Water quality testing of the Los Cerritos Channel and San Gabriel River for use in the Los Cerritos Wetlands restoration project.

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Abstract

As part of the Los Cerritos Wetlands restoration project, our goal was to explore and evaluate the water quality of the Los Cerritos Channel and San Gabriel River by examining concentration of heavy metal (Copper, Zinc, Lead) and Total Petroleum Hydrocarbons level. In addition, pH, salinity, temperature, and dissolved oxygen were also measured to see if the water quality is suitable as aquatic and wildlife habitat. We took samples from six locations in and around the Los Cerritos Wetlands. Our findings indicate that wet-weather conditions have a major influence on the heavy metal concentration. The tides did not influence heavy metal concentrations significantly. Our recommendation is that both the Los Cerritos Channel and the San Gabriel River may be used for a wetlands restoration project.

Introduction

The purpose of this study is to test the Los Cerritos Channel and San Gabriel Rivers water quality to determine whether the surrounding waters meet water quality standards. Any proposed Los Cerritos Wetlands restoration project will require water to be allowed into the wetlands, this water may not be suitable for the proposed restoration. Results of this study could determine from which water source the wetlands should be fed and the general locations of potential contaminant sources.

The Los Cerritos Wetlands have a few potential water sources for the proposed restoration project. The first is the Los Cerritos Channel that runs along the border of the wetlands north of 2nd street between Studebaker Rd and PCH. The second water source is the San Gabriel river the north east between 2nd and PCH. A third water source would be from a neighboring power plant fed by the San Gabriel River that is just east of the LCW at 2nd street. The final water source may be from the Marina stadium just west of the Los Cerritos Wetlands at PCH between 7th and 2nd street.

Long Beach has lost 98.3% of its wetlands due to urban growth over the past 100 years, transforming the local wetlands into a modern urban city (LCW Land Trust). The remaining roughly 776 acres of fragmented wetlands needs to be preserved and restored. Once this wetland is gone restoration will be near impossible. Wetlands are described as the nurseries of the sea and are home to many species of fish in their initial stages of life such as the resident flounder. Another aspect is that identifying contamination sources will allow for the remediation of water bodies that feed into our local beaches, improving water quality and biodiversity. The LCW is currently the largest salt marsh within the Los Angeles County area and is home to species that are threatened or endangered such as the Belding's Savannah Sparrow that is making a noticeable comeback within the Los Cerritos Wetlands.

The Los Cerritos wetlands have gone from some 2,400 acres at the mouth of the San Gabriel River to an estimated area of 776 acres in a span of some 100 years. These relatively small parcels of land are hardly even considered to be functioning wetlands due to intense degradation. Currently the major land owners of the Los Cerritos wetlands are Tom Dean who acquired the land from Bixby Ranch Co., Bryant Trust, and Hellman Ranch Co. These land owners have, over the years; emitted pollutants into, drained, filled in, paved over, fragmented and developed the Los Cerritos wetlands. Oil extraction is a major commercial activity for these land owners today.

The Los Cerritos Wetlands water quality analysis will be accomplished by collecting three samples from the Los Cerritos Channel. From the point where the channel first makes contact with the wetland, another just before you pass the marina and slough entrance and the last just after the marina at the southern most corner of the wetland. The fourth will be in the middle of the slough, the fifth will come from the eastern most and southern most corner of the San Gabriel River. This will allow for the water quality analysis of waters surrounding and located within the Los Cerritos Wetlands by identifying heavy metals such as zinc, lead, and copper. Los Cerritos Channel was included on the 1998, 2002 and 2006 California 303(d) lists as an impaired water body for copper, zinc, and lead. (Regional Board, 1998 and California State Water Resources Control Board, 2002 and 2006) (EPA Nov. 2008). There will also be analyses conducted for petroleum hydrocarbons; salinity, and dissolved oxygen to determine the overall health and quality of potential water sources for the LCW.

In the midst of all this urbanization still exists ecologically active wetlands in which many species native to the area live and thrives. The importance of these ecologically diverse parcels of land presents themselves in terms of cleansing toxins, the breeding grounds for many species of fish and birds, as well as a place for local residents to recreate.

