**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 March 2012 through May 2012 under the SWRCB 319(h) funded Estero Americano Watershed Sediment Reduction Project, Phase II. The data period included one storm sampling event (March 13, 2012*), one spring base flow monthly ambient sampling event (April 23, 2012) and one late spring ambient sampling event that included nutrient and TSS analysis (May 30, 2012**).

There were several rainfall events in March and early April during the sampling period. Going into this sampling period rainfall was well below normal (Santa Rosa is at 64% of normal according to the National Weather Service (NOAA's National Weather Service , 2012)). The storms in March added another ~15" of rain and delivered twice the monthly average typical for March resulted, but annual average is still well below normal. These conditions resulted in a storm response in the Estero watershed during the March 13 sampling event. The sampling was conducted early during the first wave of multi-wave storm cycle, so samples were not reflective of peak flows.

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 two hydrographs associated with this sampling period.

All of the sampling sites had continuous surface flow throughout the sampling period.

**Figure 1: Hydrograph of Salmon Creek from March 2012 through May 2012**

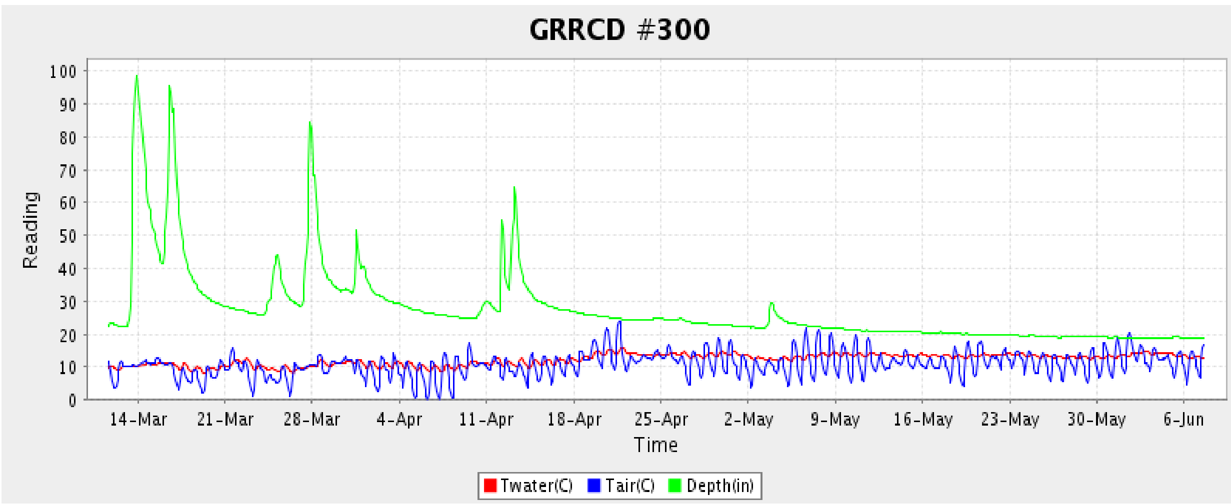



**Figure 2: Hydrograph of Salmon Creek from 3/12/12 to 3/15/12, includes 3/13/12 storm sample**

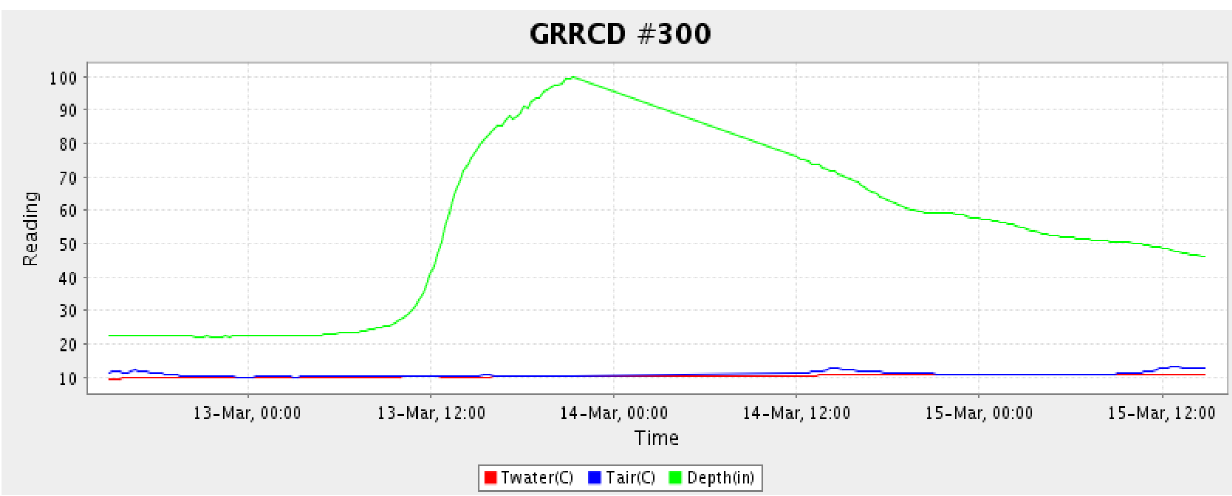
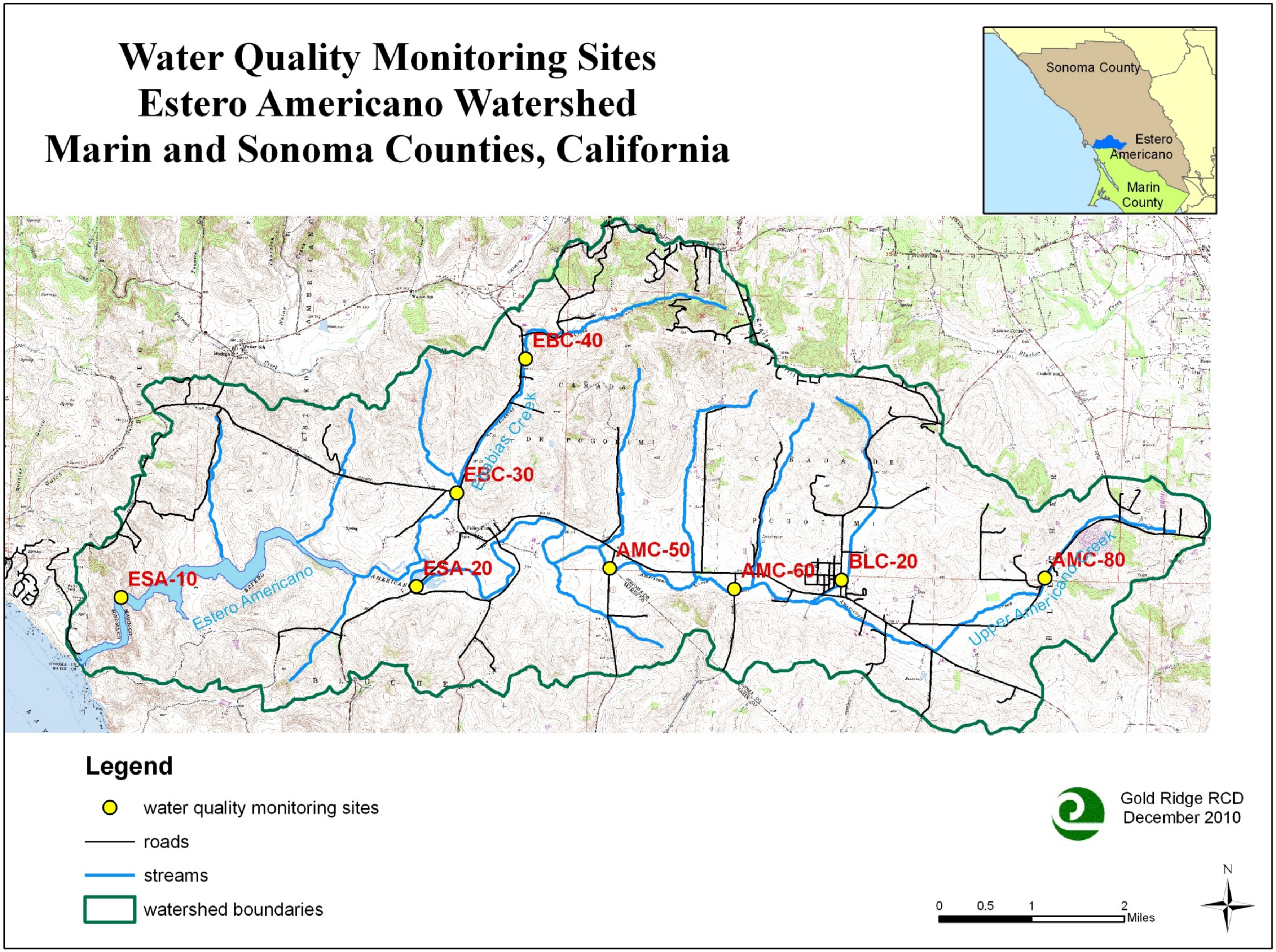


**Figure 3: Map of sampling locations throughout the Estero Americano Watershed.**



**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) |

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.

