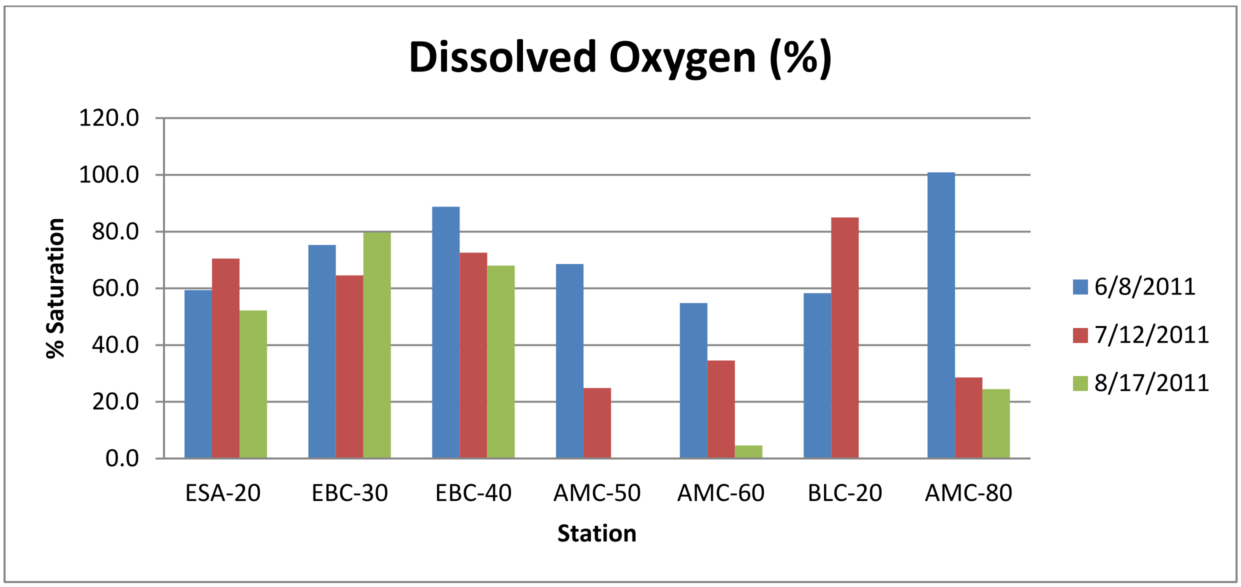
Dissolved oxygen

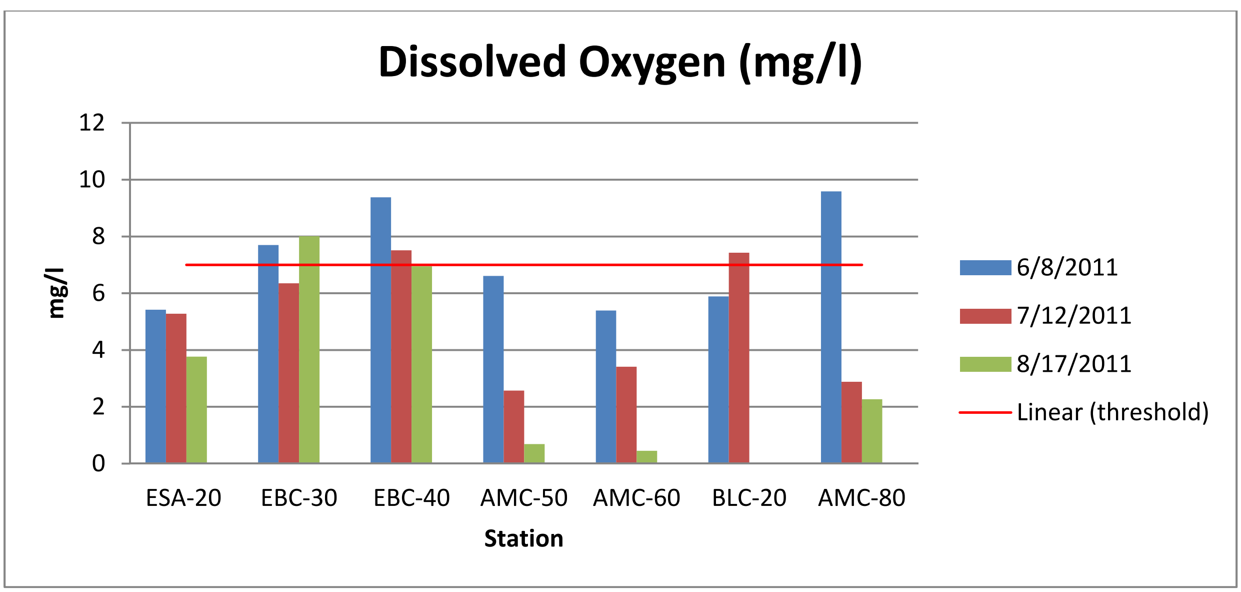
Station AMC-60, looking downstream

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 0.30 to 100.9% saturation in Americano Creek at its freshwater tributaries and from 52.2 to 70.5% saturation in the Estero. The three upper Americano Creek stations (AMC-80, AMC-60 and AMC-50) all showed trends of decreasing dissolved oxygen levels, both in percent saturation (%) and concentration (mg/l) that fell below the minimum water