The data that exists concerning the Los Cerritos wetlands would be from the previous ES&P 400 students. There are some agencies such as the Los Angeles Regional Water Quality Control Board that have collected some data related to LCW. In 1995 the LA Regional Water Quality Control Board's 303(d) list identifies the Los Cerritos Channel as not meeting standards for AMM, Cu, Pb, Zn and coliform while the San Gabriel River (Reach 1) as not meeting the standards for AMM, Pb, TOX, HIST, coliform, and algae. Beneficial Uses for the Los Cerritos wetlands are: IND, NAV, REC1, REC2, COMM, EST, WILD, RATE, MIGR, SPWN, and SHELL; for the San Gabriel River uses are: IND, NAV, REC1, REC2, COMM, EST, MAR, WILD, and RARE (CERES). The U.S. EPA Region IX also has a document titled Los Cerritos Channel Total Maximum Daily Loads for Metals, published in November of 2008. This is an in depth report of the water quality along the Los Cerritos Channel focusing on Zinc, Copper, and Lead. The Clean Water Act (CWA) requires TMDLs be set at levels necessary to achieve all applicable water quality standards in Los Cerritos Channel (EPA Nov. 2008).

It is this studies hope to determine which of the aforementioned water sources would be the most suitable source of water for use in flooding the wetlands, according the Los Cerritos Wetlands Land Trust's proposed plan for restoration. Currently it seems that their preferred water source is the San Gabriel River. We hope to conclude that this is the better choice with regards to water quality.

Methods

Sample Collection

We chose to test the water quality of six sites that we considered would give us a good representation of the state of the water surrounding the Los Cerritos Wetlands. We chose to test the San Gabriel River at a site north of the wetlands and a site south of the wetlands. This was chosen in order to give us a better idea of the water that was entering the wetland and the water exiting the wetland area. We also chose to perform the same sampling procedure along the Los Cerritos Channel. We then chose to sample the water inside of Steamshovel Slough in order to understand the water quality inside of the most preserved part of Los Cerritos Wetlands. Finally, we tested the water at the northern most section of the marina, adjacent to the slough.

As our team was the first team to test the water quality in and near the wetlands, our focus was to begin to build a set of data in order to establish a baseline of the state of the water quality.

We hypothesized that the six samples would accurately be able to describe the overall status of the water surrounding the wetlands. The San Gabriel River was hypothesized to have poorer water quality than the Los Cerritos Channel due to the greater distance it covers, allowing for potentially more pollution to enter into it. We also hypothesized that the water quality would be better at the northernmost sites along the Los Cerritos Channel and the San Gabriel River and would be better at the southernmost

Figure 1 Aerial view of the study site; locations 1 - 6 were used for water quality studies.