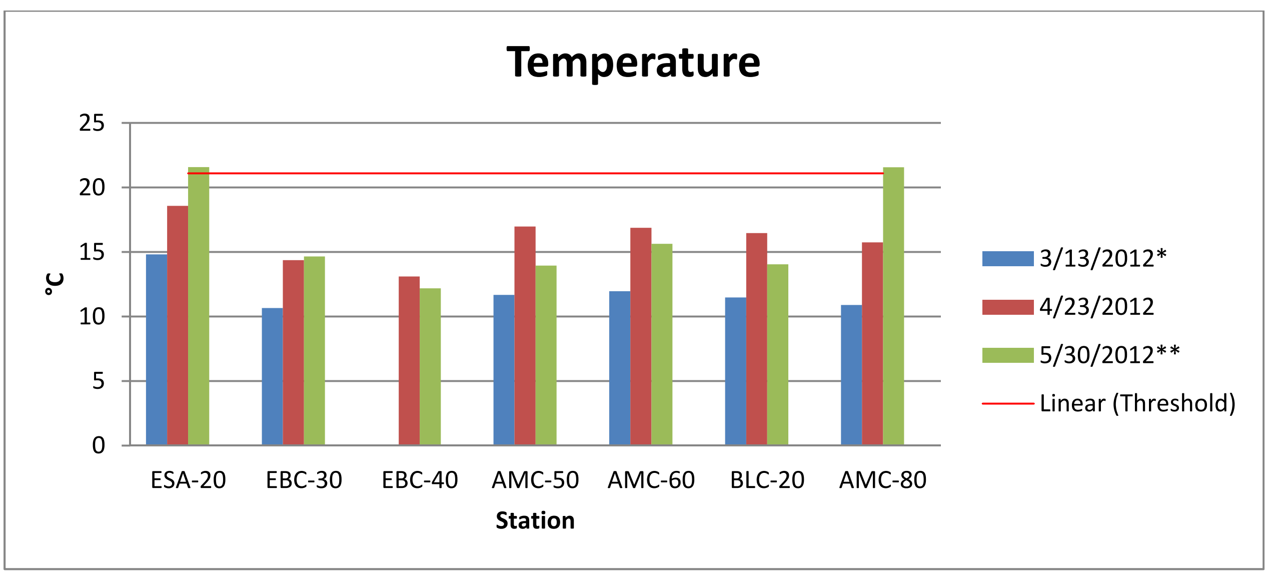
**Results and Discussion**

**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 10.66 to 21.56 °C for the freshwater stations and 14.81 to 21.58 for the Estero (ESA-20) station. The warmer temperatures measured during the May 30 sampling event (ranging from 12.19 to 21.56) exceeded water quality objectives for sensitive aquatic organisms at two locations, AMC-80 and ESA-20. AMC-80, the upstream-most sampling station, continued to exhibit the highest temperatures of all of the freshwater stations. 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 of the maximum temperature conditions, a future monitoring recommendation would be to install continuous temperature loggers to capture diurnal and seasonal variations, particularly during the summer months when temperatures are of concern.

**Figure 4: Temperature Measurements**

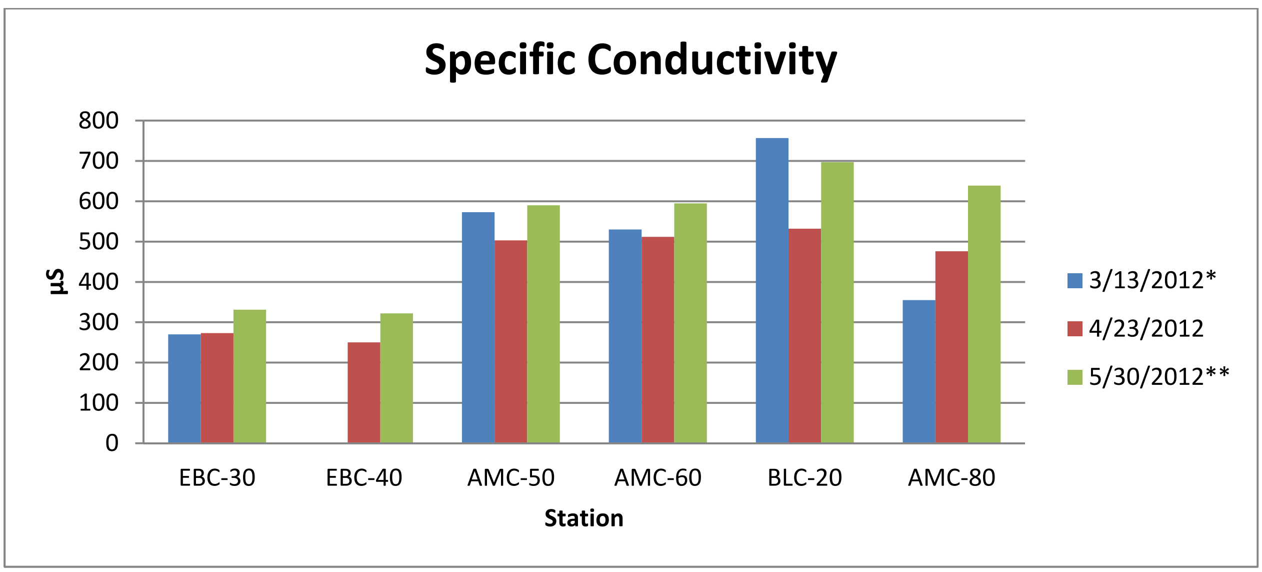


### Conductivity

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 270 to 757 μS and from 799to 23,580 μS in the Estero Americano (the ESA-20 conductivity results 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 expected, the conductivity results were highest at most stations during the May 30 sampling event. As streamflow levels drop to summer baseflow conditions, specific conductivity results generally increase. The highest conductivity result was observed at station BLC-20 during the the storm sampling event (3/13/12), this is of concern since the influx of stormwater free of pollutants generally lowers the conductivity rather than increasing it. The Ammonia and Ortho-phosphate concentrations measured at this site during the 3/13/12 sampling event were also high. Ebabias Creek continues to exhibit the lowest conductivity conditions of all sampled stations throughout the watershed.

