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Naval Base Point Loma (NBPL) Stormwater Relationships

The Naval Base Point Loma WinSLAMM analyses focused on three drainage areas: North Pier (outfall 24), South Pier (outfalls 26, 27, and 28) and Outfall 52. These areas were described in the previous modeling memo. The available stormwater monitoring data for these three locations are summarized below for all three locations combined and for each of the three areas separately. Overall, there were 112 samples for TSS, copper, and zinc, while only the south pier had data for phosphorus and magnesium (12 samples). As typical for stormwater quality, the observed concentrations were widely variable, as reflected in the relatively large standard deviations and coefficients of variability.

	TSS	Phosphorus, total	Copper, Total	Magnesium, total	Zinc, Total
	mg/L	mg/L	µg/L	µg/L	µg/L
OVERALL (3 sites)					
# of observations	111	12	112	12	112
mean	292	1.7	362	1,499	980
median	50	0.9	155	1,350	610
min	1	0.2	21	710	36
max	10,000	9.5	2,800	3,000	8,700
stdev	1,131	2.6	520	669	1,171
COV	3.87	1.51	1.44	0.45	1.19

	TSS	Phosphorus, total	Copper, Total	Magnesium, total	Zinc, Total
North pier (OF24)	mg/L	mg/L	µg/L	µg/L	µg/L
# of observations	24		24		24
mean	333		162		681
median	30		55		270
min	1		21		36
max	5,800		1,500		3,700
stdev	1,172		311		981
COV	3.52		1.92		1.44

	TSS	Phosphorus, total	Copper, Total	Magnesium, total	Zinc, Total
South pier (OF 26, 27, and 28)	mg/L	mg/L	µg/L	µg/L	µg/L
# of observations	75	12	76	12	76
mean	90	1.7	453	1,499	1,106
median	44	0.9	225	1,350	730
min	4	0.2	26	710	80
max	890	9.5	2,800	3,000	8,700
stdev	132	2.6	579	669	1,237
COV	1.47	1.51	1.28	0.45	1.12

	TSS	Phosphorus, total	Copper, Total	Magnesium, total	Zinc, Total
OF52	mg/L	mg/L	µg/L	µg/L	µg/L
# of observations	12		12		12
mean	1,477		183		781
median	525		99		425
min	5		73		170
max	10,000		950		3,900
stdev	2,827		246		1,016
COV	1.91		1.34		1.30

Due to the lack of rainfall information for these monitored events, WinSLAMM used a continuous 7 year rain period (January 1999 through December 2005) which included 248 rains ranging from 0.01 to 2.85 inches (average of 0.25). The model outputs (based on the previously calibrated model from San Diego naval facilities) were within the range of expected values reflected by the monitoring data. It was beyond the scope of this investigation to perform a special calibration for the Point Loma facilities.

The following shows the estimated percentage filterable amounts for copper and zinc for these three drainage areas. The filterable copper content is expected to range from about 25 to 80%, while the filterable zinc content is expected to range from about 60 to 70%, both within the range of most stormwater water quality observations.

Calculated Concentrations using WinSLAMM	Copper, Total, µg/L	Copper, filtered, µg/L	est Cu % filt	Zinc, Total, µg/L	Zinc, filtered, µg/L	est Zn % filt
flow-weighted average (NP)	84	66	79	419	288	69
flow-weighted average (SP)	105	56	53	711	416	59
flow-weighted average (OF52)	60	15	25	577	324	56

Correlations between Naval Base Point Loma Stormwater Constituents

The following summarizes the Pearson Correlation calculations for the observed stormwater quality data from the Naval Base Point Loma. Due to the large amount of non-detectable organic analyses, two analyses were conducted with the non-detected values substituted with half of the detection limits and another analysis that removed all non-detected values. Neither of these methods is absolutely accurate, especially considering the very large fraction of non-detected values (and missing analyses). The best method would be to use the actual recorded values from the laboratory instrumentations, even if they are below the formal detection limits as that method preserves the variability of the uncertain values. The two methods shown here attempt to bracket the likely outcomes. All of the data from the three locations were combined for these statistical analyses in order to obtain sufficient data.

The following Pearson Correlation Table (calculated using Minitab 17) shows both the correlation coefficient along with the significance of the relationship. Significant relationships (p of 0.05 or less) are high-lighted in yellow. An inverse correlation between oil and grease is shown to be significant (decreased toxicity as oil and grease increases) and is thought to be in error due to likely more complex relationships. Reasonable and strong correlations exist between TSS and Cu and Zn, between Cu and Zn, and between the four PAHs included in the analysis (chrysene, fluoranthene, phenanthrene, and pyrene).