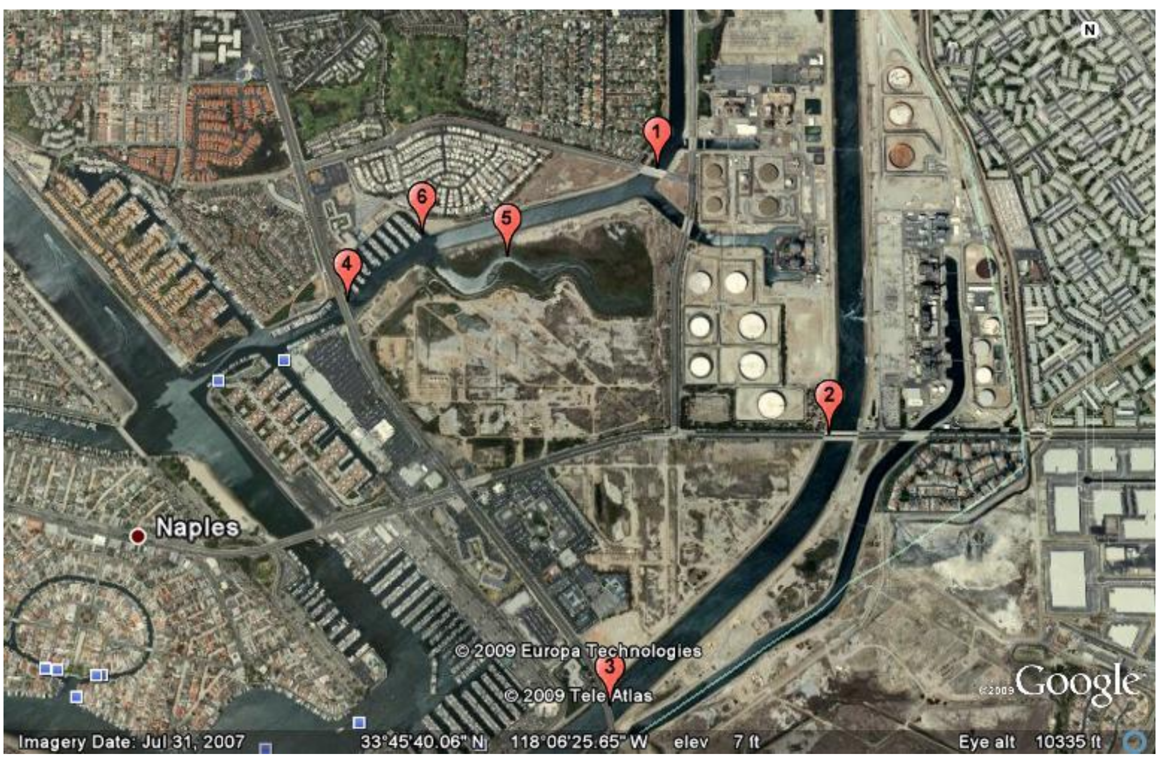

Table 1 Latitude and Longitude for sample locations measured using a Garmin eTrex Summit Handheld GPS unit.

#	Location	Latitude	Longitude
1	Loynes Dr./ Studebaker Rd.	N 33˚46.041‘	W 118˚06.264‘
2	2nd St./ DWP	N 33˚45.569‘	W 118˚05.192‘
3	PCH/ Studebaker Rd.	N 33˚45.127‘	W 118˚06.367‘
4	PCH/ Los Cerritos Channel	N 33˚45.806‘	W 118˚06.908‘
5	Steam Shovel Slough	N 33˚45.886‘	W 118˚06.578‘
6	The Marina	N 33˚45.924‘	W 118˚06.756‘

sites. This is derived from the theory that wetlands act as water treatment aids to improve water quality (West, 2001). Thus the water leaving the wetlands and flowing into the ocean would be cleaner than the water entering the wetlands, which contains urban runoff. The water quality inside of the slough was expected to be the best due to the location inside of the most pristine parcel of wetlands. We anticipated that the water tested in the marina would be of poor quality containing high heavy metal and hydrocarbon levels.
In addition to the testing of the water we tested during two high tide periods and two low tide periods. It was predicted that the water quality would be poor on a high tide due to the incoming water passing through the marina and carrying lots of pollutants from the boating activities and mere presence of the boats.

We collected our samples at sites 1, 2, and 3 with the Van Doren sampler. We lowered the Van Doren into the water from the middle of the bridge and then flushed the inside of the device out to cleanse it. We then released the weight and the doors of the device closed shut, trapping the surface water of each site. We then brought the device up and released the water into our collection containers, flushing the containers with the water as well. We put the water sample into a plastic and glass container for each site. The plastic one was for the heavy metal testing and the glass container was used to prevent plastic from leaching into the water and skewing the total petroleum hydrocarbon (TPH) results. We then tested the water's pH with the Hanna Combo® probe. We then lowered the YSI into the upper level of the water to obtain data on the water temperature, salinity, and dissolved oxygen. This procedure was identical for sites 1, 2, and 3. For sites 4, 5, and 6 we used a kayak and navigated the water. We used the same equipment, however, we submerged our containers directly into the water. We also placed the Hanna Combo® probe and YSI directly into the water at each site. All sample sites were recorded with a Garmen®. While in the Slough we took note of the fauna we saw. We saw California least terns, forster's terns, double-crested cormorants, long-billed curlews, snowy egrets, and cloudy bubble snails.

TPH analysis was performed immediately following collection with the Hach water sampling kit. Heavy metal analysis was performed in cooperation with the Institute for Integrated Research in Materials, Environment, and Society (IIRMES), CSULB.

TPH

Total Petroleum Hydrocarbon compound were measured from the six water samples using the HACH® TPH Test kit. Following the Immunoassay tests, antigen/antibody reactions were used to test for specific organic compounds in water. The antibodies were attached to the cuvettes wall, and removed TPH from the complex sample matrices. Then enzyme-conjugate molecules were added to the samples. The enzyme and TPH compete for binding sites on the antibodies; therefore, the samples with higher TPH level will have more TPH occupied their antibody sites and fewer enzymes. The color-development reagents are added to see the inverse relationship between color intensity and the concentration of TPH in the samples. Test results are measured at 450 nm.