**Figure 5: Specific Conductivity Measurements**

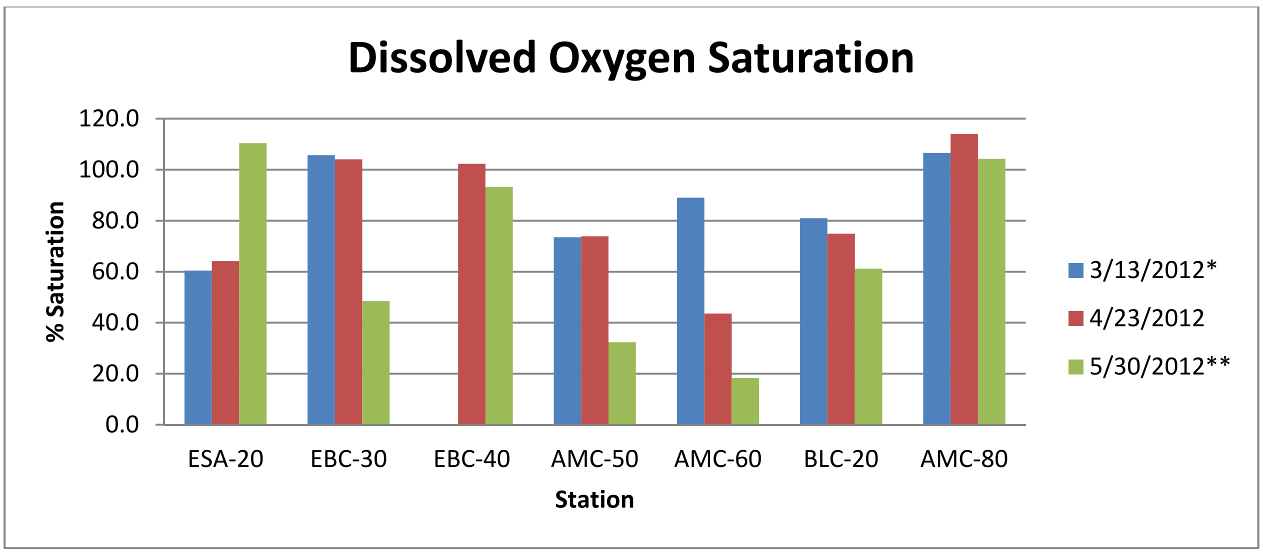


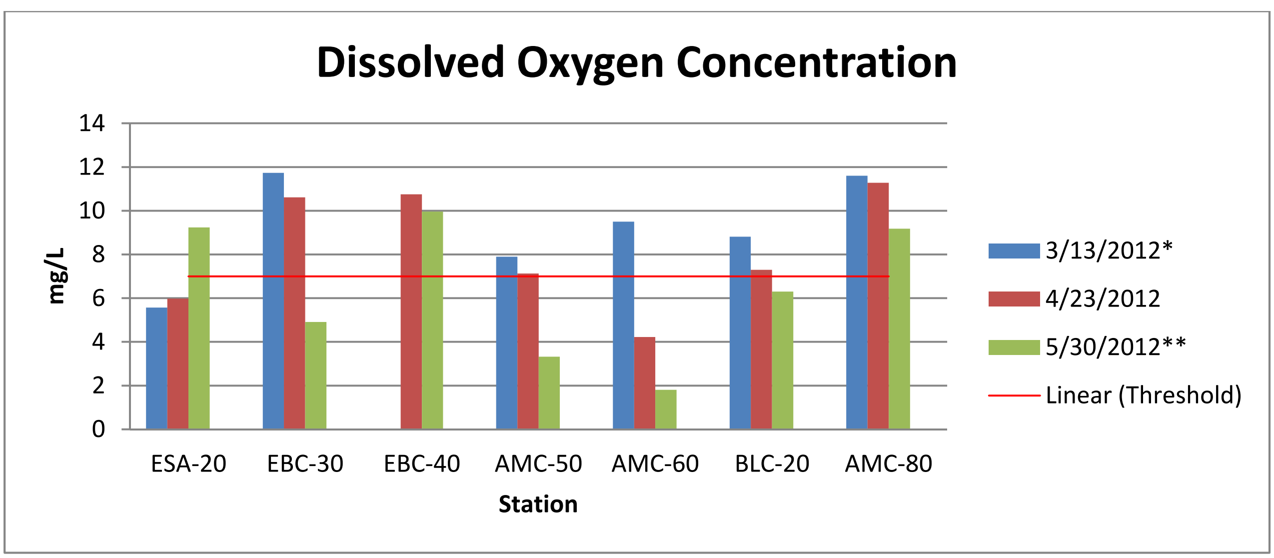

### Dissolved oxygen

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 18.3 to 114.0% saturation and 1.81 to 11.73 mg/l in Americano Creek at its freshwater tributaries. The 1.81 mg/l result at AMC-60 is unusually low for a May measurement, and should be watched during subsequent sampling events to see if the condition persists. The super-saturated DO conditions at AMC-80, ranging from 104.3 to 114.0 during the sampling period, were accompanied by relatively high temperatures (the warmest freshwater station) and the presence of algae and aquatic plants. Again, these conditions do not appear to persist downstream, in fact the next station downstream, AMC-60 had the lowest DO conditions of any site sampled. 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**



