Pier Pre- and Post-Construction Comparison

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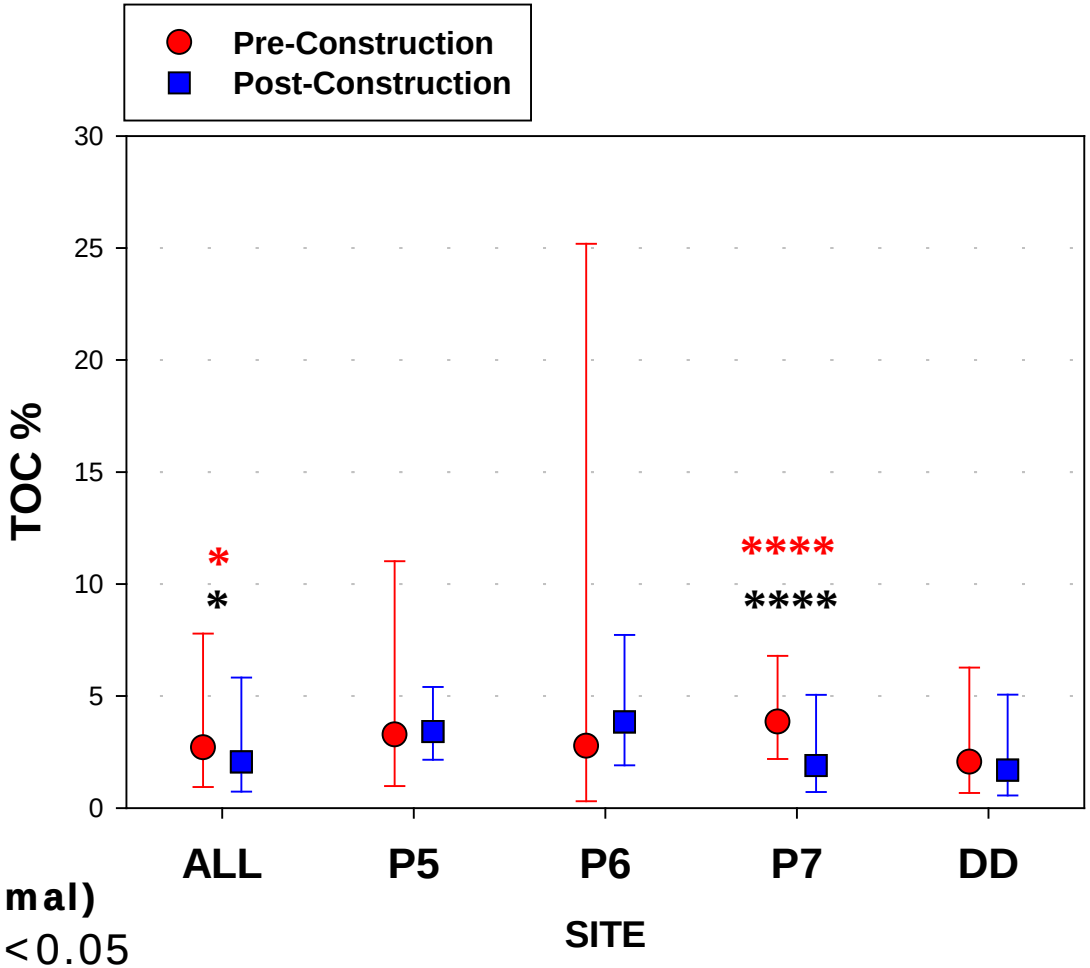
- Pier and Quay Wall Repair Projects
  - Structural Repairs
  - Many creosote piles and fenders removed and replaced with concrete piles and other materials
  - Pre- and Post- Construction Sampling
    - Pier 5
    - Pier 6
    - Pier 7
    - Dry Docks 3, 4, 5, and 6
- Null Hypothesis: No difference in contamination levels before and after construction
  - TOC, PCB/OC, Hg, Cd, Cr, Cu, Pb, Ag, Zn
  - ANOVA (LogNormal) and NonParameteric (Kruskal-Wallis)

Total Organic Carbon



	Pre	Post
	n	n
ALL	45	67
P5	9	9
P6	4	4
P7	11	33
DD	21	21

ANOVA (Lognormal)

