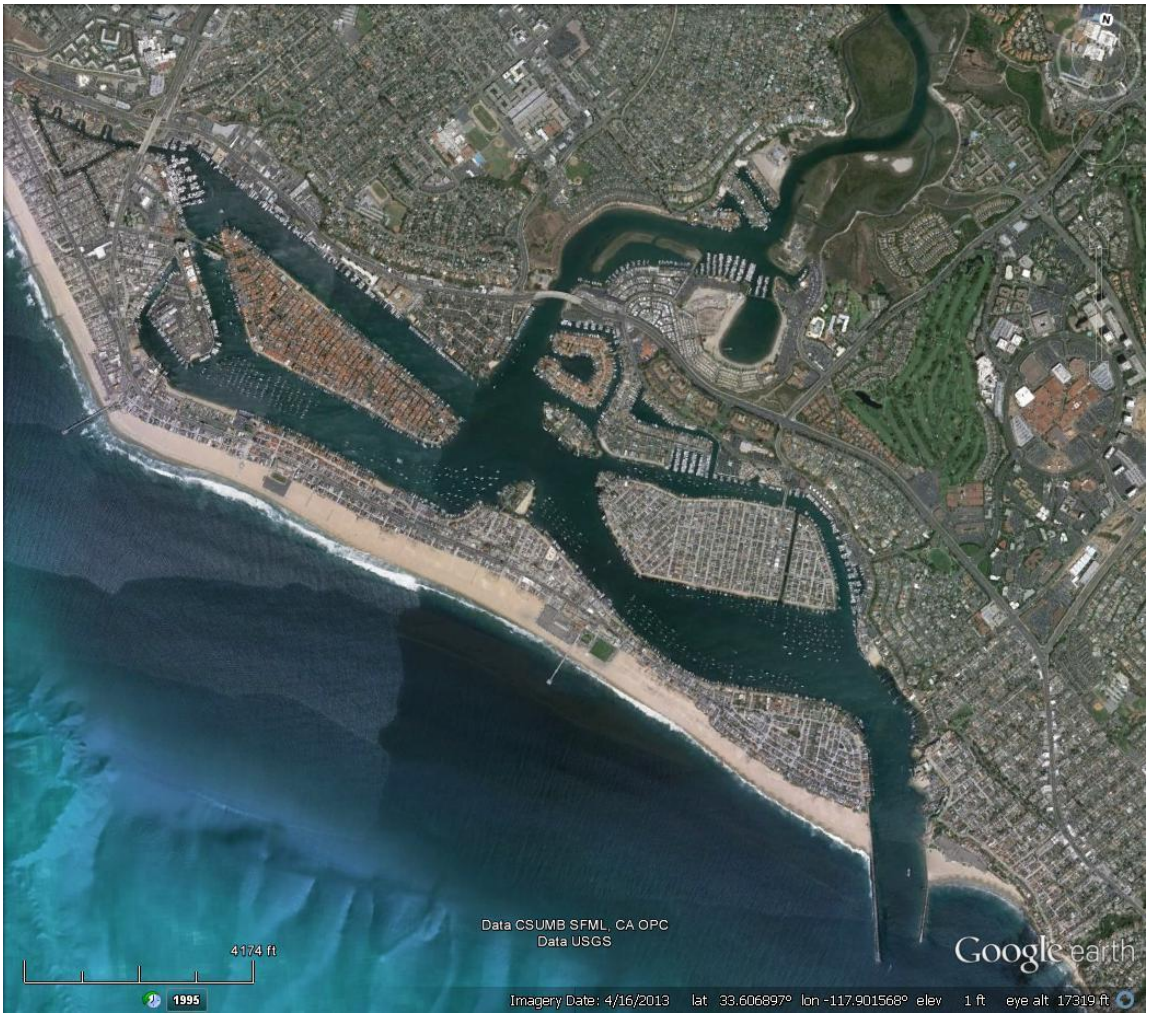
Metals Sediment Study in Lower Newport Bay (Post-dredging)

Final Report



by Orange County Coastkeeper

and

Linda M. Candelaria, PhD

for the

Santa Ana Regional Water Quality Control Board

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ORANGE COUNTY COASTKEEPER

Executive Summary

Lower Newport Bay is one of the most popular recreational boating harbors in California with approximately 10,000 recreational vessels. Stormwater, including sediments, from the San Diego Creek and Newport Bay Watersheds is carried by tributaries including San Diego Creek the Santa Ana Delhi, and Big Canyon Creek which results in sediment deposition in Upper and Lower Newport Bay. This excess sediment must be dredged periodically in order to maintain the beneficial uses of Newport Bay, which include navigation. The US Army Corps of Engineers (ACOE) and City of Newport Beach began dredging the federal navigational channels and anchorages of Lower Newport Bay in early 2012 and completed the process in February of 2013, removing over 600,000 cubic yards of sediment.