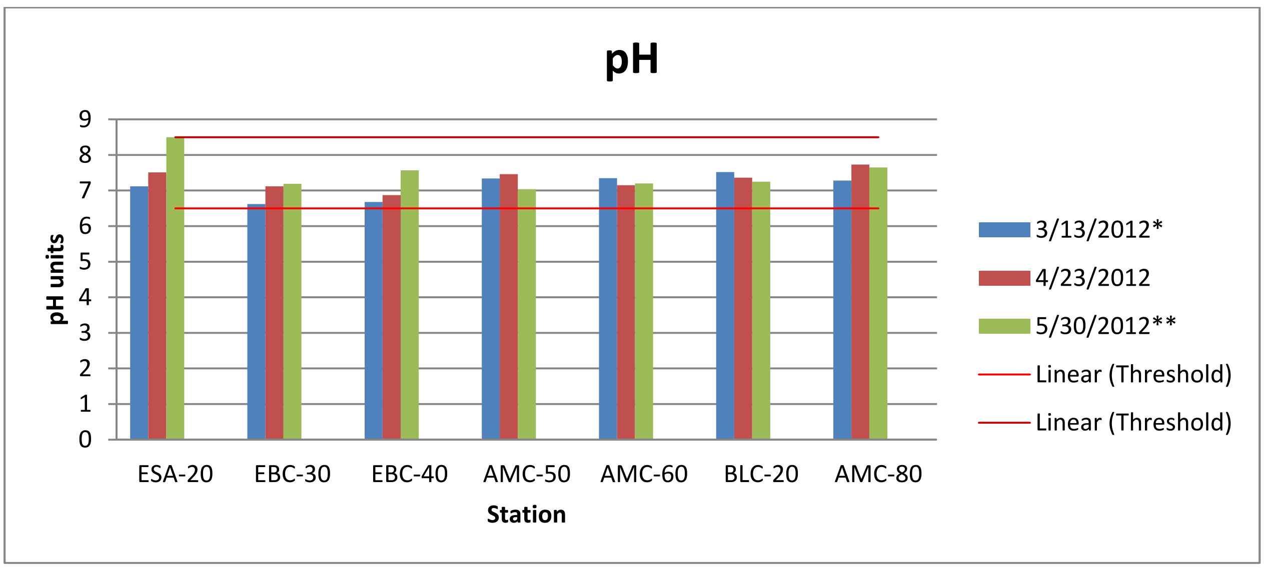



**pH**

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 6.62 to 7.65 pH units for freshwater stations and 7.12 to 8.5 at the Estero station. All measurements met water quality objectives. The most acidic measurement was at EBC-30 during the 3/13/12 storm event sampling and while this did not exceed the objective, the result continued a trend of Ebabias stations having the lowest pH readings in the Estero watershed. While this acidic condition did not persist throughout the watershed, it is something to continue monitoring since Ebabias Creek supports several sensitive aquatic organisms including California freshwater shrimp and steelhead trout.

**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 last storm sampling event of water year 2012 on March 13, 2012 and the annual late spring sampling on May 30, 2012. Data from the previous winter storm sampling on January 20, 2012 are included on the nutrient graphs for reference and trend comparison.

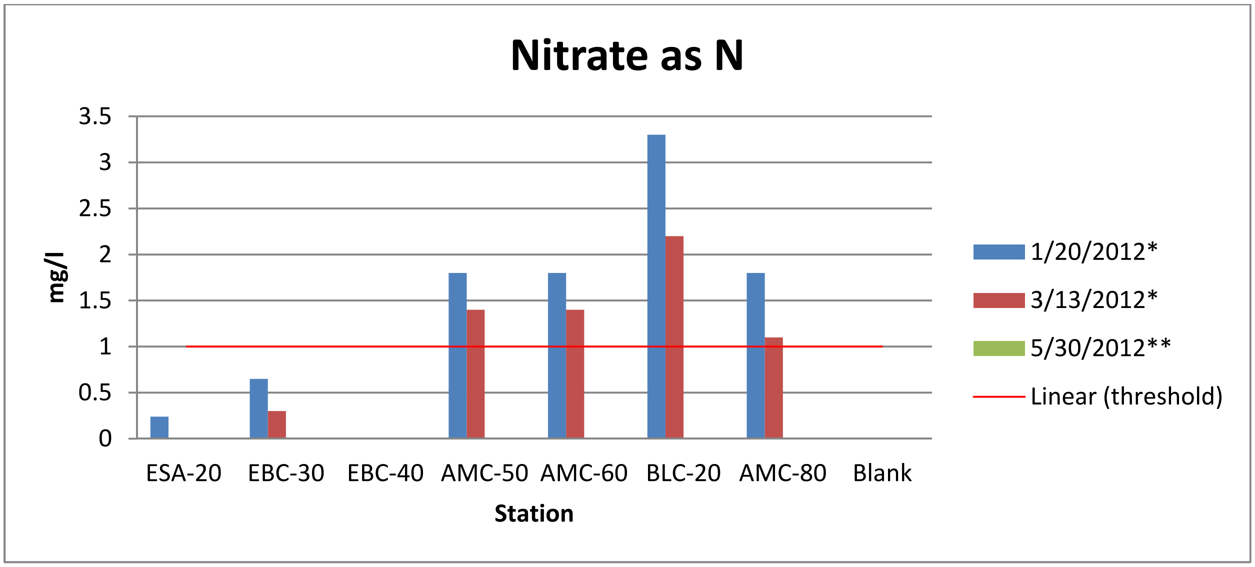
While nutrient levels generally have the greatest impact to water quality both directly (through toxicity) and indirectly (through decreased dissolved oxygen levels due to the biological oxygen demand of decaying plants and algae) during the low flow summer months, the highest concentrations are observed 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 is currently being requested.