quality objective of 7 mg/l, throughout the sampling period. Each of these stations have fairly open canopy conditions, in part due to the bridge location, and had algae and aquatic macrophytes, often blanketing the water surface, present throughout the sampling period. EBC-40 was the only site that met the dissolved oxygen objectives during this sampling period.

Figures 6, 7: Dissolved Oxygen Measurements



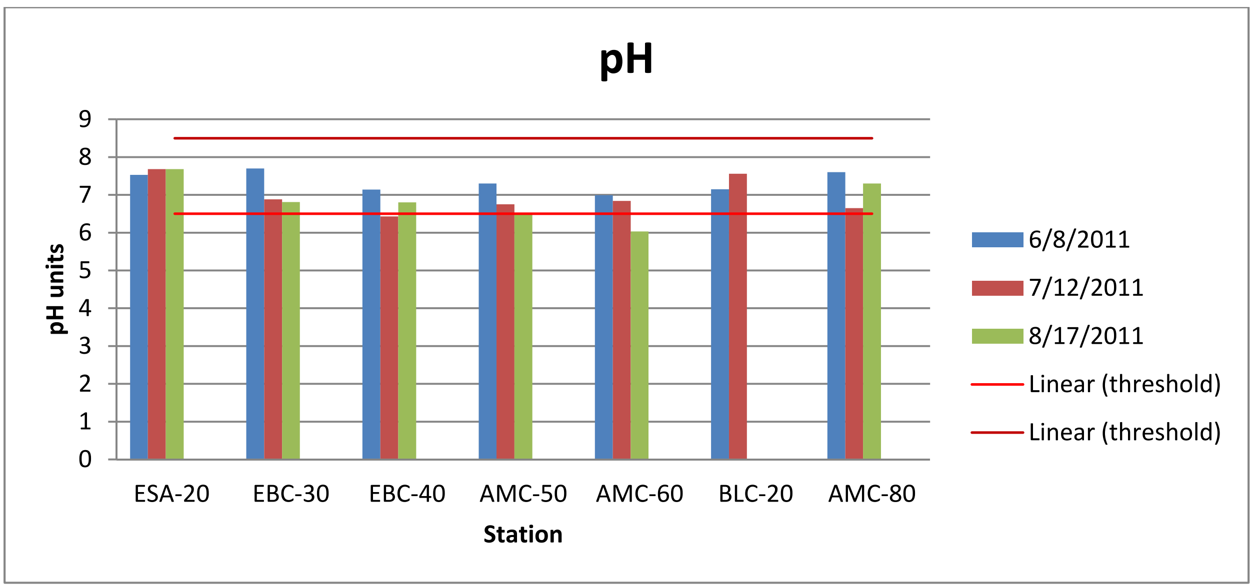


pH

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 with pH.