Sediment core samples collected prior to dredging indicate that the sediment in some dredge areas were contaminated with mercury (Hg) and other metals. Initially, sediments were scheduled to be dredged to the depth of clean sediment, thereby removing all contaminated sediments; however, due to funding constraints, some areas were dredged to lesser depths potentially leaving contaminated sediments in place. In addition, some sediments may have been redistributed during dredging. This project conducted post-dredging sediment sampling to determine metal concentrations in the surface sediments that remain.

Surface sediment and bottom water samples were collected from 15 sites (26 stations) in Newport Bay during three two day sampling sessions in October 2012, March 2013 and August 2013. Eleven sites were changed and one site added in March 2013, due to modifications in dredging locations. All sediment and water samples were analyzed for metals, including mercury (Hg) Copper (Cu), Nickel (Ni), and Zinc (Zn). In addition, sediment samples were analyzed for total organic carbon (TOC); and water samples were analyzed for pH, dissolved organic carbon (DOC) and total suspended solids (TSS). Based on the metals analyses in October 2012 and March 2013, a subset of six sites were analyzed for sediment toxicity.

Results: Sediment copper (Cu), mercury (Hg) and zinc (Zn) exceeded the ERM sediment guidelines. All ERM exceedences were in or near marina sites (Harbor Marina, Lido Village, Lido Yacht Anchorage and Balboa Island Channel (BC2)). Exceedences of the ERL sediment guidelines were common. Sediment Cu exceeded the ERL in all samples at all sites throughout the Lower Bay, and sediment Hg, Zn, arsenic (As) and nickel (Ni) exceeded the ERLs at most sites (14/15 for Hg, As, Ni, 13/15 for Zn). In addition, sediment cadmium (Cd) exceeded the ERL at 8/15 sites, and sediment chromium (Cr) and lead (Pb) exceeded the ERLs at the 3 marina sites. In bottom water samples, only dissolved Cu exceeded the metals CTR criteria only in October 2012 at 4/14 sites.

Sediment toxicity was determined in 6/15 surface sediment samples in August 2013 only. No toxicity to *Eohaustarius* survival was determined at any site tested, and percent survival ranged

from 95 to 98%. These toxicity results differ from those in the marina study where toxicity was found in the majority of the sediments tested.

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Acknowledgements

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I. Background

Newport Bay is located in the City of Newport Beach in Southern California and consists of the Upper and Lower Bay. The Lower Bay includes Balboa, Lido, Linda, Harbor and Bay Islands. The Channels in the harbor average one-quarter mile in width and the bay is about four miles long with the outlet to the ocean at its southeast end. Depth averages 20 feet.

Lower Newport Bay is one of the most popular recreational boating harbors in California with approximately 10,000 recreational vessels. Stormwater inputs, including sediments, from the Newport Bay Watershed carried by two major tributaries, San Diego Creek and Santa Ana Delhi, result in sediment deposition in Newport Bay. This excess sediment must be dredged periodically in order to maintain the beneficial uses of Lower Newport Bay, which includes navigation. The city of Newport Beach has a contractor that is currently dredging the federal navigational channels and anchorages of Lower Newport Bay and dredging will continue through 2012.

Sediment core samples collected for the Army Corps of Engineers (ACOE) prior to dredging indicate that the sediments in some areas proposed for dredging are contaminated with mercury (Hg) and other metals; however, when pre-dredging cores were collected, the core sediments were homogenized and multiple cores within a site were also homogenized. Because of this homogenization, most areas have a single analysis and data set point for several cores and metal concentrations at specific depths are unknown.

Initially, sediments were scheduled to be dredged to the depth of clean sediment, thereby removing the contaminated sediments. However, due to funding constraints, some areas were dredged to lesser depths potentially leaving contaminated sediments in place at the surface. In addition, some contaminated sediments may be redistributed during dredging. Therefore, it is imperative to determine metal concentrations in surface sediments that remain after dredging to determine whether these sediments are a source of metals to the Bay and whether these sediments are toxic to benthic organisms.