**Nitrate**

Nitrate ($NO_3$) is an inorganic form of nitrogen that is soluble and therefore subject to leaching and biological uptake. For the 3/13/12 storm sampling event, Nitrate results at freshwater stations ranged from 0.3 to 2.2 mg/l for freshwater stations, with all stations except Ebabias Creek (EBC-30) exceeding the 1.0 mg/l Water Quality Objective. These results were uniformly lower than during 1/20/2012 storm sampling event, but that storm was significantly larger and resulted in higher peakflow and erosion rates and followed the trend observed in Americano Creek of runoff with higher nutrient concentrations occurring earlier in the rainy season. The 5/30/12 late spring ambient sampling did not show measurable concentrations of Nitrate-Nitrogen at any of the monitored stations (all results were less than the 0.2 mg/l analytical detection limit).

**Figure 9: Nitrate Measurements**

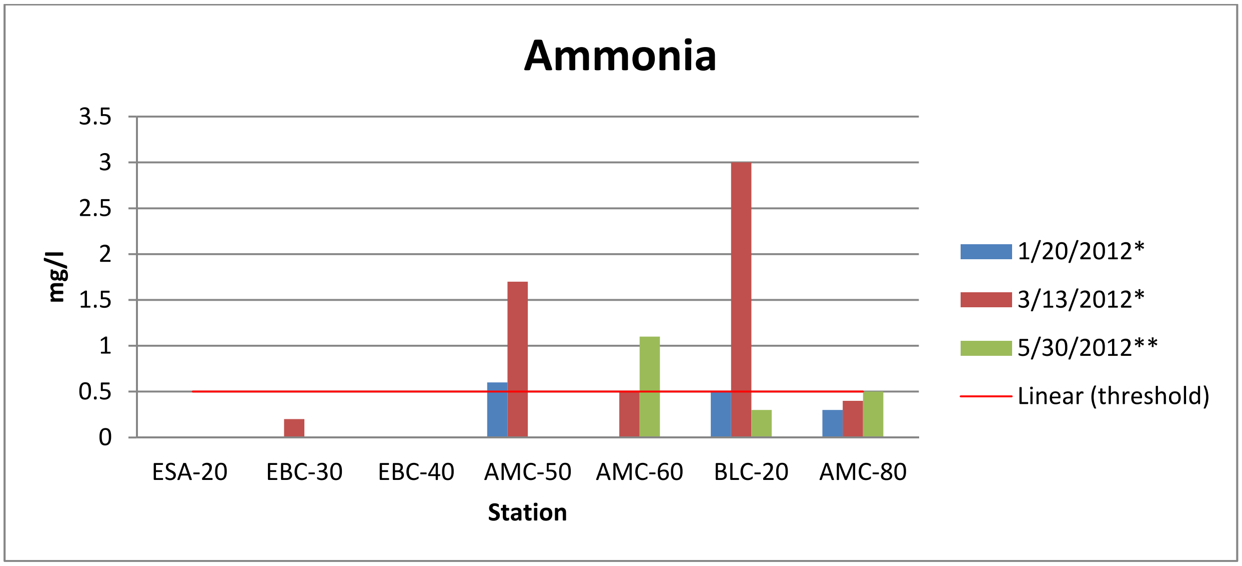



**Ammonia**

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 3.0 mg/L for the freshwater sampling stations during the 3/13/12 sampling event and from <0.2 (non-detect) to 1.1 on 5/30/12. During the storm event, ammonia concentrations exceeded the water quality objective at the AMC-50 and BLC-20 stations. During the late spring ambient sampling event on 5/30/12, ammonia concentrations exceeded the water quality objective only at the AMC-60. Due to the low water temperatures and generally neutral pH values during the 3/20/12 sampling, 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 3/13/12 storm sampling event, Orthophophate results ranged from 0.26 to 3.8 mg/l for freshwater stations, with all stations exceeding the 0.1 mg/l Water Quality Objective of 0.10 mg/l. The concentrations of orthophosphate measured during the 3/13/12 storm event and

5/30/12 late spring ambient sampling were higher than those measured during the 1/20/12 storm event. Since the January 2012 storm was larger and resulted in higher stream flow levels and the orthophosphate concentration appears to be increasing as the streamflows lessen to summer baseflow conditions, this available orthophosphate will likely serve as a biostimulant for algae and aquatic macrophytes this summer.