pH measurements ranged from 6.03 to 7.70 pH units. There were two acidic exceedences of the water quality objectives (WQOs) one at AMC-60 and one on upper Ebabias Creek (EBC-40) during the sampling period. Considering that Ebabias Creek also had pH measurements that exceeded the WQOs during the last quarterly sampling period and otherwise consistently has the highest habitat water quality conditions of any of the freshwater stations sampled in the Estero Americano watershed, this is something that should be watched for future occurrences. There are no current sampling stations on the Estero Americano downstream of the confluence of Ebabias Creek so the impact to receiving waters was not measured.

Figure 8: pH Measurement



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. While this effect is not generally of concern during winter and spring flow conditions, the input and deposition of high nutrient sediments can exacerbate these conditions later in the year.

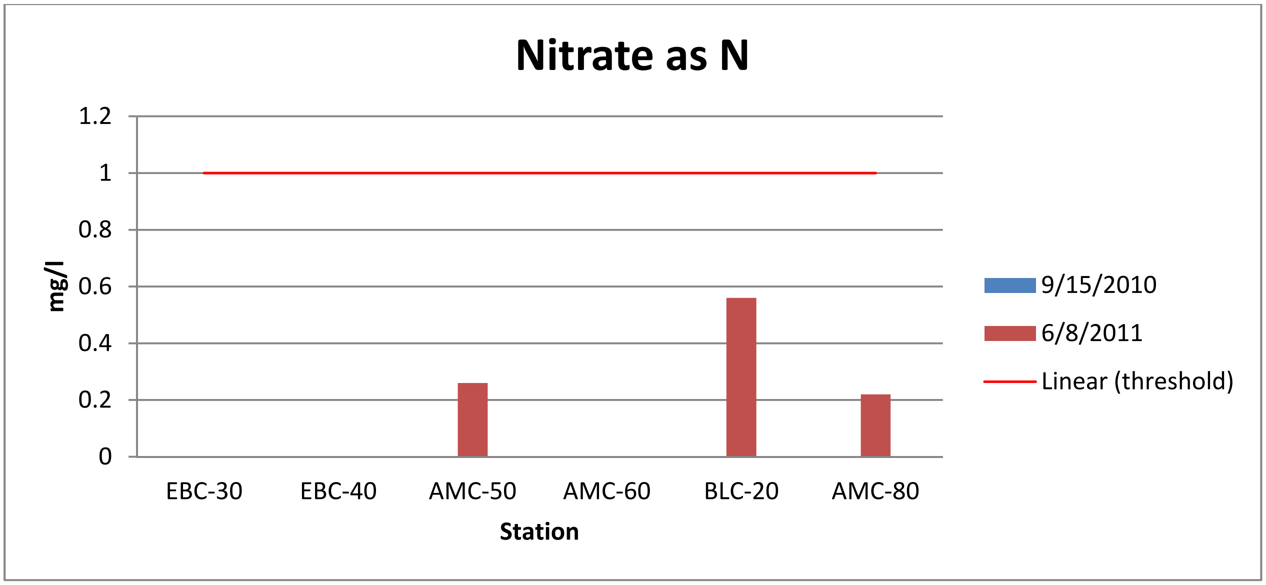
As per the Monitoring Plan for this project, nutrients are measured several times a year to characterize seasonal conditions when they may have water quality impacts. The conditions monitored during the course of this quarterly report include the late spring sampling event on June 8, 2011. Data from the previous summer sampling on September 15, 2010 is included on the nutrient graphs for reference and trend comparison. Data for the Estero stations (ESA-20) are excluded in the discussion since the nutrient dynamics for marine influenced waters are not comparable to freshwater conditions.

