Water Quality Monitoring

Source Water Assessments

Source Water Assessments are conducted by the state under the 1996 amendments to the Federal Safe Drinking Water Act. The purpose of these assessments is to provide basic information about the drinking water in each public system and its safety. The City of San Marcos submitted an assessment in 1996 under report number 1050001.

Water Quality Monitoring Data

Water quality data and information was collected by many different entities and compiled to build a large data set for this plan. Monitoring locations are presented in Figure 1, monitoring dates in Table 1 and data used for model calibration are summarized in Table 2.

City of San Marcos: The City of San Marcos conducts surveys on the fecal coliform counts after rain events within various segments of the river. This data was integrated into the model in order to assist in the calibration process. The data utilized for the model ranged from January 2009 to May 2013 at 11 sampling sites.

Texas State University: During the development of the Watershed Protection Plan, data was collected at 6 sites on the Upper San Marcos River which include from upstream to downstream: Spring Lake, the Old Mill site just below the Spring Lake dam, the Lion's Club Park, Rio Vista Park, Interstate 35 crossing, and River Road crossing. There were 6 events collected during baseflow conditions, and 4 events collected during storm flow conditions. These samples were taken via grab samples and brought to the lab at Edwards Aquifer Research and Data Center (EARDC) for analysis.

Table 1. Texas State University sampling dates

Storm Event Sampling	Base Flow Sampling
10-31-13	11-20-13
11-25-13	12-4-13
4-14-14	12-19-14
5-12-14	8-27-14
	9-25-14
	1-21-15

The primary stormwater data utilized for calibration efforts was collected by Dr. Ben Schwartz and Dr. Weston Nowlin from the Biology Department at Texas State University as part of the San Marcos Observing System (SMOS) at the Meadows Center for Water and the Environment. Stormwater data was collected during stormflow events. A Teledyne ISCO automated water sampler was installed at tributaries including Sink Creek, Sessom, Purgatory, and the lower river reach before the confluence with the Blanco River (The Meadows Center for Water and the Environment, 2012). Parameter data from the water quality monitoring includes: discharge, *E. coli*, ammonia, nitrogen, phosphorous, biochemical oxygen demand (BOD), TSS, and DO. For each event, the sensors recorded various parameters for a 24-hour duration after it detected the first pulse of discharge.

EA HCP, 2013: As part of a wide-reaching Habitat Conservation Plan, the Edwards Aquifer Authority has increased their water quality monitoring by installing two real-time water quality sensors and sampling sediment at 7 sites. Constituents measured within sediment samples include heavy metals, hydrocarbons, Pesticides (DDE, DDT, and DDD), and PCBs. On May 30, 2013, two real-time water quality sondes were installed at Sewell Park and the Railroad track near Cypress Island. The station monitors the amount of DO, turbidity, conductivity, temperature, and pH every 15 minutes.

WWTP and Fish Hatchery: As stated by section 502(14) of the Clean Water Act, all permitted point sources are required to document their flow and quality of water discharged. The frequency and parameters measured are set by the type of discharge permit. Since WWTP discharge is regulated and permitted from a WWTP, the water quality constituents are more comprehensive than the permitted discharge from the A. E. Wood Fish Hatchery. The constituents are monitored by the wastewater treatment plant daily and include all the parameters modeled within Hydrological Simulation Program—Fortran (HSPF). Whereas, the A. E. Wood Fish Hatchery discharge data was a monthly average along with daily Total Suspended Solids (TSS). The monthly average amounts were subdivided into daily estimates of discharge in order to calibrate the inflow data.

Guadalupe Blanco River Authority: The GBRA provided one of the most extensive water quality monitoring datasets. Through a partnership between the GBRA and the TCEQ the Clean Rivers Program (CRP) strives to assess wastewater discharge and water rights permit holders. In the Upper San Marcos watershed, this program has monitored various water quality parameters at IH-35 Bridge since 1998. Due to the fact that they have continuously monitored at the exact location, their dataset provided a comprehensive inventory of change over time. Therefore, this

dataset was useful for not only calibrating the 2009-2013 simulation period, but also validating the 1998-2003 simulations for water quality concentrations above IH-35.