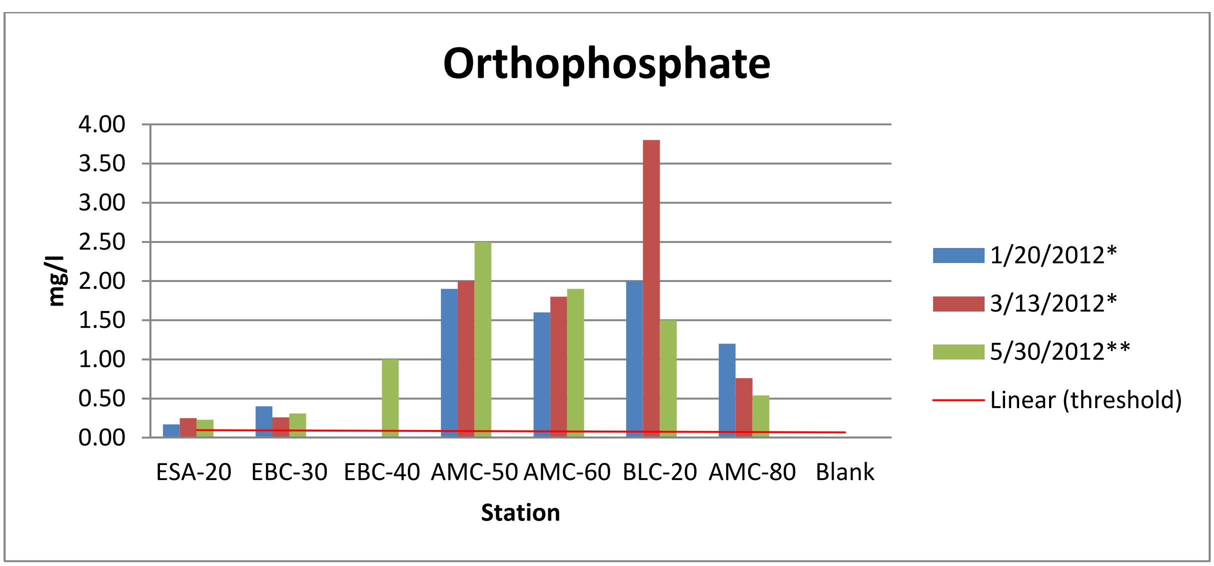
Considering the amount of algal and aquatic plant growth observed throughout Americano Creek and its tributaries under low flow conditions, it is likely that persistently high orthophosphate concentrations are causing a habitat and water quality impact.

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**



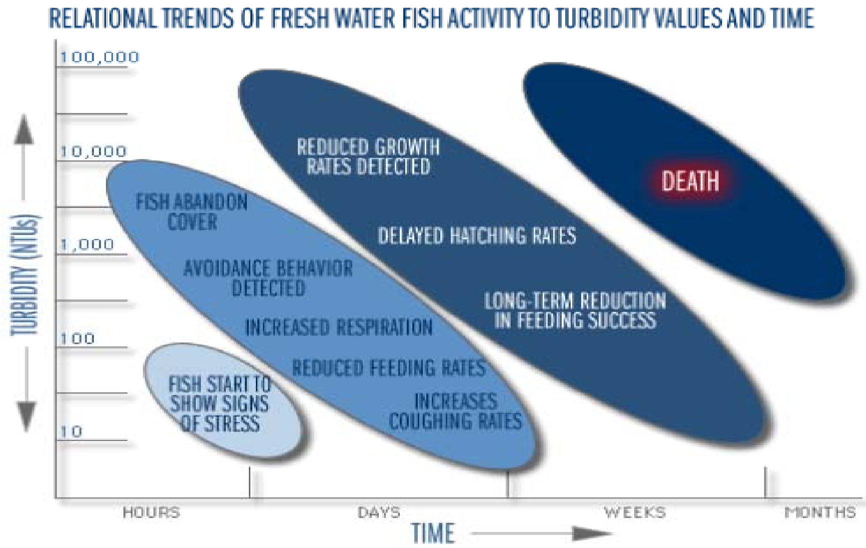
**Turbidity and Total Suspended Solids**

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.

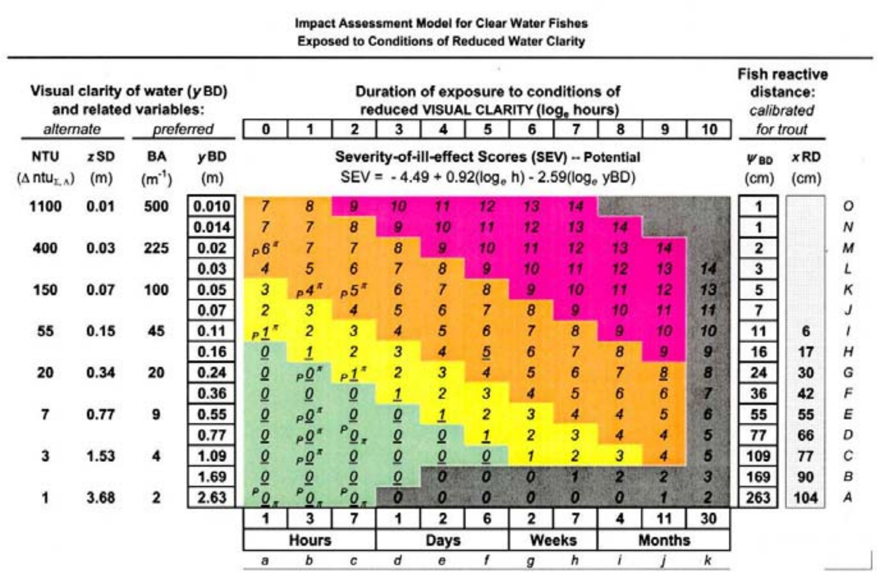
Excess turbidity reduces light, thereby reducing benthic organisms and ultimately fish populations. High turbidity level can increase water temperatures due to suspended particles absorbing heat. High turbidity levels also affect aquatic organisms by causing reduced feeding rates, reduced growth rates, 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](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 $SEV = -4.49 + 0.92(\log_e h) - 2.59(\log_e yBD)$ | | | | | | | | | | | $\psi_{BD}$ (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 3/13/12 storm event ranged from 179.0 to 332.0 NTUs at freshwater stations. Both turbidity and TSS levels were relatively high, compared with the higher volume and intensity 1/20/12 storm event, though considering how dry the winter was up to the March event, it is likely that this storm delivered more sediment since the watershed had been "re-primed" or saturated through the series of smaller storms in late February/early March. The highest turbidity and TSS results were measured at AMC-80 during the 3/13/12 storm event.