The late spring (June) and summer (September) sampling events will measure nutrient levels while they can have the greatest impact to water quality both directly (through toxicity) and indirectly (through depressed dissolved oxygen levels due to the biological oxygen demand of decaying plants and algae). Based on the large amount of algae and aquatic macrophytes observed throughout the Americano Creek system, 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.

Nitrate

Nitrate (NO_3) is an inorganic form of nitrogen that is soluble and therefore subject to leaching and biological uptake. For the 6/8/11 sampling event, Nitrate results ranged from non-detect (<0.20 mg/l) to 0.56 mg/l for freshwater stations, with no stations exceeding the 1.0 mg/l Water Quality Objective.

Figure 9: Nitrate Measurements

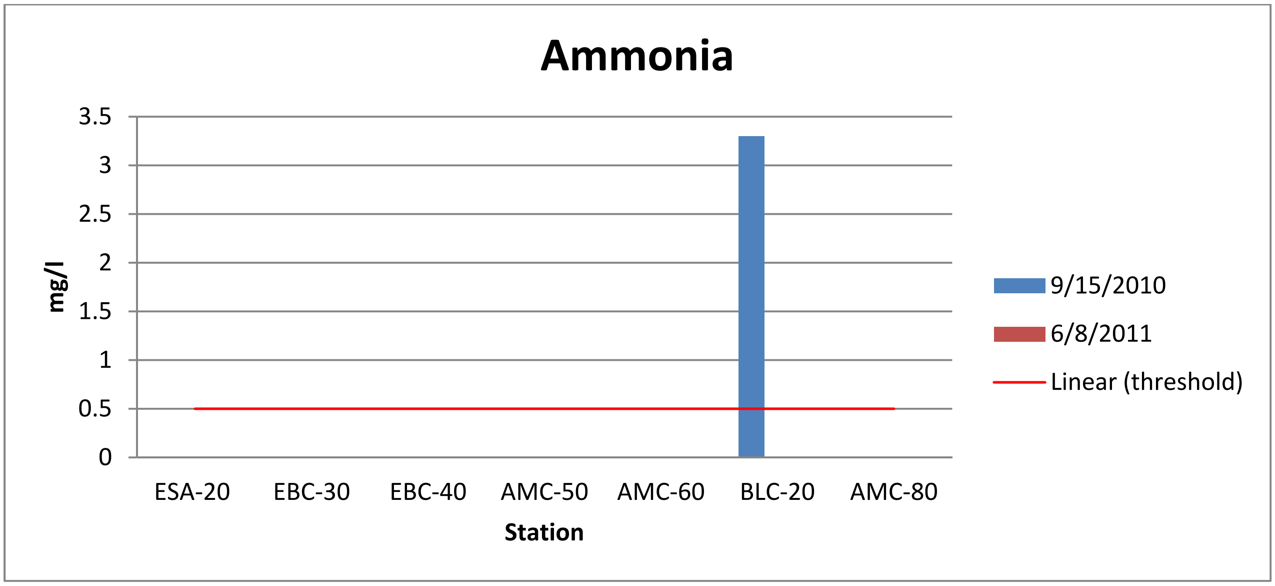


Ammonia

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 during the 6/8/11 sampling event ranged from <0.2 (ND) to 3.3 mg/l. Ammonia concentrations that exceeded the water quality objective were measured only on Bloomfield Creek (BLC-20). It is of concern that high Ammonia concentrations were measured during a non-storm event. Due to the low water temperatures and neutral pH values during the sampling period, toxicity due to unionized ammonia concentration may not be a threat to aquatic organisms. Ammonia concentration will become more potentially toxic as water volumes decrease and water temperatures increase under summer conditions. These concentrations will be measured during the September sampling event. 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.