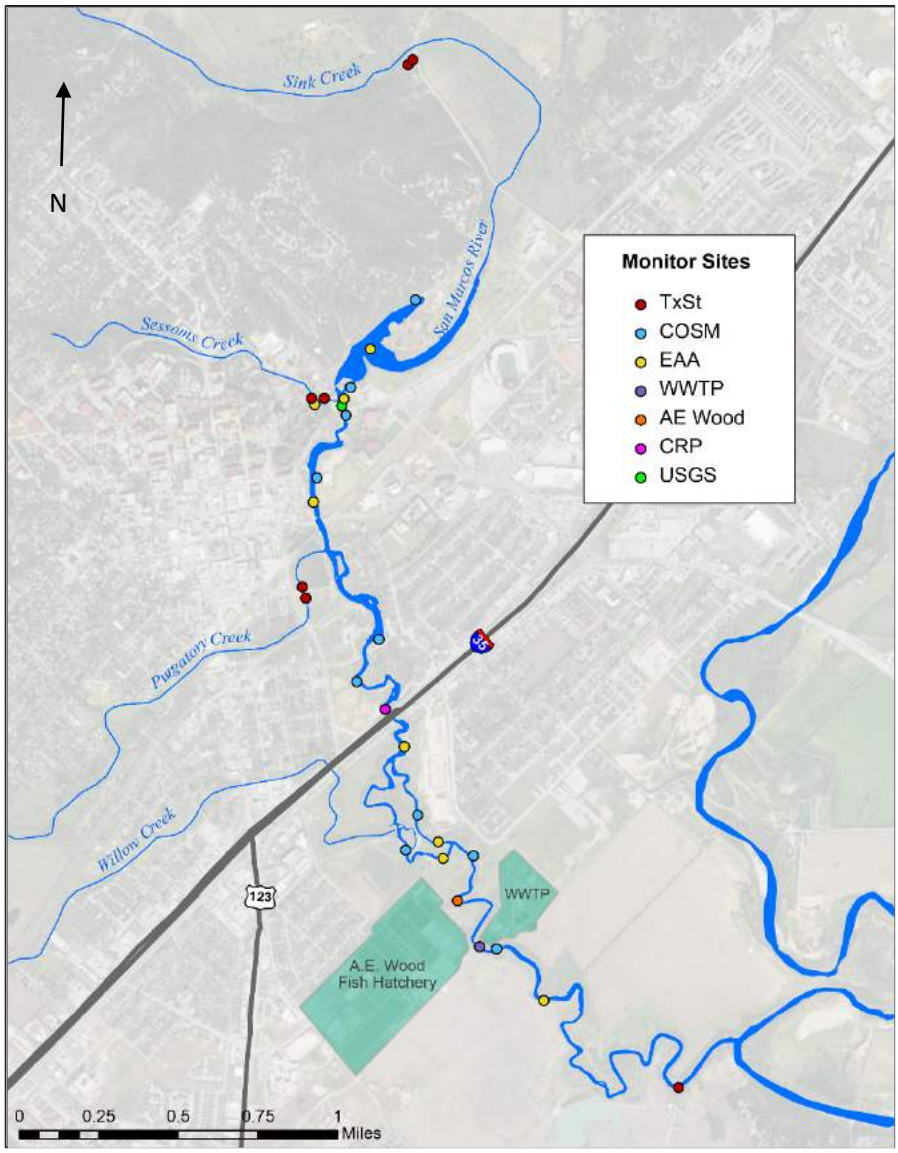

Figure 1. Upper San Marcos River water quality monitoring sites

Table 2. Water quality data and sources used for calibration of simulated results

	USGS	COSM	Texas State Univ.	EAA	COSM WWTP	State A.E. Wood	GBRA (CRP)
Discharge	X		X	X	X	X	X
E. coli		X			X		X
Ammonia			X	X	X		X
Nitrogen			X	X	X		X
Total Phosphorous			X	X	X		X
BOD			X	X	X		X
TSS			X	X	X	X	X
DO			X	X	X	X	X
TDS/Conductivity			X	X			X

Texas Stream Team: Texas Stream Team (TST) is a statewide citizen science program that collects monthly surface water quality and environmental data from creeks, rivers, lakes and bays all across the state. Citizen scientists collect surface water quality data that may be used in the decision-making process to promote and protect a healthy and safe environment for people and aquatic inhabitants. Citizen scientist water quality monitoring data provides a valuable resource of information by supplementing professional data collection efforts where resources are limited. The data may be used by professionals to identify water quality trends, target additional data collection needs, identify potential pollution events and sources of pollution, and to test the effectiveness of water quality management measures.

TST Citizen Water Quality Monitors are trained to collect measures for temperature, dissolved oxygen, specific conductivity and total dissolved solids, pH and total depth, as well as E. coli bacteria, nitrate/nitrogen, and orthophosphate/phosphorous and operate under a state and federally approved quality assurance plan (http://gato-docs.its.txstate.edu/jcr:aa7f7473-f0a2-4698-bf73-2b9e8acfb62e/TST_QAPP_2015_2016.pdf). In the Upper San Marcos Watershed, The San Marcos River Rangers collect data monthly or bi-monthly at least 15 sites in the watershed. Some sites have been monitored for more than 20 years. Please visit http://sanmarcosriver.org/smrf-projects/water-quality-monitoring/ for more information about the River Rangers.

Add info from LMP on total # monitors, sites, map etc

In December of 2013, TST compiled and analyzed collected data between 1995 and 2013 and present specific site analyses for monitoring site in Sink Creek, Sessom Creek, Spring Lake, Purgatory Creek, a culvert/outflow to the main stem, an outfall downstream from the fish hatchery, and multiple sites on the main stem of the river, including key recreation areas. This report can be found online and in Appendix A5.1.

Stormwater, Baseflow Monitoring Analyses

Water quality data was collected by Texas State University at six sites on the main stem of the river, located between major tributaries, as well as one site on Willow Springs Creek. This data was analyzed to determine potential contributions of pollutants from tributaries to the main stem of the river. Most parameters were well below the state standard or screening level during baseflow conditions. Only TSS and TDS exceeded standards/screening levels. Concentrations of TDS were significantly higher in samples taken in baseflow conditions compared to samples collected during storm events, indicating the TDS may be primarily supplied by spring flows.

Data also was collected at all seven sites during four storm events. During storm flow conditions, a few sites showed elevated concentrations of phosphorus and E. coli (above the state standards and screening levels).

Both Purgatory Creek and Sessom Creek provide nutrients and sediments to the Upper San Marcos River during rainfall events. Sampling conducted during the Spring Lake Watershed Characterization showed that the water discharged by Purgatory Creek was shown to be significantly higher in total phosphorous and phosphates than water discharged from Sessom Creek. Thus, Purgatory Creek may be of greater concern than Sessom Creek when assessing phosphorous and phosphates (Nowlin and Schwartz, 2012).

Nitrogen is an essential nutrient for plants, but elevated levels can be detrimental and increase the likelihood of eutrophication in rivers and streams (USEPA, n.d. [c]). Sources of nitrogen include wastewater effluent, runoff from fertilized cropland and lawns, failing septic tanks, and runoff from animal manure storage sites. Of 14 surface water sampling events conducted by Edwards Aquifer Authority, the Sessom Creek site recorded the two highest readings for nitrogen. The highest amount, 1.7 mg/L, was detected on April 16, 2013 and the second highest amount, 1.52 mg/L, was measured on October 8, 2013. While these values are still below the 10 mg/L MCL standard for drinking water, they do surpass the USEPA's suggested average of 1 mg/L for freshwater bodies.