Heavy Metal Concentration

Heavy metal analysis and preparation was performed per the iron-palladium protocol suggested by Chris Mull at IIRMES, CSULB. The preparation process was completed in three days and analysis was performed on the fourth consecutive day. Following capture of our water samples one micro liter of concentrated nitric acid was added for every milliliter of water. Therefore 500 µL of acid was added to our 500mL samples. On the second day we added 500mg of $NaBH_4$ to 10ml of water. We then allowed this to offgas until it completed effervescing. Meanwhile 0.5 mL of Fe/Pd was added to our water sample. Then we added 0.3 mL of NH_4OH to the sample. This was then mixed. Next, 0.5mL of our 5% $NaBH_4$ was added followed by the addition of 0.25 mL of 2% APDC. This was then mixed and allowed to age overnight. On the third day the samples were placed in a centrifuge set at 2500 rpm for 10 minutes. Next the water was decanted out of the sample tube. Then 1 mL of 20% nitric acid was added. The samples were once again mixed. Next, the samples were heated in a sonicator bath set at 65°C until they turned clear (a few hours). On the fourth day the samples were transferred to a 15 mL tube and diluted to 10 mL with deionized water. The samples were then analyzed by the Perkin-Elmer 6100 ICP-MS. The heavy metals tested for were zinc, copper, and lead.

pH

pH was measured using the Hanna Combo® probe. The device was submerged in our samples at sites 1-3 and submerged directly in the water source at sites 4-6.

Temperature, Salinity, and Dissolved Oxygen

Salinity, temperature, and dissolved O_2 data were collected by YSI™ Sonde following the manufacture's protocol. We connected the YSI™ sonde with the cable then placed it into the water. We waited for the YSI™ sonde to calibrate and settle, then we recorded the results at each location.

Results:

TPH

All of the locations, except location #3 (PCH/ Studebaker Rd.), the sample reading 0.728 was between the readings for the TPH calibrators number c2 and c3. This means that the TPH concentration in the sample from that location is between 5 ppm and 10 ppm diesel fuel, 3.5 ppm and 7 ppm Gasoline, and 4.5 ppm and 8.5 ppm. All other samples readings are less than the readings for all of the TPH calibrators. Therefore the concentrations of TPH in the samples are less than 2 ppm diesel fuel, 1.5 ppm gasoline, and 2 ppm benzene.

Table 2: Total Petroleum Hydrocarbons results

TPH Calibrator Number:	**Absorbance**	**Diesel Fuel (ppm)**	**Gasoline (ppm)**	**Benzene (ppm)**
c1	0.852	2	1.5	2
c2	0.800	5	3.5	4.5
c3	0.677	10	7	8.5
c4	0.548	20	14	16

Sample Numbers:	**Absorbance**
1	1.052
2	1.035
3	0.728
4	0.905
5	0.918
6	0.938

Heavy Metals

All sites tested were found to have extremely high values of zinc during testing of week 1. These values then dramatically dropped and leveled off for the following three weeks. All locations contained mildly high levels of copper during week 1. The following weeks saw slight decreases. Lead concentration levels remained constant throughout all four weeks of water sampling. There was no correlation between the tides being high or low at time of water sample collection. The only possible correlation was found for Location 1 at the southern site of the San Gabriel River (for copper only). All heavy metal concentrations seemed to follow a trend that was independent of the tides. There were even cases where the concentration was higher on the fourth week (low tide) compared to the previous week (high tide) especially for Location 5 at the slough. Figure 3 shows the heavy metal concentrations for each location during the four week sampling period.