	Oil and Grease	pH	TSS	Acute Toxicity
pH	-0.059			
	0.535			
TSS	0.020	0.069		
	0.837	0.469		
Acute Toxicity	-0.351	0.369	0.169	
	0.013	0.008	0.246	
Copper, Total	-0.068	-0.245	0.184	0.197
	0.477	0.009	0.053	0.171
Zinc, Total	0.000	-0.198	0.307	0.091
	0.998	0.037	0.001	0.529
Chrysene	0.051	-0.024	-0.053	-0.234
	0.611	0.810	0.600	0.102
Fluoranthene	0.043	0.050	-0.043	-0.124
	0.671	0.625	0.672	0.393
Phenanthrene	0.070	-0.026	-0.049	-0.299
	0.491	0.798	0.628	0.035
Pyrene	0.128	-0.095	-0.077	-0.259
	0.204	0.346	0.446	0.069

	Copper, Total	Zinc, Total	Chrysene	Fluoranthene
Zinc, Total	0.714			
	0.000			
Chrysene	-0.113	0.018		
	0.265	0.860		
Fluoranthene	-0.044	0.072	0.808	
	0.666	0.475	0.000	
Phenanthrene	-0.110	0.072	0.696	0.562
	0.275	0.474	0.000	0.000
Pyrene	-0.042	0.080	0.486	0.593
	0.678	0.428	0.000	0.000

|	Phenanthrene
Pyrene	0.376
	0.000

Cell Contents: Pearson correlation
              P-Value

The following is a dendogram calculated using Minitab 17 that indicates close simple to complex relationships between the different constituents. As indicated with the Pearson Correlation, the two metals are closely related as are the four PAHs (phenanthrene not as closely related to the others). The toxicity, TSS, oil and grease, and pH are noted as not closely related to any of the other constituents.

Dendrogram
Complete Linkage, Correlation Coefficient Distance
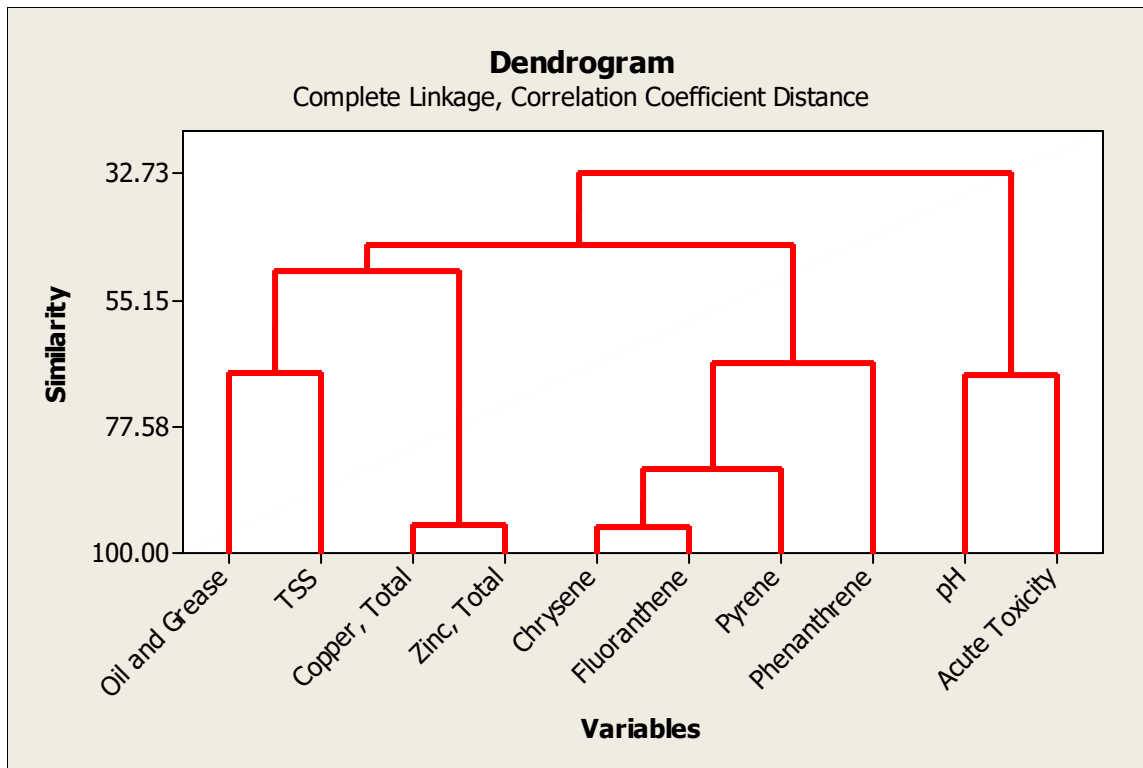
As noted above, an alternative analysis was conducted by eliminating all non-detectable values. This removes substantial information, but does not have the problems associated with greatly reduced variability when most values for a constituent are substituted by the same value (half of the detection limit as above). Boot-strapping or random data substitution can preserve the variability of the data set better, but the assigned values are random for each sample and create additional problems for these types of correlation analyses. In the analyses shown below, the general outcomes are similar to the prior analyses, in that the TSS with copper and zinc are closely related as are the four PAHs. There are also a few odd significant relationships shown associated with pH and oil and grease.