I. Phosphorus

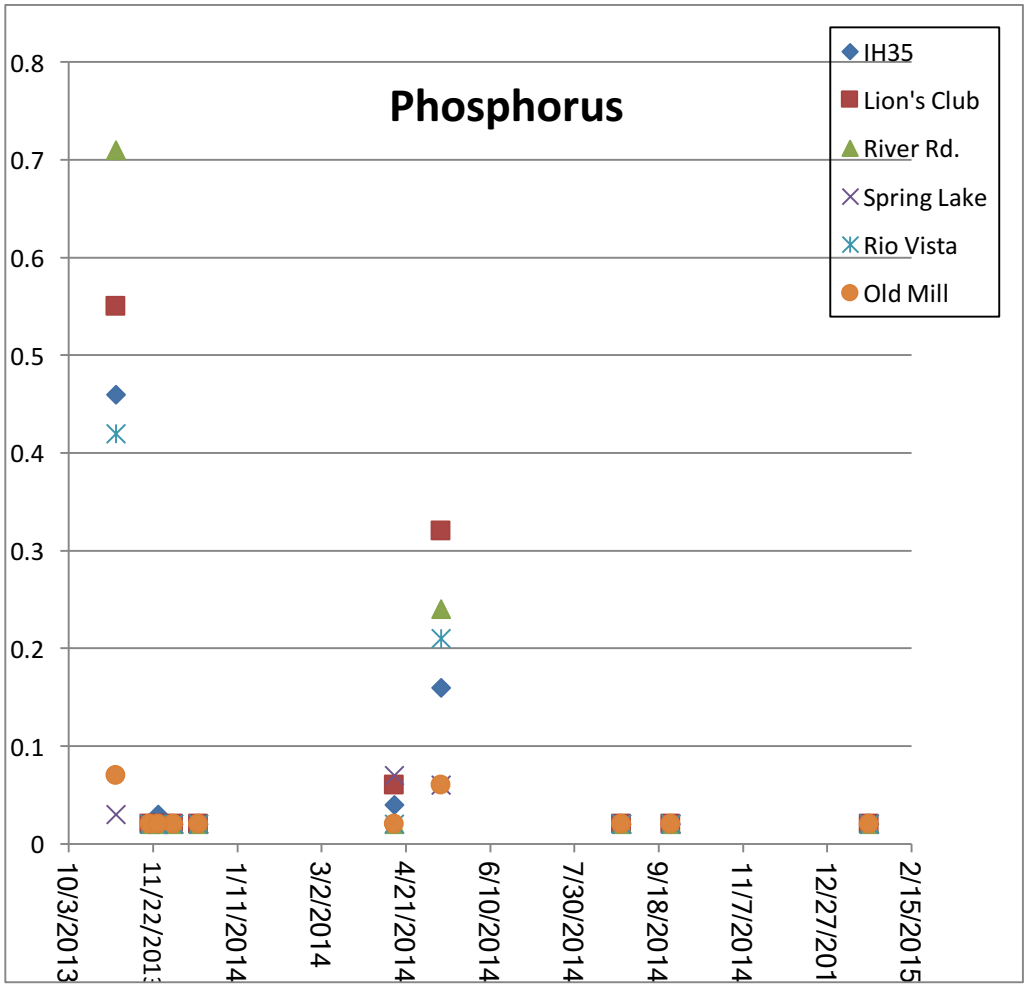

Figure 2. Phosphorus levels in baseflow and stormflow conditions

Phosphorus during baseflow conditions is generally below 0.1 mg/L. Phosphorus monitored during the project period only showed one instance of levels being over the state screening level of 0.69 mg/L. This occurred at River Rd, during the Halloween Flood of 2013. The storm event which occurred on May 12, 2014 had higher Phosphorus levels, but no sites measured above the screening level. Only two stations during the Halloween flood were above the strictest stakeholder Target B of .55 mg/L.