* Significant at P<0.05

**** Significant at P<0.0001

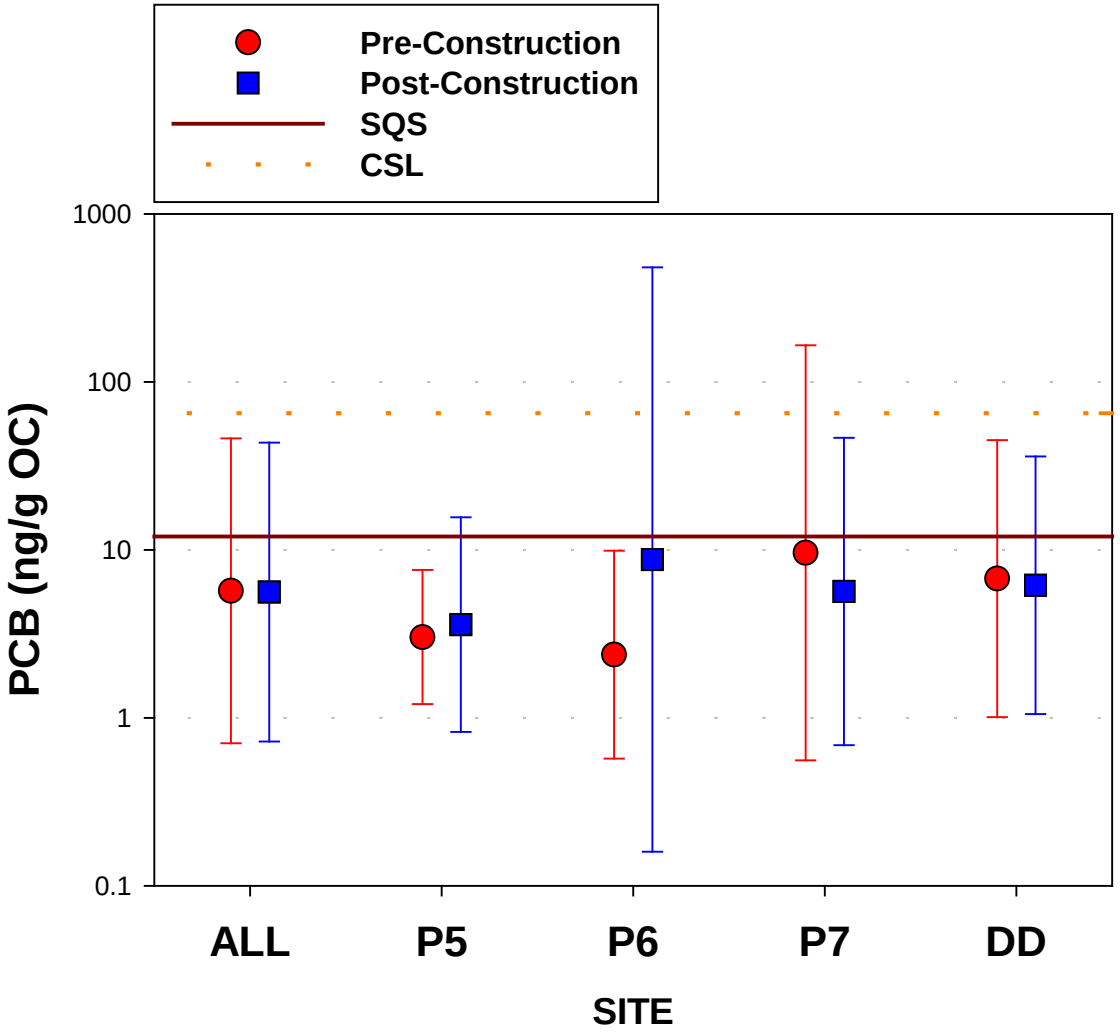
Nonparametric

* Significant at P<0.05

**** Significant at P=0.0001

Error bars are 5th - 95th Percentile of the Mean

Total PCB per unit Organic Carbon



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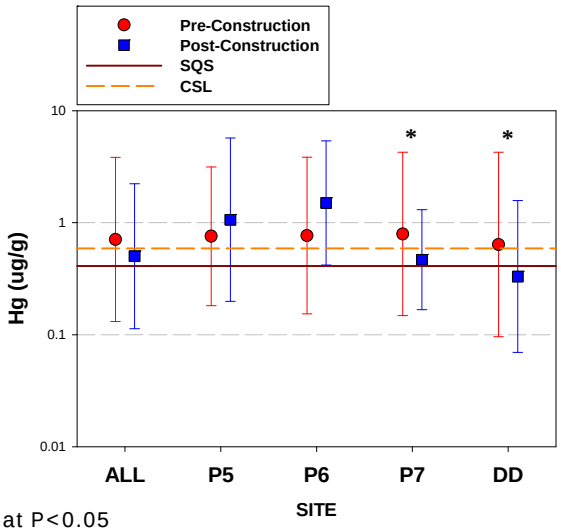
Parameters and Sites with Statistically Significant Differences Pre- and Post-Construction

	ALL	P5	P6	P7	DD
TOC	↓			↓	
PCB/OC					
Hg				↓	↓
As					
Cd					
Cr		↓			
Cu			↑		
Pb					
Ag	↓	↓			
Zn					

Summary

- High variance for all parameters was encountered at all sites for both pre- and post-construction sampling