	Oil and Grease	pH	TSS	Acute Toxicity
pH	0.111			
	0.527			
TSS	0.633	0.069		
	0.000	0.469		
Acute Toxicity	0.270	0.369	0.169	
	0.351	**0.008**	0.246	
Copper, Total	0.058	-0.245	0.184	0.197
	0.741	**0.009**	**0.053**	0.171
Zinc, Total	0.015	-0.198	0.307	0.091
	0.934	**0.037**	**0.001**	0.529
Chrysene	0.056	-0.134	-0.139	-0.001
	0.832	0.452	0.442	0.998
Fluoranthene	0.154	0.014	0.006	-0.090
	0.516	0.919	0.969	0.649
Phenanthrene	-0.117	-0.047	-0.113	-0.230
	0.678	0.770	0.482	0.343
Pyrene	0.117	-0.284	0.025	-0.197
	0.604	**0.031**	0.854	0.279

	Copper, Total	Zinc, Total	Chrysene	Fluoranthene
Zinc, Total	0.714			
	0.000			
Chrysene	-0.077	0.240		
	0.663	0.172		
Fluoranthene	-0.033	0.052	0.776	
	0.814	0.709	**0.000**	
Phenanthrene	-0.114	0.214	0.755	0.836
	0.477	0.178	**0.000**	**0.000**
Pyrene	0.045	0.366	0.651	0.547
	0.740	**0.005**	**0.000**	**0.000**

	Phenanthrene
Pyrene	0.472
	0.011

The following dendogram only considers quantified values and has some similarities with the prior results that substituted half of the detection limit for non-detected values. Copper and zinc are closely (and simply) correlated, as are chrysene, pyrene, and fluoranthene. Phenanthrene is now closely correlated to TSS and acute toxicity (the major difference from the prior substitution analysis).

Dendrogram
Complete Linkage, Correlation Coefficient Distance
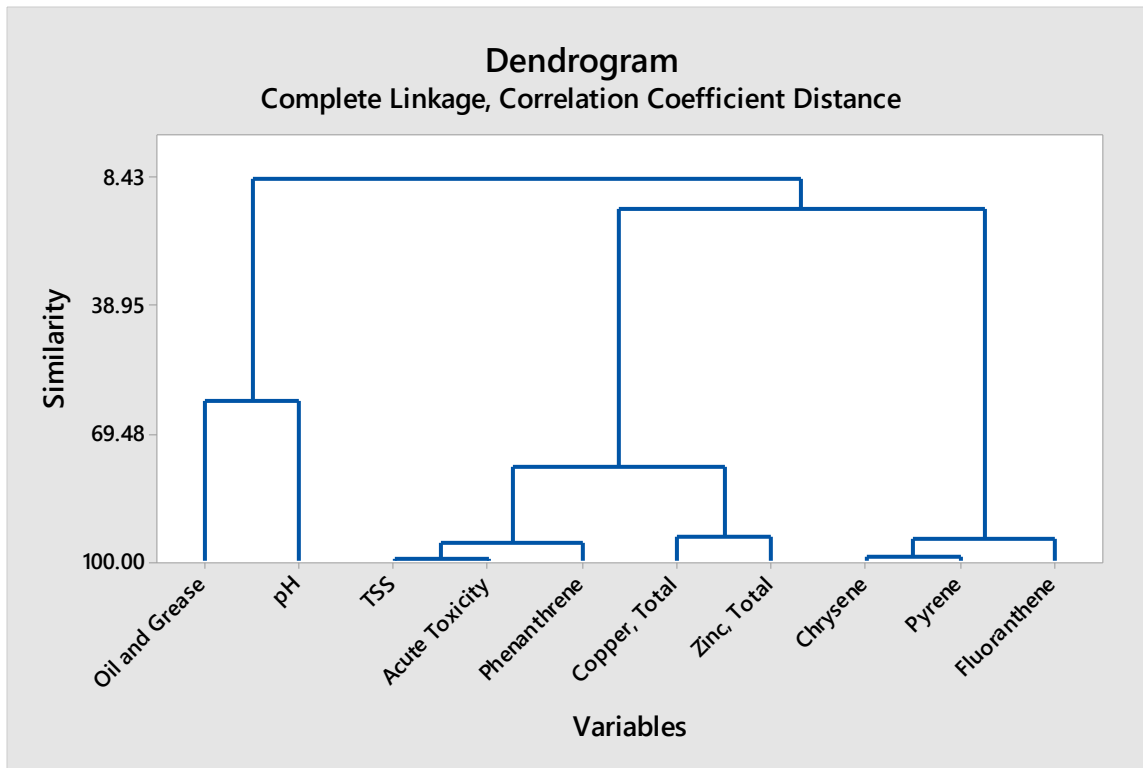
An attempt was also made to examine all of the Naval Base Point Loma data together (not just from the three study areas), but the few available organic analyses prevented a complete analysis. The following are the analyses using the available constituents (removing the non-detected values with no substitutions). Specific conductance is shown to be significantly correlated to pH and TOC and oil and grease with TSS. More likely strong correlations are shown for TSS and copper and zinc, and between copper and zinc.