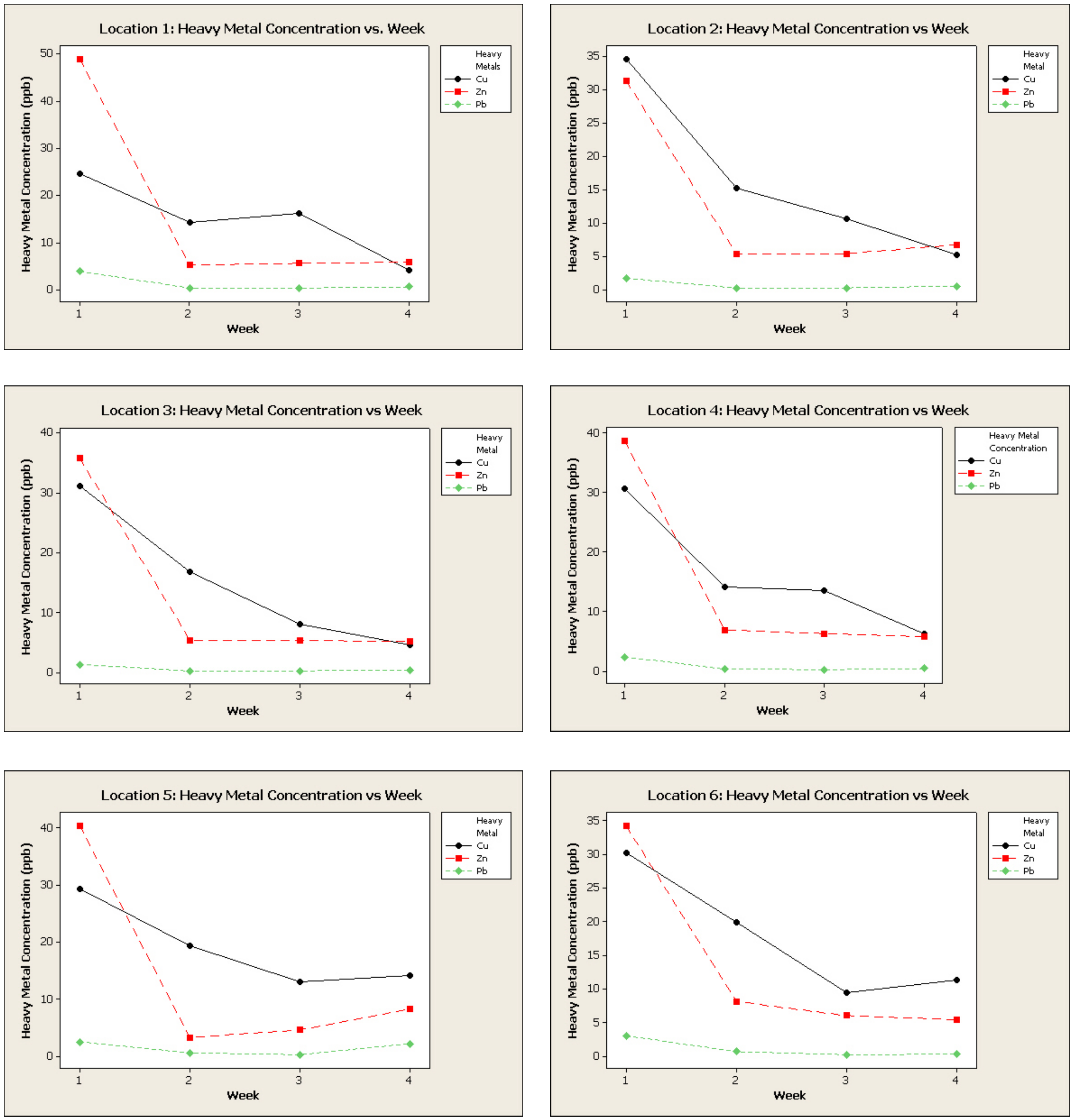

Figure 3: Heavy metal concentrations for each location during the four week sampling period.

Table 3: Tides recorded for each sampling session.

	Tide (ft)	Tide Type
Week 1 3/30/09	3.0	High Tide
Week 2 4/06/09	-0.3	Low Low Tide
Week 3 4/13/09	2.9	Low High Tide
Week 4 4/20/09	0.5	Low Low Tide

Average copper concentrations from San Gabriel River's data are 15.795211 μg/L, and 16.228567 μg/L from the Los Cerritos Channel's data. They both violate the Total Maximum Daily Loads (TMDLs). Lead and zinc concentration level are well within the quality standards. The heavy metal concentrations are compared to evaluate the quality among the 2 water bodies. First, the each metal concentration from location #2 and #3 of the San Gabriel River is compared using ANOVA to see if the means are statistically the same. Then the same analysis was performed with samples from the Los Cerritos Channel, location #1, #4, and #6 and they were compared. The results turn out that the concentrations from different locations within the same water bodies are the same. Then each metal concentration from both water bodies was compared. The average concentration of copper, lead, and zinc are higher in the Los Cerritos Channel compare to San Gabriel River; however, the statistical analysis by ANOVA, Minitab shows that there are no statistically significant differences between the metal concentrations of the two water bodies.

Table 4: Water quality objectives for copper, lead, and zinc established in the California Toxic Rule (CTR) for the protection of aquatic life and average metal concentration data in the Los Cerritos Channel.