II. Nitrogen

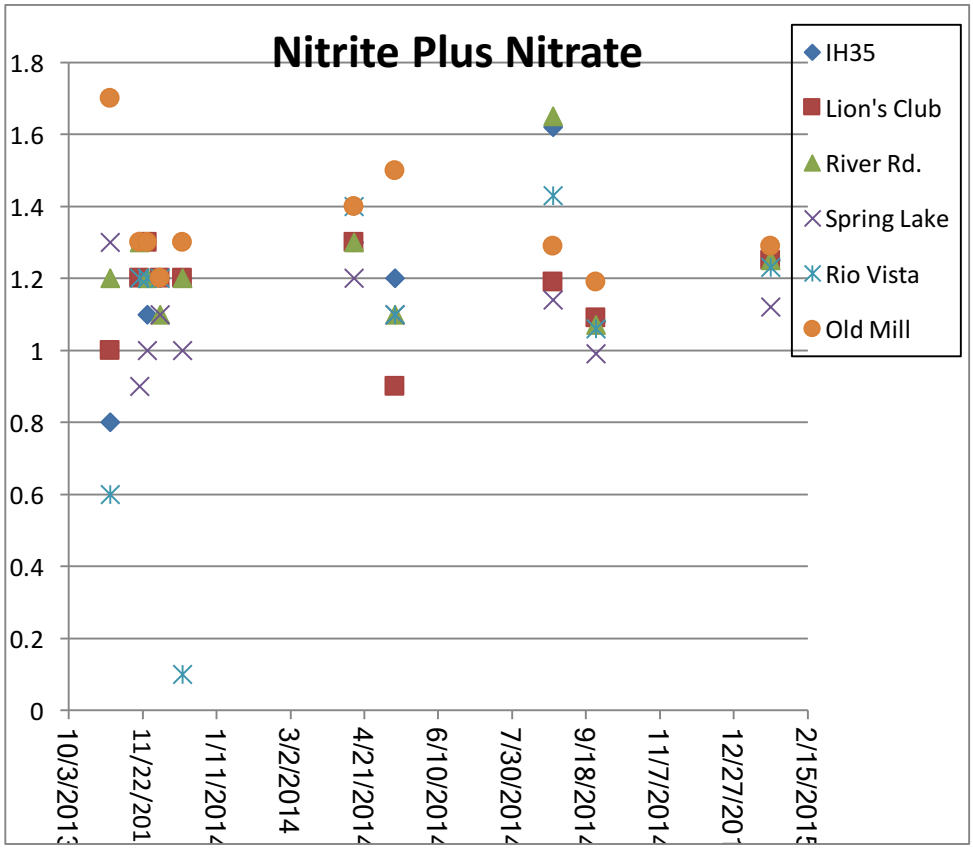

Figure 3. Nitrogen levels in baseflow and stormflow conditions

Nitrogen during baseflow and stormflow conditions during sampling was below 1.8 mg/L. Nitrogen monitored during the project period showed no instances of levels being over the state screening level of 1.95 mg/L. The flood event which occurred on October 31, 2013 had higher Nitrogen levels, but no sites exceeded the screening level during base or storm flows. Three sites during two storm events were above the strictest stakeholder Target B of 1.60 mg/L.

III. E. Coli

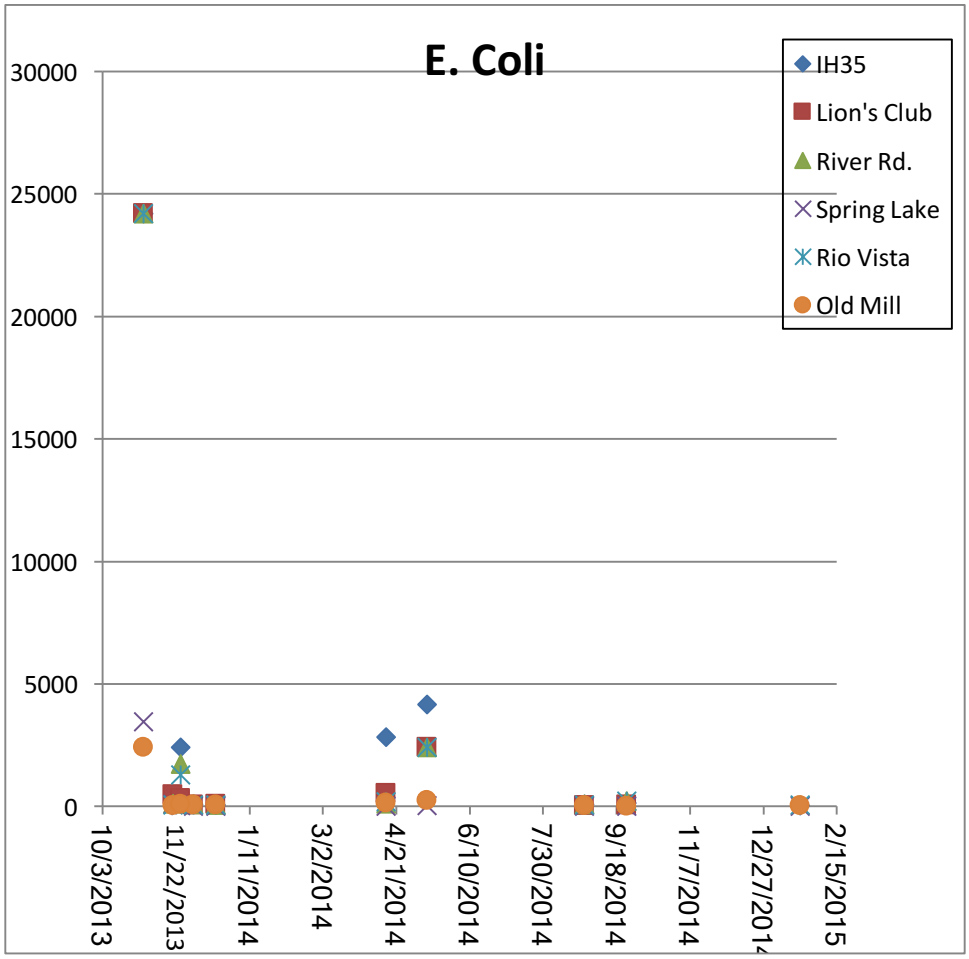

Figure 4. *E. coli* levels in baseflow and stormflow conditions

E. coli during baseflow and stormflow conditions during sampling was below 25000 CFU/100mL and only 3 sites during the Halloween flood were above 5000 CFU/100m/L. The geometric mean of all E. coli samples taken in the main stem during base and storm flows had a value of 105.6 CFU/100mL Geometric Mean. This Geomean is above the strictest stakeholder Target B of 101 CFU/100mL, but not above Target A of 113.4 CFU/100mL.