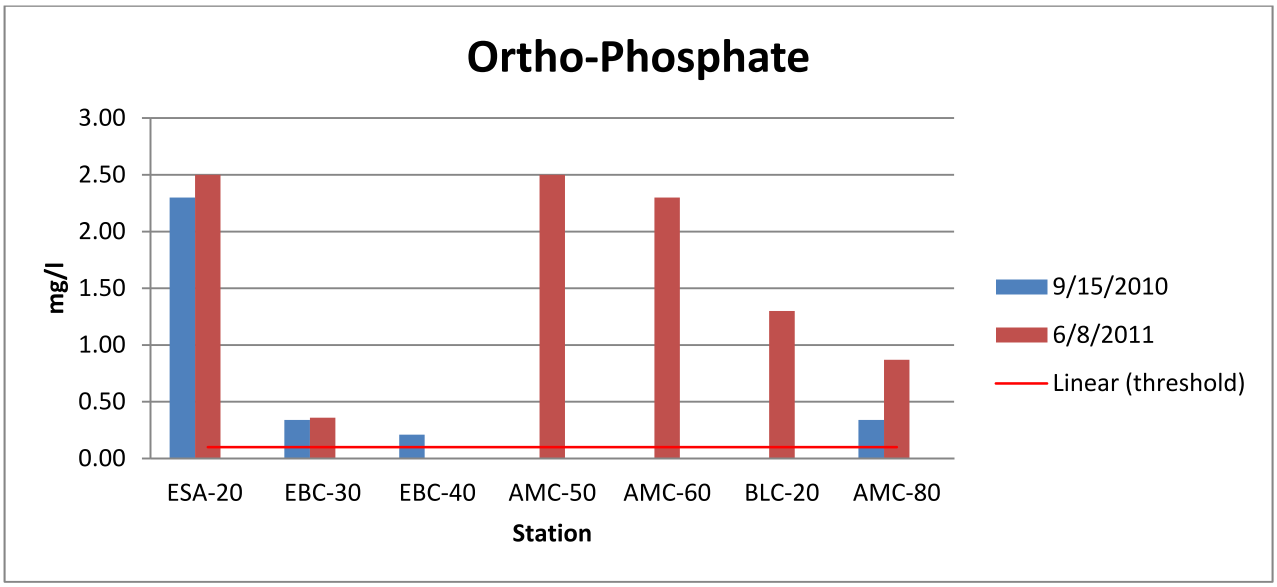
Detectable concentrations of Orthophosphate were measured at all of the stations (except EBC-40 which wasn't sampled for Orthophosphate) during the 6/8/11 sampling event. Results ranged from 0.36 to 2.50 mg/l, all of which exceeded the 0.10 mg/l Water Quality Objective.