Metal	**Freshwater Acute** (μg/L)	**Freshwater Chronic** (μg/L)	**Avg. Data** (μg/L)
Copper	13	9.0	16.228567
Lead	65	2.5	1.0474424
Zinc	120	120	14.730427

Table 5: Water quality objectives for copper, lead, and zinc established in the California Toxic Rule (CTR) for the protection of aquatic life and average metal concentration data in the San Gabriel River.

Metals	**Freshwater Chronic** (μg/L)	**Freshwater Acute** (μg/L)	**Saltwater Chronic** (μg/L)	**Saltwater Acute** (μg/L)	**Avg. Data** (μg/L)
Copper	9	13	3.0	4.8	15.795211
Lead	2.5	65	8.1	210	0.624364
Zinc	120	120	81	90	12.561206

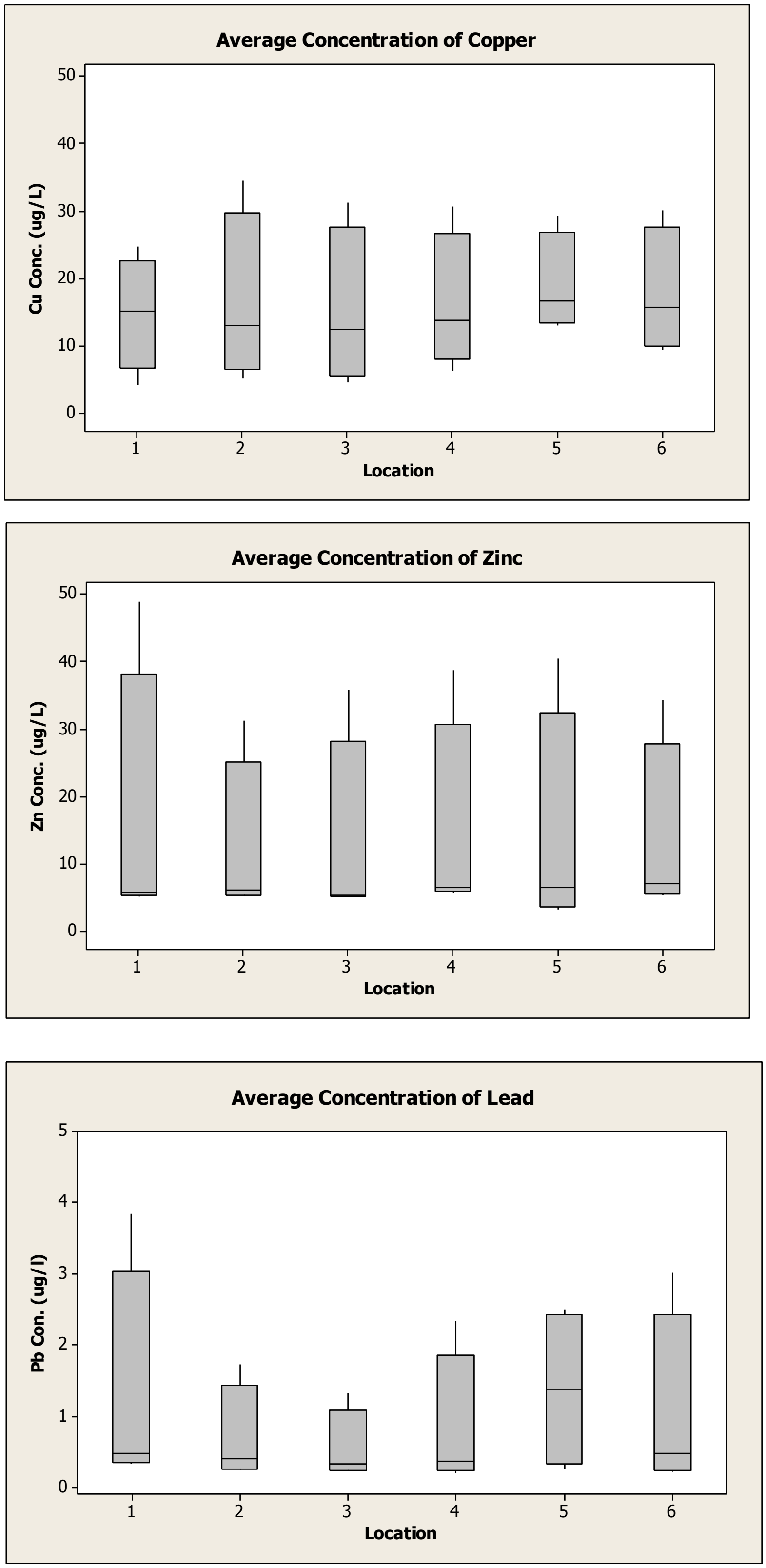

Figure 4: Average concentrations of individual heavy metals at each location

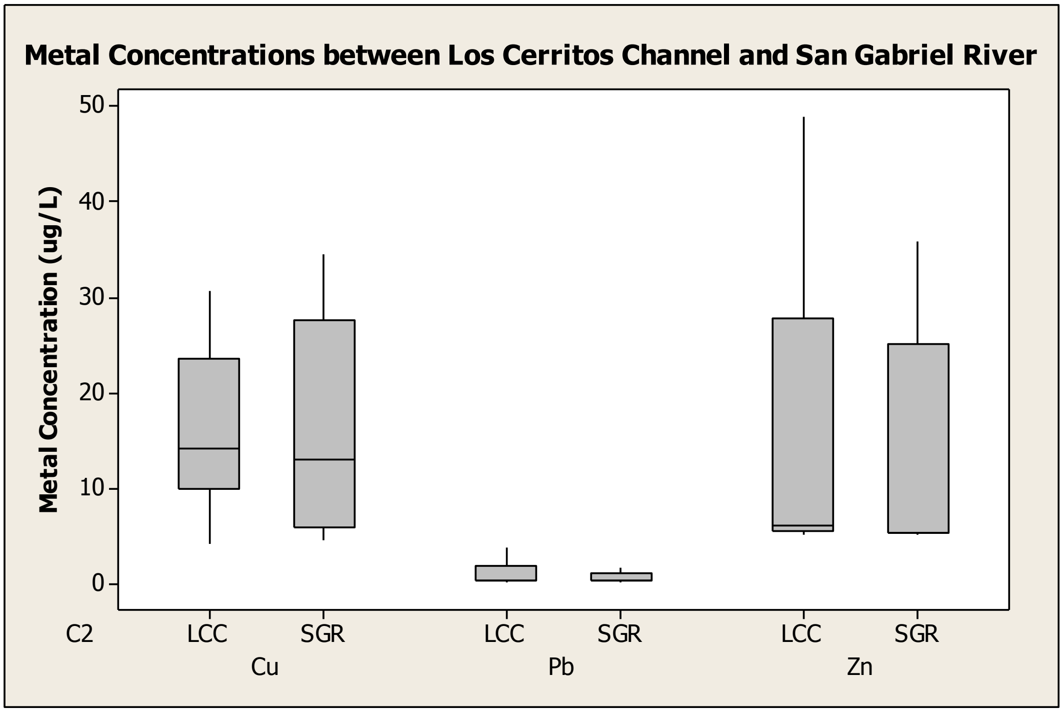

Figure 5: Each heavy metal comparison between the Los Cerritos Channel and the San Gabriel River

pH

On average, pH is consistently neutral with a range of values from 6.08±1.91 to 8.25±0.21. The deviation between and among 6 locations is quite different. The highest deviation had nearly 2 units of varied difference with actual standard deviation of 1.91.