- Data had high probability of exceeding Sediment Quality Guidelines
  - All sites: PCB/OC, Hg, Cu, and Zn
  - P6: As, Pb
  - DD: As
- Most likely that contaminant distributions are unrelated to pier improvement projects
- Pockets of elevated sediment contamination were identified

Mercury



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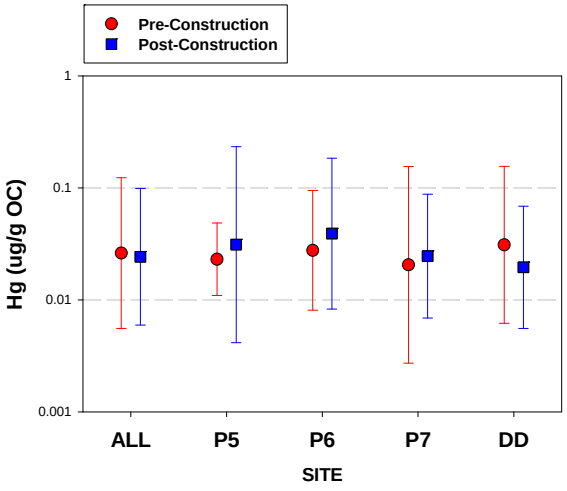
Mercury per unit Organic Carbon



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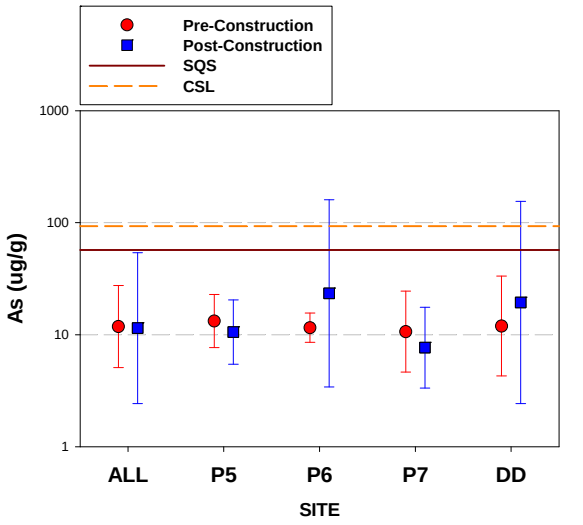
Arsenic



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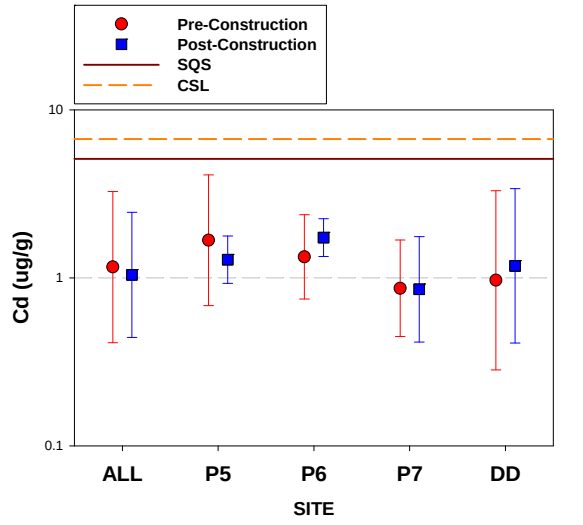
Cadmium