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

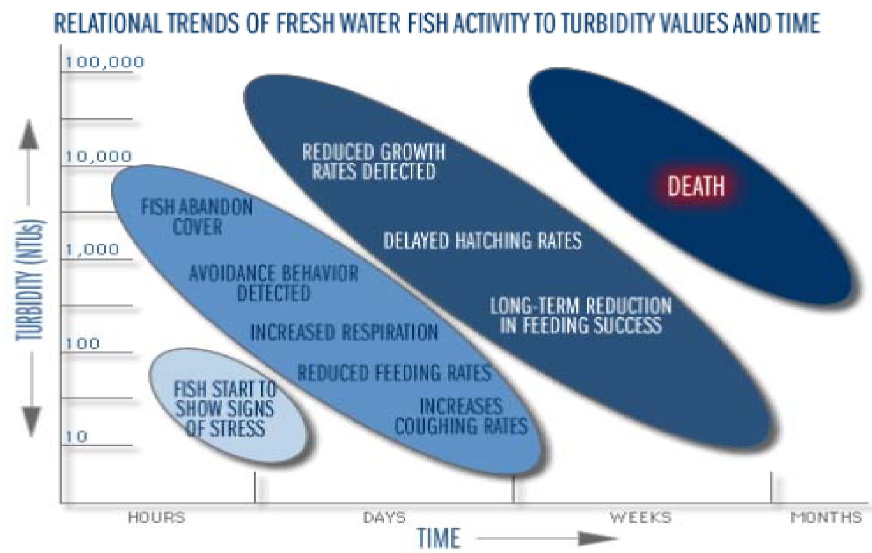


Turbidity and Total Suspended Solids

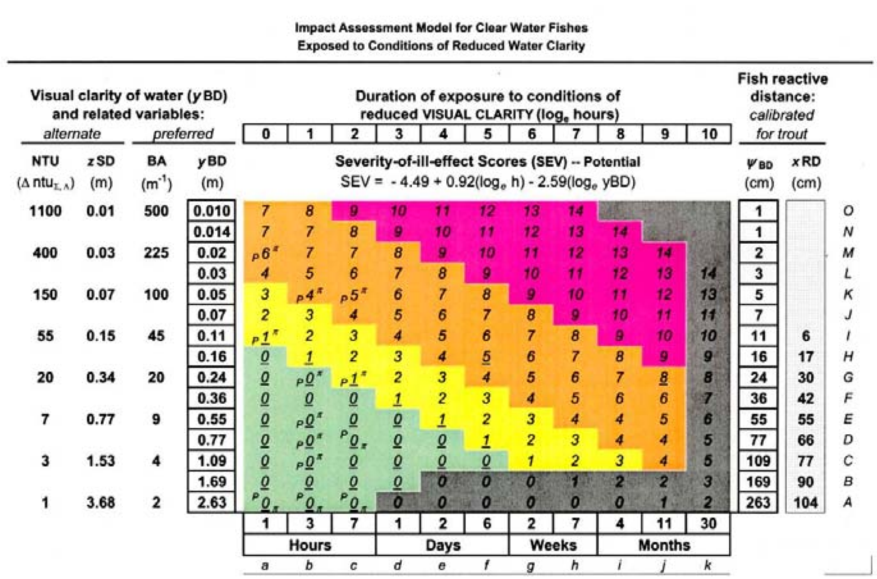
Turbidity, which can make water appear cloudy or muddy, is caused by the presence of suspended and dissolved matter, such as clay, silt, finely divided organic matter, plankton and other microscopic organisms. Sources of turbidity include soil erosion, streambank erosion, animal waste, road and urban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

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)											Fish reactive distance: calibrated for trout		
				0	1	2	3	4	5	6	7	8	9	10			
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).

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.

Turbidity conditions exceeded WQOs at a number of locations at two mainstem Americano Creek stations (AMC-60 and AMC-80). Both of these stations had both aquatic vegetation and algae present, as well as signs of current or recent channel disturbance due to livestock. It appeared that the highest value at AMC-80 on August 17, was due to a localized channel disturbance and not necessarily a persistent issue, though a high TSS measurement was also measured during the 9/15/10 sampling.