Temperature, Salinity, and Dissolved Oxygen

Average dissolved Oxygen values ranged from 5.63±3.57 mg/L to 8.02±3.56mg/L with a standard deviation of 3.71 away from the mean. The temperature of each location fluctuated from 17.71±0.49 to 25.50±6.65 degrees Celsius among 6 locations which have a standard deviation varying up to 6.65 Celsius degree. Lastly, average salinity between six locations are significant which vary from 31.04 ms/cm to 34.47 ms/cm with no standard deviation larger than 13.6.

Table 6 Average Temperature, Salinity, pH, and Dissolved Oxygen

#	**Location**	**Average Temperature (Celsius)**	**Average Salinity (ms/cm)**	**Average pH**	**Dissolved O_2 (mg/l)**
1	Loynes Dr/Studebaker Rd	18.22±0.56	33.69±13.60	6.08±1.91	6.22±3.70
2	2nd St/ DWP	22.13±3.32	32.88±13.01	6.35±1.58	5.64±3.26
3	PCH/ Studebaker	22.27±2.19	31.04±11.3	6.87±1.64	5.63±3.57
4	PCH/ Los Cerritos Channel	17.71±0.49	33.72±13.6	7.25±1.21	7.03±3.59
5	Steam Shovel Slough	25.50±6.65	34.47±13.04	8.25±0.21	8.02±3.56
6	The Marina	18.56±0.80	33.70±13.6	7.95±0.05	7.24±3.71