IV. Conductivity

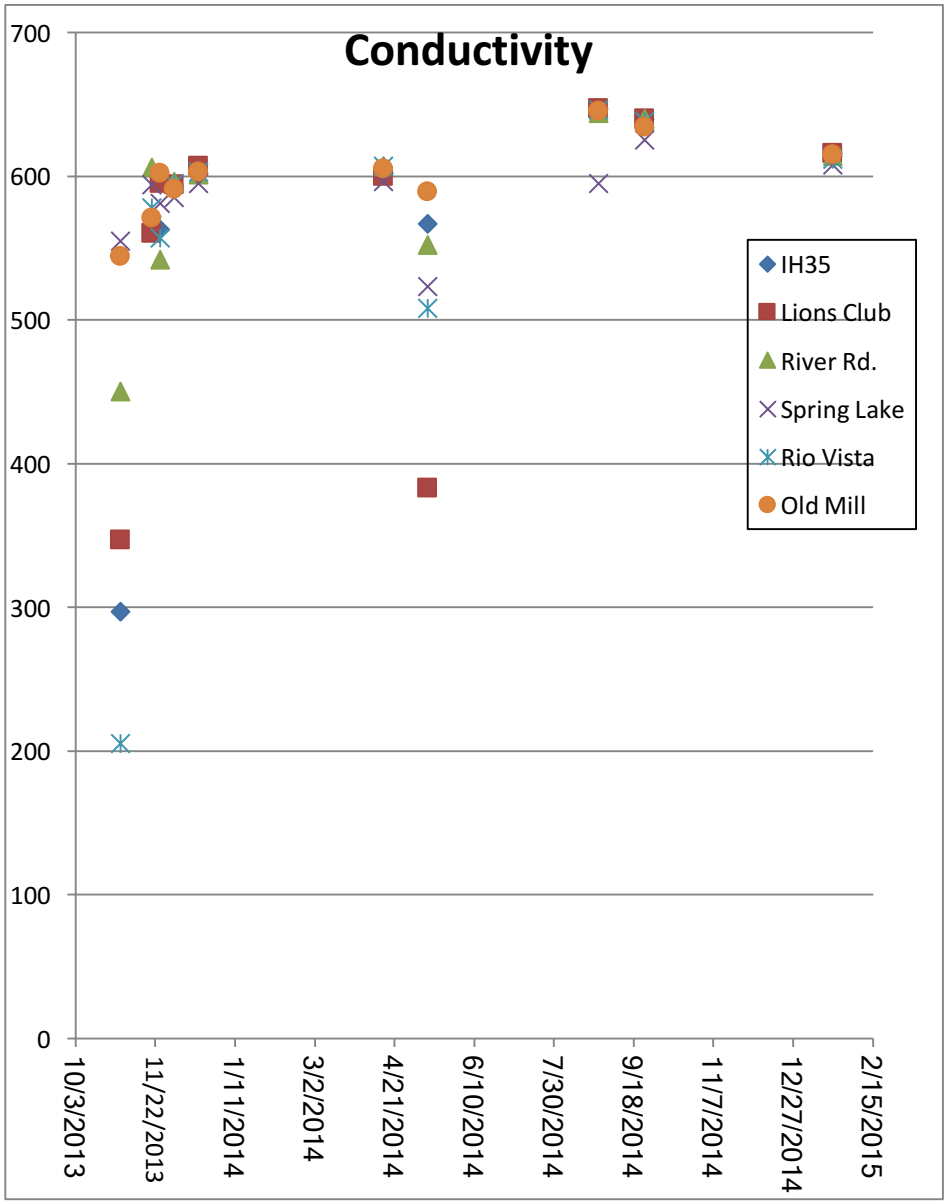

Figure 5. Conductivity levels in baseflow and stormflow conditions

Conductivity during baseflow and stormflow conditions during sampling was below 700 S/m. When this conductivity data is multiplied by the conversion factor of .65 to get Total Dissolved Solids data, there are 13 instances of a TDS reading over the state standard of 400 mg/L. However, as seen in Figure 7 and Figure 8 depicting direct TDS measurement below, the readings are quite lower, with a ratio between TDS and conductivity closer to .55. Also noteworthy is that the baseflow dates are the highest TDS ratings, while the major flood event on October 31, 2013 is the lowest conductivity measured during the project period. This confirms speculation that TDS

and conductivity have an inverse relationship to rainfall and that the source of the TDS is groundwater and not non-point source pollution transported by storm events.