II. Methodology

Fifteen sites were chosen to be sampled in October 2012, March 2013 and August 2013 both during dredging and after dredging was completed. The 15 sites included 12 sites in dredge areas across the Lower Bay and 3 marina sites from a previous marina study (OCCK and Candelaria 2007). In March 2013, eleven site locations were modified due to dredge boundary modifications. Sediment samples were collected for all sampling events, bottom water samples were collected in October 2012 and March 2013, and sediment toxicity samples were collected from a subset of sites in August 2013.

II.1 Sampling Sites

Sampling sites were chosen prior to the start of the project in consultation with Contract Manager, Linda Candelaria, PhD. Sites in dredge areas were selected from maps of proposed dredge areas (ACOE, Newfields ADD Refs) and were targeted towards areas that had ERM exceedences of sediment Hg. Later, some dredge areas were modified; therefore, sampling sites were moved in March 2013 (Table 1 and Figure 1). Three (3) marina sites from a previous study (Harbor Marina, Lido Village, Lido Yacht Anchorage) were also resampled since they had exceedences of ERMs for sediment Cu, Hg and Zn.

Table 1 Sampling Sites by Sampling Event

Site Locations	October 12	March 13	August 13
Marinas			
*Harbor Marina**	6053 (33.61996 N, -117.92804 W)	6051 (33.62053 N, -117.92781 W)	6051 (33.62058 N, -117.92781 W)
*Lido Village**	6062 (33.61824 N, -117.92687 W)	6061 (33.61915 N, -117.92776 W)	6061 (33.61911 N, -117.92786 W)
*Lido Yacht Anchorage**	6073 (33.61104 N, -117.92319 W)	6072 (33.61195 N, -117.92333 W)	6072 (33.611572 N, -117.9233311 W)
Dredge Sites			
Lido Isle Reach North (West)	LNW (33.6158 N, -117.92056 W)	LW2 (33.61694 N, -117.92056 W)	LW2 (33.61694 N, -117.92056 W)
Lido Isle North East		LE (33.61444 N, -117.91417 N)	LE (33.61417 N, -117.91389 N)
Lido Isle Reach	LIS	LS2	LS2

South	(33.61324 N, -117.91319 W)	(33.61277 N, -117.91416 N)	(33.61278 N, -117.91417 N)
Upper Newport Channel	UNC (33.61417 N, -117.90565 W)	UNC2 (33.61583 N, -117.90556 W)	UNC2 (33.61583 N, -117.90557 W)
Balboa Island Channel	BC (33.60892 N, -117.89256 W)	BC2 (33.60932 N, -117.89508 W)	BC2 (33.60932 N, -117.89508 W)
Collins Island	CI (33.60889 N, -117.901019 W)	CI (33.60889 N, -117901019 W)	CI (33.60889 N, -117901019 W)
Harbor Island Reach	HIR (33.60517 N, -117.89976 W)	HIR2 (33.60685 N, -117.901717 W)	HIR2 (33.60767 N, -117.901717 W)
Balboa Reach	BR (33.601631 N, -117.890178 W)	BR2 (33.602833 N, -117.894083 W)	BR2 (33.6025 N, -117.89417 W)
West Lido Area A	WLA (33.60892 N, -117.91448 W)	WLA (33.60892 N, -117.91448 W)	WLA (33.60892 N, -117.91448 W)
West Lido Area B	WLB (33.60750 N, -117.91387 W)	WLB (33.60755 N, -117.91403 W)	WLB (33.60855 N, -117.91403 W)
Yacht Anchorage Area Middle	YAM2 (33.60723 N, -117.90838 W)	YAM3 (33.60868 N, -117.90962 W)	YAM3b (33.60783 N, -117.90917 W)
Yacht Anchorage Area North	YAN1 (33.60935 N, -117.90841 W)	YAN2 (33.6083 N, -117.90638 W)	YAN2 (33.60833 N, -117.906 W)

**Marina sites correspond to those sites in the Copper-metals marina study (OCCK 2007)*

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Figure 1 Sample Site Map by Sampling event
(Green indicates sampling sites for October 2012, Blue for March 2013 and Yellow for August 2013)