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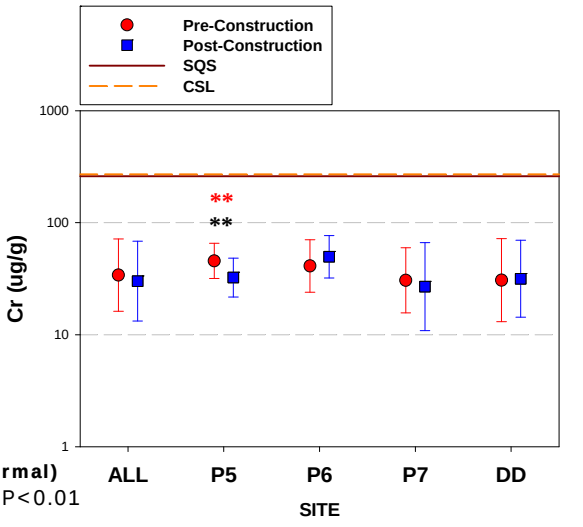
Chromium



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ANOVA (Lognormal)
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Nonparametric
** Significant at P<0.01

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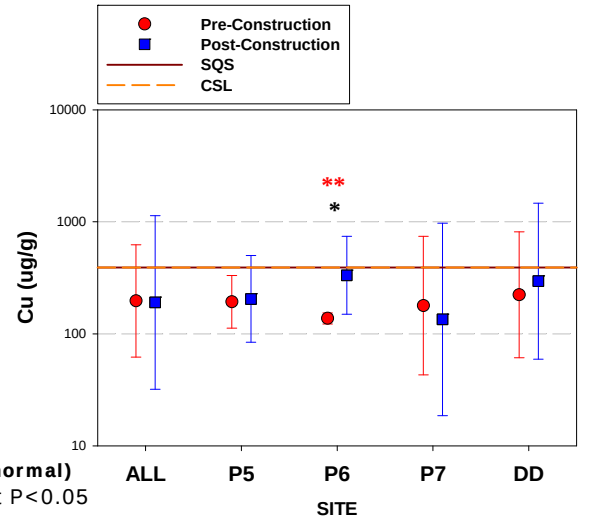
Copper



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* Significant at P<0.05

Nonparametric
** Significant at P<0.01

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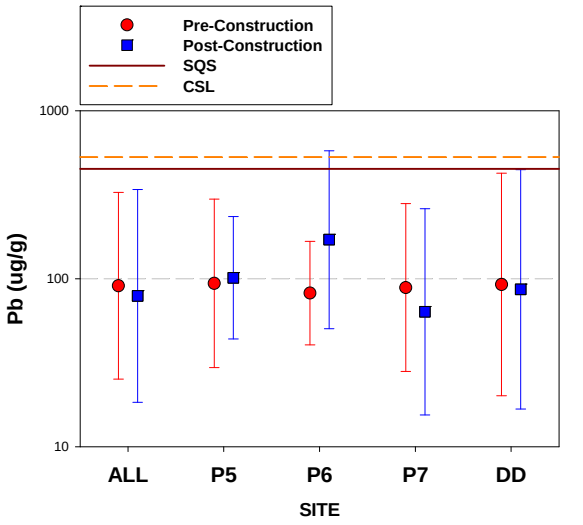
Lead



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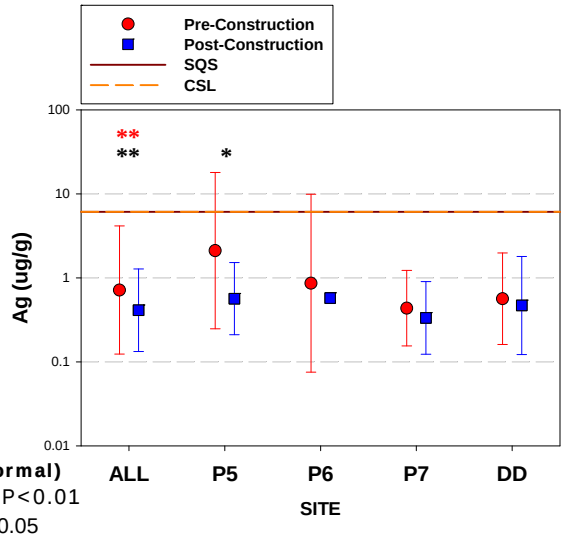
Silver