V. TDS

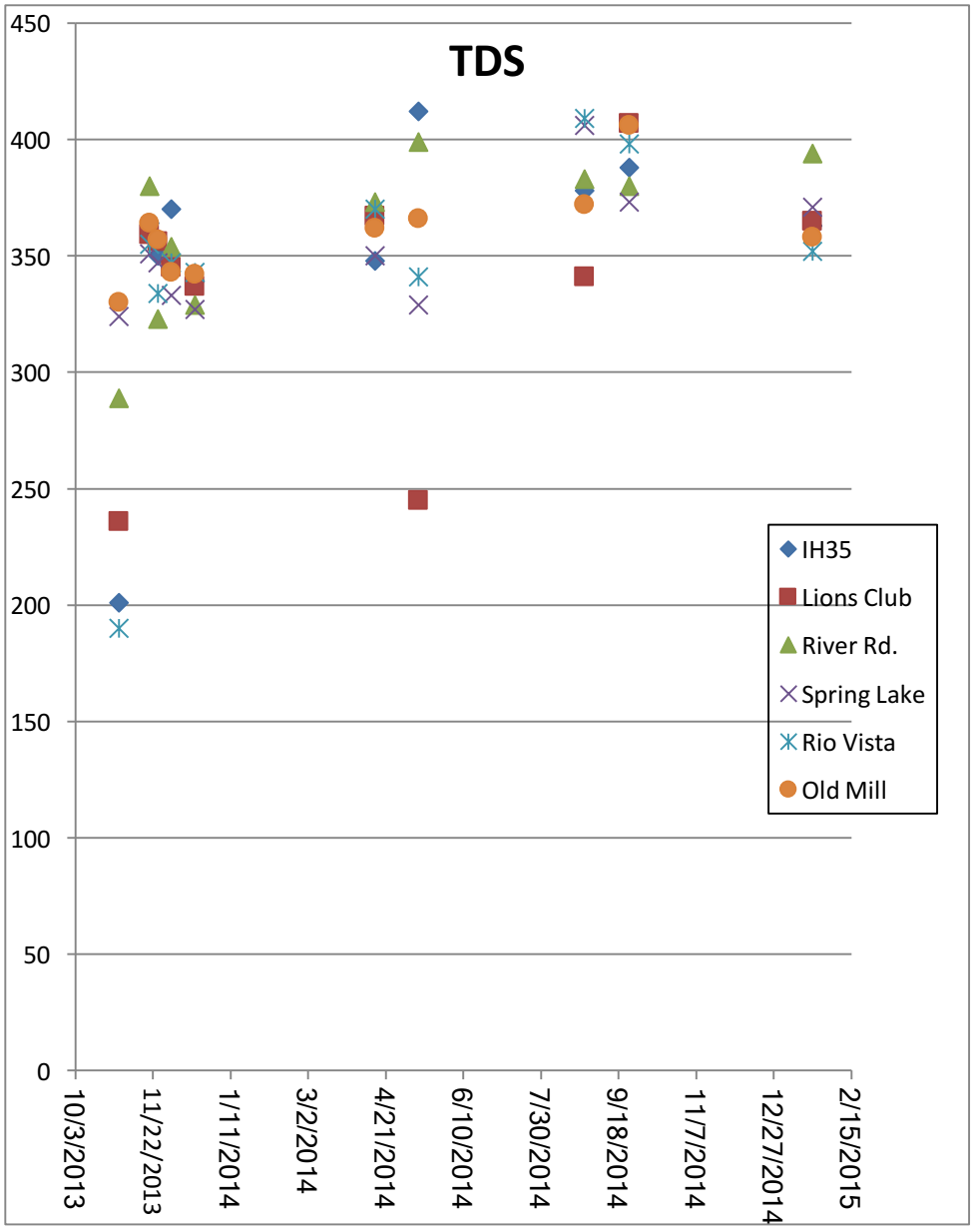

Figure 6. TDS levels in baseflow and stormflow conditions

Total Dissolved Solids measurements were over the state standard of 400mg/L at 5 sites over three events. Two of these events were base flow and one was a storm event. Most of the lowest recorded TDS measurements were observed during storm events.

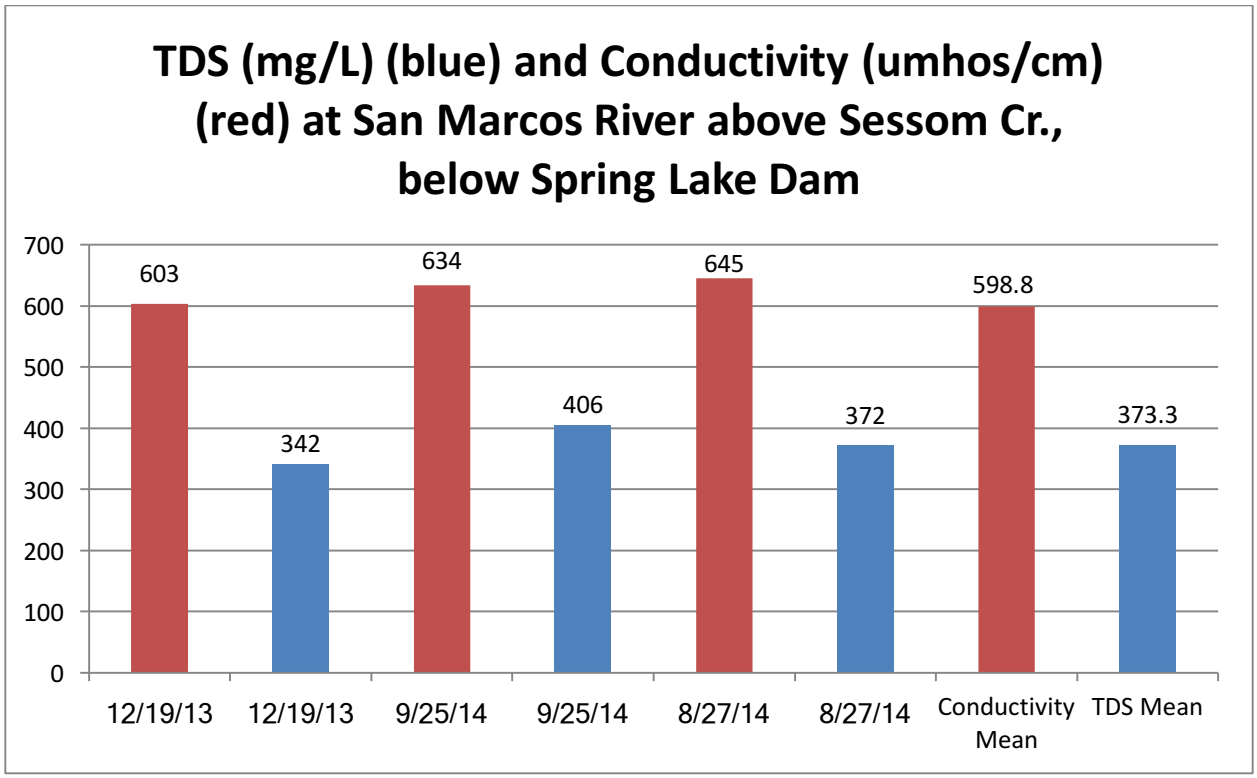

Figure 7. TDS and Conductivity at San Marcos River above Sessom Cr., below Spring Lake Dam