Figure 14: Turbidity Measurements

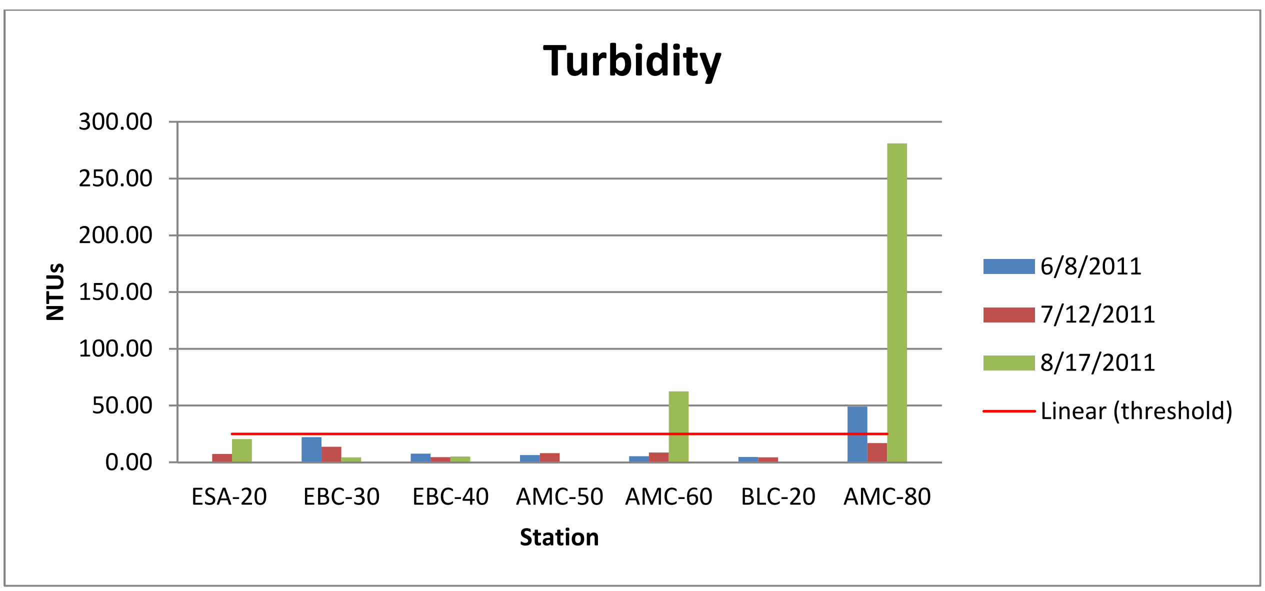
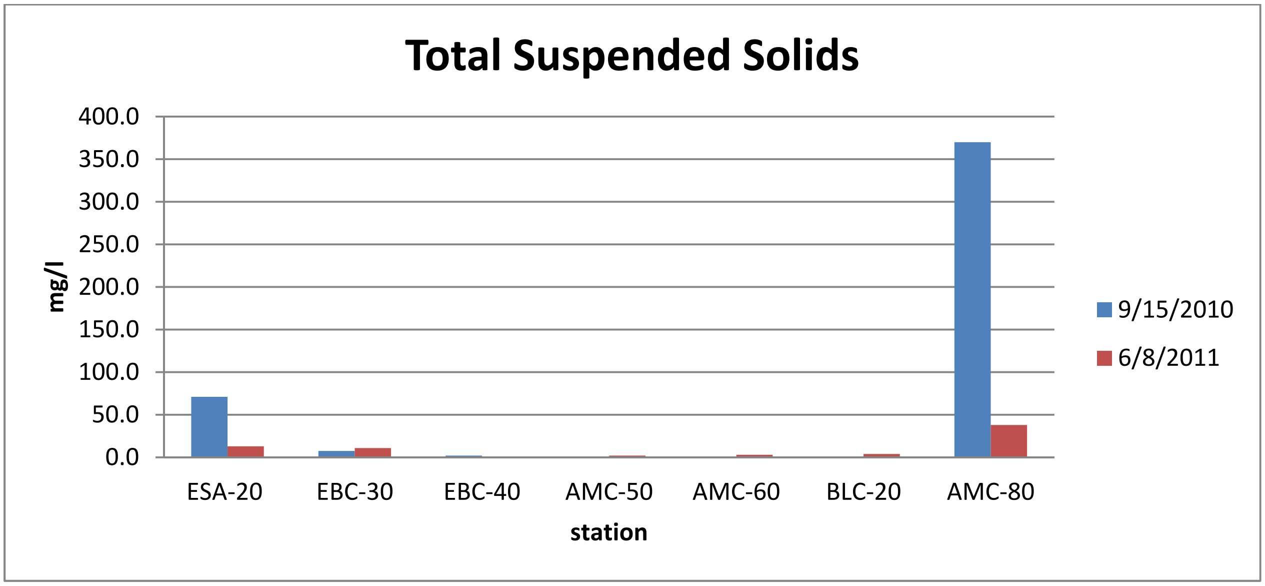


Figure 15: TSS Measurements



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.