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** Significant at P<0.01
* Significant at P<0.05
Nonparametric
** Significant at P<0.01

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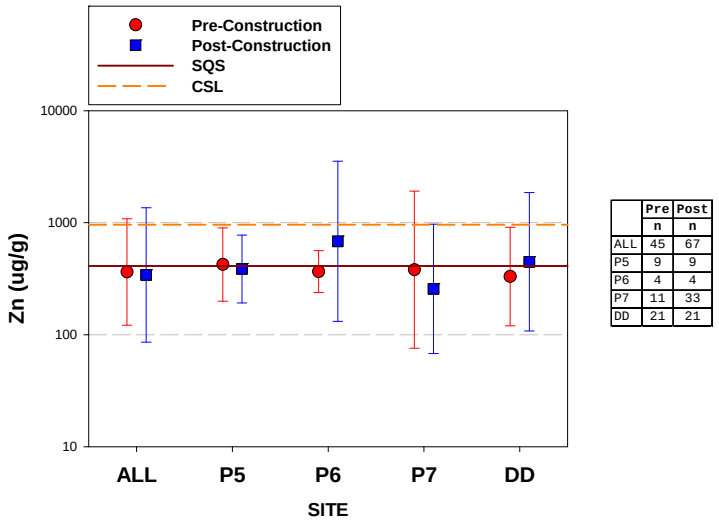
Zinc



	Pre	Post
	n	n
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P5	9	9
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DD	21	21

Error bars are 5th - 95th Percentile of the Mean

Statistics for All Sampling

		Pre-Construction			Post-Construction			ANOVA	Kruskal-Wallis
Group	Parameter	n	mean	stdev	n	mean	stdev	P	P
ALL	TOC %	45	3.3303	2.2790	67	2.4567	1.3762	0.0300 *	0.0325 *
ALL	Log(TOC %)	45	0.4323	0.2799	67	0.3150	0.2747	0.0301 *	0.0325 *
ALL	Hg ug/g	45	1.3680	2.1853	67	0.8005	1.0810	0.0712	0.1169
ALL	Log(Hg ug/g)	45	-0.1497	0.4466	67	-0.2994	0.3950	0.0648	0.1169
ALL	Log(Hg ug/g OC)	45	-1.5820	0.4102	67	-1.6145	0.3714	0.6647	0.8517
ALL	PCB ng/g	45	789.6300	3779.1000	67	296.4900	915.6000	0.3070	0.2440
ALL	Log(PCB ng/g)	45	2.1886	0.5306	67	2.0636	0.4952	0.2059	0.2440
ALL	PCB ng/g OC	45	25.0060	105.1300	67	14.7500	38.1250	0.4661	0.8643
ALL	Log(PCB ng/g OC)	45	0.7563	0.5533	67	0.7486	0.5428	0.9418	0.8643
ALL	Log(As ug/g)	45	1.0729	0.2232	67	1.0587	0.4105	0.8315	0.1080
ALL	Log(Cd ug/g)	45	0.0641	0.2745	67	0.0174	0.2267	0.3284	0.1353
ALL	Log(Cr ug/g)	45	1.5320	0.1972	67	1.4781	0.2175	0.1854	0.0758
ALL	Log(Cu ug/g)	45	2.2937	0.3060	67	2.2800	0.4727	0.8984	0.4880
ALL	Log(Pb ug/g)	45	1.9579	0.3387	67	1.8976	0.3863	0.3972	0.4642
ALL	Log(Ag ug/g)	45	-0.1453	0.4651	67	-0.3864	0.2992	0.0011 **	0.0030 **
ALL	Log(Zn ug/g)	45	2.5595	0.2897	67	2.5341	0.3658	0.6964	0.7368