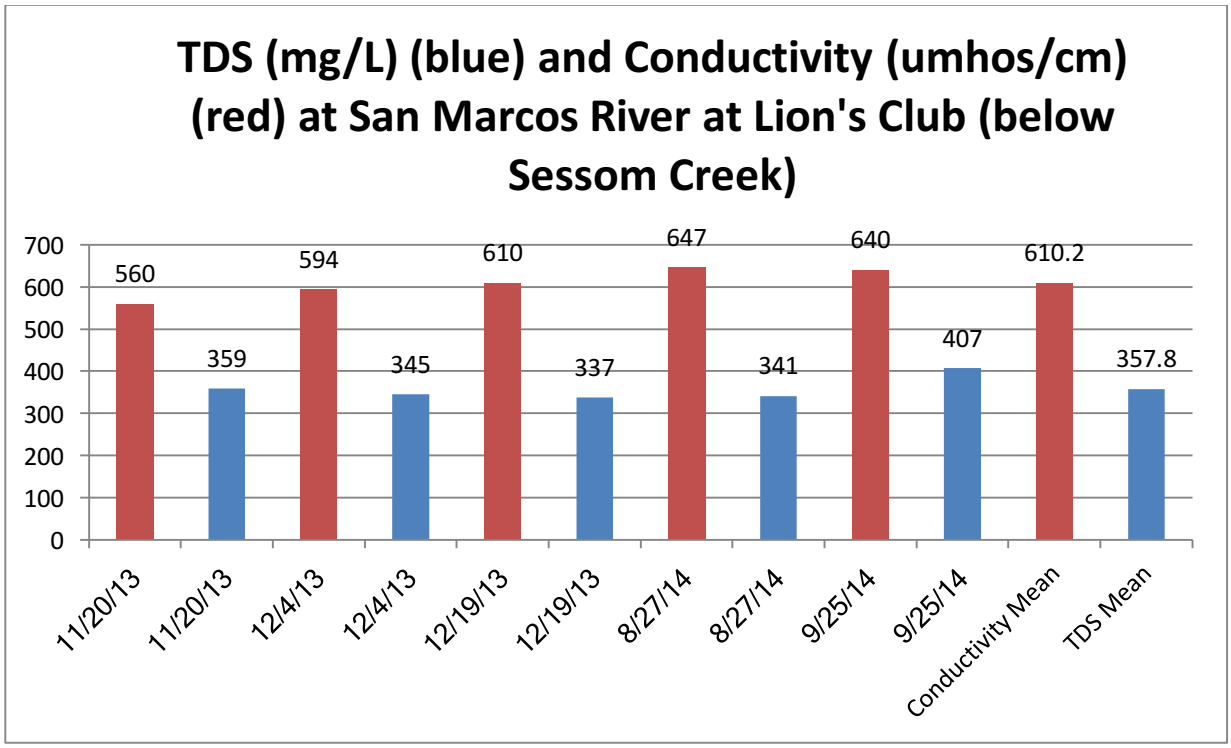

Figure 8. TDS and Conductivity at San Marcos River at Lion's Club

VI. TSS

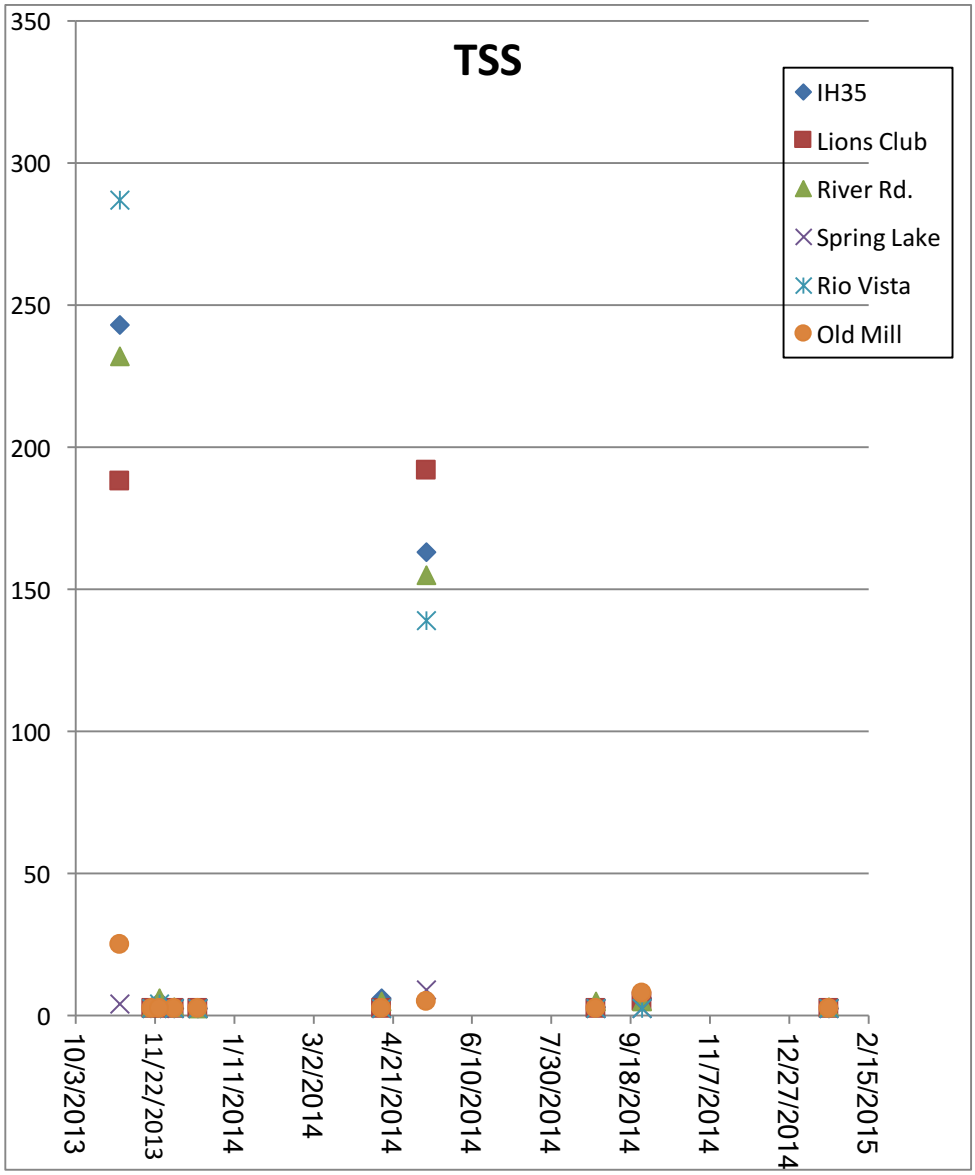

Figure 9. TSS levels in baseflow and stormflow conditions

Total Suspended Solids were mostly below 3 mg/L during base flow conditions. But during the Halloween flood and a storm event on May 12, 2014, TSS spiked as high as 287 and 188 respectively. TSS is highly susceptible to the flashy hill country climate in the watershed.