	Electrical Co	Oil and Grease	pH
Oil and Grease	-0.058		
	0.580		
pH	0.112	0.074	
	0.036	0.437	
TOC	0.459	0.243	-0.020
	0.000	0.317	0.872
TSS	-0.024	0.269	0.072
	0.659	0.004	0.164
Copper, Total	-0.010	0.012	-0.119
	0.880	0.912	0.059
Zinc, Total	-0.013	0.032	-0.106
	0.834	0.756	0.066

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                            TOC                 TSS      Copper, Total
TSS                        0.119
                           0.342

Copper, Total             -0.022               0.181
                           0.912               0.004

Zinc, Total                0.116               0.262              0.727
                           0.438               0.000              0.000
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The following dendogram shows the stronger correlation of TSS with copper and weaker correlations of TSS and zinc, along with the conductivity/TOC and oil and grease/pH pairing.
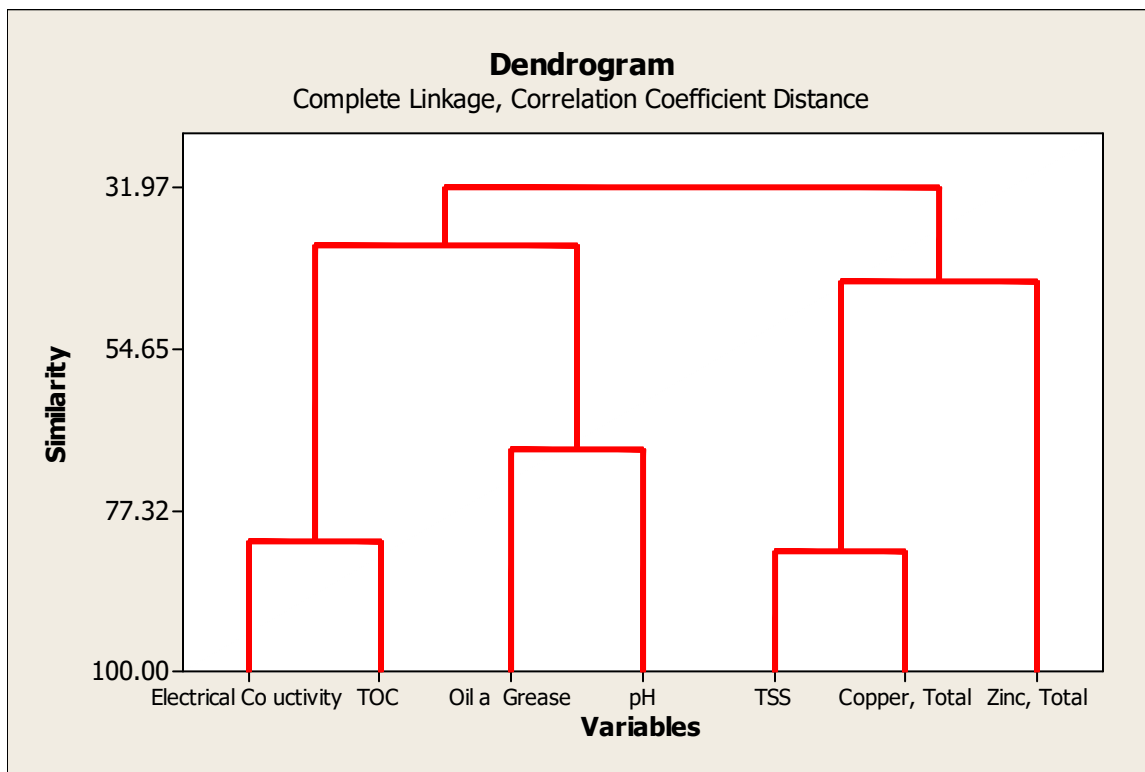
In summary, the limited data shows strong and simple correlations between copper and zinc and strong associations of TSS with these metals (especially copper). The PAHs are also strongly correlated with each other, except for phenanthrene.