Statistics for Pier 5 Sampling

		Pre-Construction			Post-Construction			ANOVA	Kruskal-Wallis
Group	**Parameter**	**n**	**mean**	**stdev**	**n**	**mean**	**stdev**	**P**	**P**
P5	TOC %	9	4.5722	5.4664	9	3.5330	0.9899	0.5826	0.3691
P5	Log(TOC %)	9	0.5161	0.3208	9	0.5331	0.1218	0.8832	0.3691
P5	Hg ug/g	9	1.1556	1.4525	9	1.8033	2.2089	0.4729	0.4178
P5	Log(Hg ug/g)	9	-0.1209	0.3776	9	0.0266	0.4449	0.4592	0.4178
P5	Log(Hg ug/g OC)	9	-1.6369	0.1972	9	-1.5065	0.5338	0.5013	0.8329
P5	PCB ng/g	9	118.8300	79.4820	9	167.7800	173.8600	0.4536	0.4953
P5	Log(PCB ng/g)	9	1.9971	0.2811	9	2.0881	0.3377	0.5429	0.4953
P5	PCB ng/g OC	9	3.5154	2.3142	9	5.1579	4.9434	0.3800	0.9327
P5	Log(PCB ng/g OC)	9	0.4810	0.2435	9	0.5550	0.3894	0.6355	0.9327
P5	Log(As ug/g)	9	1.1222	0.1445	9	1.0233	0.1750	0.2098	0.1915
P5	Log(Cd ug/g)	9	0.2235	0.2370	9	0.1079	0.0858	0.1880	0.2810
P5	Log(Cr ug/g)	9	1.6588	0.0961	9	1.5101	0.1056	0.0065 **	0.0049 **
P5	Log(Cu ug/g)	9	2.2857	0.1437	9	2.3113	0.2359	0.7849	0.5199
P5	Log(Pb ug/g)	9	1.9724	0.3055	9	2.0057	0.2221	0.7946	0.5652
P5	Log(Ag ug/g)	9	0.3231	0.5675	9	-0.2482	0.2617	0.0144 *	0.0667
P5	Log(Zn ug/g)	9	2.6265	0.1996	9	2.5866	0.1846	0.6628	0.8991

Statistics for Pier 6 Sampling

		Pre-Construction			Post-Construction			ANOVA	Kruskal-Wallis
Group	**Parameter**	**n**	**mean**	**stdev**	**n**	**mean**	**stdev**	**P**	**P**
P6	TOC %	4	2.8500	0.7853	4	4.1250	1.8857	0.2584	0.2797
P6	Log(TOC %)	4	0.4427	0.5844	4	0.5844	0.1852	0.2449	0.2797
P6	Hg ug/g	4	1.1825	1.4133	4	1.9250	1.6879	0.5251	0.1619
P6	Log(Hg ug/g)	4	-0.1149	0.4266	4	0.1762	0.3381	0.3259	0.1619
P6	Log(Hg ug/g OC)	4	-1.5576	0.3260	4	-1.4082	0.4109	0.5897	0.6036
P6	PCB ng/g	4	78.7500	61.0760	4	1934.8000	3578.1000	0.3396	0.0781
P6	Log(PCB ng/g)	4	1.8186	0.2791	4	2.5266	0.9288	0.1946	0.0781
P6	PCB ng/g OC	4	3.3116	3.4723	4	75.6280	144.2700	0.3540	0.4287
P6	Log(PCB ng/g OC)	4	0.3760	0.3777	4	0.9421	1.0605	0.3533	0.4287
P6	Log(As ug/g)	4	1.0625	0.0793	4	1.3689	0.5092	0.2794	0.2457
P6	Log(Cd ug/g)	4	0.1244	0.1528	4	0.2391	0.0687	0.2200	0.2797
P6	Log(Cr ug/g)	4	1.6132	0.1428	4	1.6955	0.1153	0.4046	0.4258
P6	Log(Cu ug/g)	4	2.1375	0.0299	4	2.5222	0.2119	0.0114 *	0.0041 **
P6	Log(Pb ug/g)	4	1.9146	0.1879	4	2.2321	0.3229	0.1401	0.1130
P6	Log(Ag ug/g)	4	-0.0640	0.6458	4	-0.2416	0.0396	0.6028	--
P6	Log(Zn ug/g)	4	2.5632	0.1143	4	2.8341	0.4362	0.2748	0.4258