Other Constituents of Concern

Particulates and metals: The Slough Arm portion of Spring Lake accumulates a large amount of fine sediment and particulates transported from Sink Creek and various upstream tributaries. According to land cover data, Sink Creek subbasin contains the highest concentration of

agricultural land use all the modeled San Marcos tributaries. The Habitat Conservation Plan's monitoring effort included testing soils for metals. Although values did not exceed regulatory standard of 10 µg/L, the site sampled within the Sink Creek subbasin had the highest surface water reading of arsenic, 4.64 µg/L.

Volatile Organic Compounds: (VOCs) are commonly associated with anthropogenic sources. Of three surface water sampling events conducted at seven sites, one semi-volatile organic compound was detected at the Sessom Creek site on October 8, 2013. The compound was identified as diethyl phthalate, which is commonly found in plastics, cosmetics, and pesticides. The concentration of the VOC, 2.98 µ/L, was well below the threshold limit of 980 µg/L (EAHCP, 2013).

Polynuclear Aromatic Hydrocarbons: (PAHs) are a diverse group of organic compounds that are produced during the combustion of wood and fossil fuels. They can have natural or anthropogenic sources. However, high concentrations in urban waterways are most likely due to anthropogenic sources such as roads and parking lots (Barra et. al, 2009). The PAH concentration is the sum of concentration of various compounds, including: anthracene, pyrene, fluoranthene, flourene, acenaphthylene, chrysene, phenanthrene, and others. The Edwards Aquifer Authority collected sediment samples at five sites on June 12, 2013 and analyzed 16 different PAH compounds. Two of the five sample sites, Sessom Creek and City Park, exceeded the threshold of 22,800 µg/kg as set by McDonald et al. (2000). Sediment sampling conducted at Sessom Creek detected 16 different PAH compounds that had a total concentration of 52,218 µg/kg. This site is located below Aquarena/San Marcos Springs Road, which receives a lot of automobile traffic due to its proximity to Texas State University. This location receives runoff from large impervious areas upstream.

The PAH concentration at the City Park site was even higher than the Sessom Creek combined PAH (Figure 10). The City Park site is located adjacent to the Hopkins Street Bridge, which is a major street that connects downtown San Marcos to IH-35. Therefore, this site is very susceptible to particulates emitted and deposited from automotive vehicles and can be toxic for organisms that dwell in sediments (EAHCP, 2013).

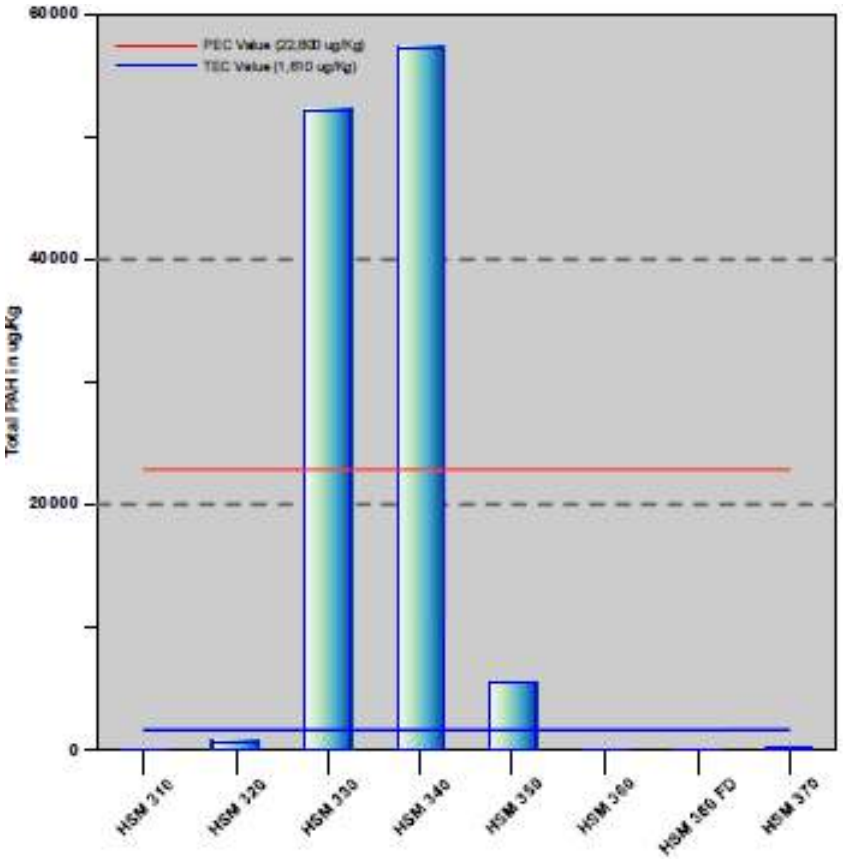

Figure 10. San Marcos sediment PAH detections compared to TEC (detection threshold) and the PEC (safety standard) [Courtesy of the EAA HCP 2013 Water Quality Summary Report]