Discussion

TPH

Since the study site is susceptible to petroleum product contamination, such as nearby streets, power plants, and oil operations, Total Petroleum Hydrocarbons is tested for the level of contamination. TPH concentrations contain a mixture of chemical compounds that originate from crude oil. Therefore, the result is a general indicator for the level of contamination, so further testing can be done in the future to trace the source of the compound at the site, where the TPH concentration level was high. Among the six samples recorded at each location, site number 3 (Pacific Coast Highway/ Studebaker Rd.) had the highest level of TPH. This might be because of the runoff from the PCH, power plant's discharge, and accumulation from upstream.

Heavy Metals

All values of heavy metal concentration for copper, zinc, and lead were higher for week 1. Copper and zinc levels were considerably higher during week 1 compared to the following weeks. This can be explained by high levels of rainfall prior to week 1. Warm and dry weather were constant during weeks 2-4. Thus, it seems that the heavy metal concentrations (for copper, zinc and lead) were not strongly influenced by the tides, if at all. It can be stated that heavy metal concentration in and around Los Cerritos Wetlands are greatly affected by rainfall. This leads us to believe that the sources of water pollution, at least heavy metal pollution, is not coming from the ocean and influenced by the tide. Rather, the sources of heavy metal pollution in the water must be deriving from inland sources that lead into Los Cerritos Channel and the San Gabriel River. Urban runoff combined with industrial discharge into these two reservoirs can be attributed as the sources of heavy metal pollution in the water for copper, zinc, and lead.

The heavy metal concentrations were compared to see which water source has less contamination and can be use as a better source for future restoration. Copper concentration levels for both water bodies were so high that they exceed the Total Maximum Daily Load limit while the zinc and lead concentration levels were well within the limit. When comparing the levels of heavy metal contaminations between the Los Cerritos Channel and the San Gabriel River for the restoration purpose, the statistical result shows no significant difference between the two. It is also interesting that the copper, zinc, and lead concentrations are higher in the Steam Shovel Slough compared to the Marina.

pH

The pH levels were consistent at each site (**Table 6**). Most animals and plants have adapted to life in water with a specific pH and may suffer from future events that may alter their habitat. Water with extremely high or low pH causes many plant and animal to die. A pH below 4 or above 10 will kill most fish (Mesner and Geigner, 2005). According to the data above, with pH level ranging from 6.08 to 8.25 it is safe to say that life of many wild animals and plants in the Los Cerritos Wetlands will continue to survive. The change in pH would affect the plants daily when aquatic plants convert sunlight to energy during photosynthesis; during this process they remove carbon dioxide from the water. It also depends on the chemical in water, heavy metal such as Lead, Cadmium and chromium, etc…

Temperature, Salinity, and Dissolved Oxygen

Dissolved Oxygen is molecular oxygen that is dissolved in water. Sources of dissolved oxygen are diffusion from the surrounding air, a waste product of photosynthesis. Dissolved oxygen levels are indicating a water body's ability to support aquatic life. If dissolved oxygen is greater than 5 mg/L, it is considered favorable for growth and activity of most aquatic organism (_jacksonbottom_, 2004). Los Cerritos Chanel wetland and San Gabriel River's dissolved oxygen were calculated and range from 5.63 to 8.02 which also supports aquatic life in the Los Cerritos Channel wetland and the San Gabriel River. There are many factors that cause concentrations of dissolved oxygen to increase or decrease. Increased temperature or excess nutrients may result in higher algal and plant growth, causing DO levels to increase.

As the salinity increases, it reduces aquatic plant community richness and abundance and also reduces diversity of aquatic invertebrate communities. Salinity is a strong determinant of communities because if it changes over 1000ms/cm it will clearly affect the community composition(Nielsen; Brock; ect…,2003). Outside of this range, the community will be negatively affected and may die. Some animals can handle high salinity, but not low salinity, while others can handle low salinity, but not high salinity Los Cerritos Channel and San Gabriel's average salinity is very stable; it is between a ranges of 31.03 ms/cm to 34.5 ms/cm. The results indicate that LCC and SGR can sustain many aquatic species. Our results show that salinity is less than 800 ms/cm, which supports an abundance of species in the area. Aquatic animals and plants are adapted for a certain range of salinity.

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