The high turbidity and TSS results from the 5/30/12 sampling were related to disturbance directly upstream of the sampling station by livestock at EBC-30 and AMC-60.

**Figures 14: Turbidity Measurements**

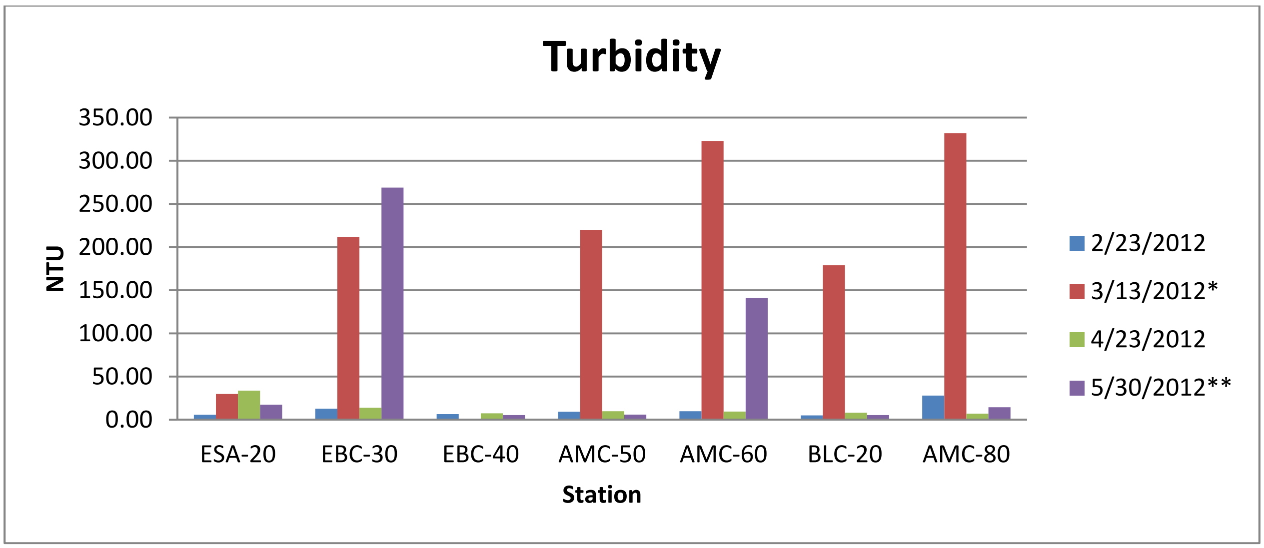
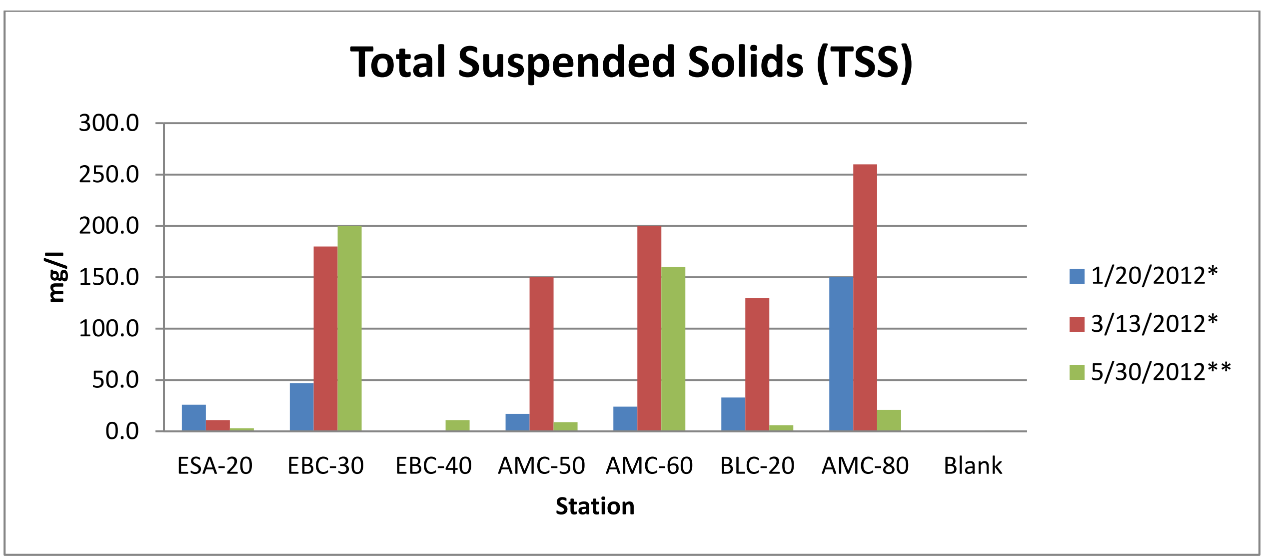



**Figure 15: Total Suspended Solids Measurements**



**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.