II.2 Sample Collection Methods

Sediment Samples

Sediment samples were collected using a petite ponar grab sampler, deployed from the Coastkeeper boat, and processed on site for delivery the same day to the Institute for Integrated Research in Materials Environment and Science (IIRMES). A single sediment sample was collected at each station. Approximately 50g of sediment was taken from the undisturbed surface of the grab and placed into pre-cleaned labeled bottles provided by the contract lab. The grab sampler was cleaned before collecting the sediment at each site by scrubbing it with a brush and rinsing it with seawater. All sediment samples were analyzed for total metals using EPA method 6012, including mercury (Hg) Antimony (Sb), Arsenic (As), Barium (Ba), Beryllium (Be), Cadmium (Cd), Chromium (Cr), Cobalt (Co), Copper (Cu), Iron (Fe), Lead (Pb), Manganese (Mn), Molybdenum (Mo), Nickel (Ni), Selenium (Se), Silver (Ag), Strontium (Sr), Thallium (Tl), Tin (Sn), Titanium (Ti), Vanadium (V) and Zinc (Zn). Sediment samples were also collected for Total Organic Carbon (TOC) analyses. During the last sampling session, surface sediment samples for toxicity analysis were also collected at six sites where Hg levels were highest based on the first two sampling sessions. Toxicity testing required 1L of sediment so multiple grabs at each site were required. All samples were stored in a cooler containing ice until delivery to the contract analytical lab. Extra care was taken to avoid cross contamination and all equipment will be decontaminated between the stations. Samples were delivered to ABC Labs and toxicity testing was done using EPA method 600/R-94/025.

Water Samples

Bottom water samples were collected above the surface sediments during the first and second sample collection sessions. Water samples were collected just above the surface of the sediment using a Van Dorn water sampler which was lowered on a line to a depth of approximately three feet above the sediment as determined by a depth sounder on the boat. The samples were then transferred to bottles provided by the lab and stored in a cooler (in the dark, on ice) until delivery to the contract analytical lab. The Van Dorn Bottle was triple rinsed with site water between each sample site. Water samples were analyzed using EPA method 1640 for dissolved and total metals, pH, dissolved organic carbon (DOC) and total suspended solids (TSS).

II.3 Data Analysis

As the data from the laboratory analysis was received from the contract lab it was entered into a project data base for later analysis. Sediment metals were compared to the ERM sediment guidelines (Long et al, 1995), and the dissolved metals were compared the CTR dissolved metals saltwater criteria.

Table 2 Saltwater CTR Criteria for Dissolved Metals

Element	Criterion Maximum Concentration	Criterion Continuous Concentration
1. Arsenic (As)	69 ug/l	36 ug/l
2. Cadmium (Cd)	42 ug/l	9.3 ug/l
3. Chromium (Cr) (VI)	1100 ug/l	50 ug/l
4. Copper (Cu)	4.8 ug/l	3.1 ug/l
5. Lead (Pb)	210 ug/l	8.1 ug/l
6. Mercury (Hg)	1.8 ug/l	0.94 ug/l
7. Nickel (Ni)	74 ug/l	8.2 ug/l
8. Selenium (Se)	300 ug/l	71 ug/l
9. Silver (Ag)	1.9 ug/l	
10. Zinc (Zn)	90 ug/l	81 ug/l

Table 3 Sediment Guidelines for Metals

Element	Salt ERL (mg/kg)	Salt ERM (mg/kg)
As	8.2	70
Cd	1.2	9.6
Cr-tot	81	370
Cu	34	270
Pb	46.7	218
Hg	0.15	0.71
Ni	20.9	51.6
Ag	1.0	3.7
Zn	150	410

III. Results

III.1 Sediment Chemistry

Sediment ERM Exceedences
Sediment copper (Cu), mercury (Hg) and zinc (Zn) exceeded the ERM sediment guidelines at or near the marina sites (Table 4, Appendix 1). Sediment Cu, Hg and Zn exceeded in Harbor Marina and Lido Village, sediment Cu and Hg exceeded in Lido Yacht Anchorage and sediment Hg exceeded in Balboa Island Channel (BC2). Harbor Marina and Lido Village are in the Turning Basin area which is a more stagnant area in western Newport Bay. Lido Yacht Anchorage is southeast of the Turning Basin at the end of the peninsula near the outlet to the Rhine Channel.The BC2 site was located near the Balboa Yacht Basin marina shipyard.