Statistics for Pier 7 Sampling

		Pre-Construction			Post-Construction			ANOVA	Kruskal-Wallis
Group	Parameter	n	mean	stdev	n	mean	stdev	P	P
P7	TOC %	11	4.0636	1.3835	33	2.1985	1.0828	<0.0001 ****	0.0001 ****
P7	Log(TOC %)	11	0.5861	0.1500	33	0.2781	0.2594	0.0006 ****	0.0001 ****
P7	Hg ug/g	11	1.4459	1.9984	33	0.5721	0.4337	0.0209 *	0.1305
P7	Log(Hg ug/g)	11	-0.1004	0.4446	33	-0.3308	0.2724	0.0460 *	0.1305
P7	Log(Hg ug/g OC)	11	-1.6865	0.5353	33	-1.6090	0.3374	0.5746	0.2540
P7	PCB ng/g	11	2627.3000	7596.0000	33	214.6200	384.0000	0.0696	0.0055 **
P7	Log(PCB ng/g)	11	2.5680	0.6809	33	2.0303	0.4698	0.0053 **	0.0055 **
P7	PCB ng/g OC	11	76.1380	210.9200	33	13.3400	22.1620	0.0924	0.6400
P7	Log(PCB ng/g OC)	11	0.9819	0.7533	33	0.7522	0.5580	0.2858	0.6400
P7	Log(As ug/g)	11	1.0277	0.2201	33	0.8847	0.2198	0.0689	0.1167
P7	Log(Cd ug/g)	11	-0.0624	0.1750	33	-0.0685	0.1912	0.0513	0.1135
P7	Log(Cr ug/g)	11	1.4848	0.1772	33	1.4292	0.2392	0.4834	0.3016
P7	Log(Cu ug/g)	11	2.2515	0.3768	33	2.1283	0.5243	0.4772	0.2213
P7	Log(Pb ug/g)	11	1.9470	0.3045	33	1.8029	0.3745	0.2557	0.2060
P7	Log(Ag ug/g)	11	-0.3616	0.2735	33	-0.4774	0.2639	0.2182	0.2654
P7	Log(Zn ug/g)	11	2.5803	0.4276	33	2.4092	0.3520	0.1929	0.2592

Statistics for Dry Dock and Quay Wall Sampling

		Pre-Construction			Post-Construction			ANOVA	Kruskal-Wallis
Group	Parameter	n	mean	stdev	n	mean	stdev	P	P
DD	TOC %	21	2.5053	1.5402	21	2.0832	1.4539	0.3666	0.2906
DD	Log(TOC %)	21	0.3138	0.2948	21	0.2283	0.2903	0.3490	0.2906
DD	Hg ug/g	21	1.4535	2.7070	21	0.5154	0.5471	0.1274	0.0802
DD	Log(Hg ug/g)	21	-0.1946	0.5016	21	-0.4804	0.4132	0.0506 *	0.0802
DD	Log(Hg ug/g OC)	21	-1.5084	0.4270	21	-1.7087	0.3328	0.0978	0.2172
DD	PCB ng/g	21	249.9500	312.5500	21	168.2500	159.3500	0.2923	0.5948
DD	Log(PCB ng/g)	21	2.1429	0.4679	21	2.0173	0.4836	0.3991	0.5948
DD	PCB ng/g OC	21	11.5650	11.7230	21	9.4784	7.9830	0.5041	0.8145
DD	Log(PCB ng/g OC)	21	0.8286	0.5031	21	0.7890	0.4677	0.7931	0.8145
DD	Log(As ug/g)	21	1.0774	0.2716	21	1.2877	0.5502	0.1241	0.4648
DD	Log(Cd ug/g)	21	-0.0148	0.3252	21	0.0713	0.2804	0.3634	0.6473
DD	Log(Cr ug/g)	21	1.4868	0.2262	21	1.4999	0.2092	0.8465	0.9901
DD	Log(Cu ug/g)	21	2.3490	0.3428	21	2.4700	0.4248	0.3160	0.6296
DD	Log(Pb ug/g)	21	1.9657	0.4036	21	1.9364	0.4343	0.8223	0.9508
DD	Log(Ag ug/g)	21	-0.2481	0.3319	21	-0.3302	0.3558	0.4444	0.3984
DD	Log(Zn ug/g)	21	2.5193	0.2681	21	2.6507	0.3767	0.2001	0.2317