Sediment ERL exceedences
Sediment Cu exceeded the ERL guideline in all sediment samples at all sites throughout the Lower Bay including marina and post-dredge sites (Table 4, Appendix 1). Sediment Hg and Zn exceeded the ERLs at most sites: Hg, 14/15 sites with no exceedences at Harbor Island Reach; Zn 13/15 sites with no exceedences at Harbor Island Reach or Balboa Reach. Arsenic (As) and nickel (Ni) also exceeded the ERLs at most sites (14/15) with no exceedences at Upper Newport Channel. Sediment Cd exceeded the ERL at 8/15 sites throughout the Lower Bay. Sediment chromium (Cr) and lead (Pb) exceeded the ERLs at 3/15 sites which included the marina sites - Harbor Marina, Lido Village and Lido Yacht Anchorage.

Comparison to marina study
The marina sites in this study plus Balboa Yacht Basin and Bahia Corinthian marinas all exceeded the sediment Cu ERM in the marina study (2005-2006). The marina sites in this study plus H & J Moorings and Balboa Yacht Basin exceeded the sediment Hg ERM, and Harbor Marina, Lido Yacht Anchorage and H & J Moorings exceeded the sediment Zn ERM in the marina study.

These data demonstrate that the marina sites, especially those in western Newport Bay, are still exceeding ERM guidelines for sediment Cu, Hg and Zn, and that most post-dredge sites are exceeding ERLs for multiple metals but not ERMs.

Table 4 Sediment Metal Exceedences of the Effects Range Median (ERM) and Effects Range Low (ERL) Guidelines

Site	Sediment metals >ERM			Sediment metals >ERL		
	October 2012	March 2013	August 2013	October 2012	March 2013	August 2013
Harbor Marina	Cu	Cu, Zn	Cu, Hg	Cu,Hg,Zn As,Pb,Ni	Cu,Zn As,Cr, Pb,Ni	Cu,Hg,Zn Cd,Cr Pb,Ni
Lido Village		Cu, Hg, Zn	Cu, Hg	Cu,Hg,Zn As,Cr Pb,Ni	Cu,Hg,Zn As,Cd,Cr Pb,Ni	Cu,Hg,Zn As,Cr Pb,Ni
Lido Yacht Anchorage	Cu, Hg	Hg	Cu,Hg	Cu,Hg,Zn As,Cr Pb,Ni	Cu,Hg,Zn As	Cu,Hg,Zn As,Cr Pb,Ni
Lido Isle Reach North (West)				Cu,Hg Ni	Cu,Hg,Zn As,Ni	Cu,Hg,Zn Ni
Lido Isle North East	NS			NS	Cu,Hg,Zn As,Cd,Ni	Cu,Hg,Zn As,Ni
Lido Isle Reach South				Cu,Zn As,Ni	Cu,Hg,Zn As,Cd,Ni	Cu,Hg,Zn As,Cd,Ni
Upper Newport Channel				Cu,Hg,Zn	Cu	Cu,Hg,Zn
Balboa Island Channel		Hg	Hg	Cu,Hg	Cu,Hg,Zn As,Ni	Cu,Hg,Zn As,Pb,Ni
Collins Island (CI)				Cu,Hg,Zn As,Ni	Cu,Zn As,Ni	Cu,Hg
Harbor Island Reach				Cu	Cu As,Ni	Cu Ni
Balboa Reach				Cu	Cu As,Cd,Ni	Cu,Hg
West Lido Area A				Cu,Hg,Zn As,Ni	Cu,Hg,Zn As,Ni	Cu,Hg,Zn As,Pb,Ni
West Lido Area B				Cu,Hg,Zn As,Pb,Ni	Cu,Hg,Zn As,Cd,Ni	Cu,Hg,Zn As.Ni
Yacht Anchorage Area Middle				Cu,Hg,Zn As,Cd,Ni	Cu,Zn As,Cd,Ni	Cu,Hg,Zn As,Ni
Yacht Anchorage Area North				Cu,Hg,Zn As,Ni	Cu,Zn As,Cd,Ni	Cu,Zn Cd

NS = site not sampled
Cu =copper, Hg =mercury, Zn =zinc, As =arsenic, Cd =cadmium, Cr =chromium, Ni =Nickel, Pb =lead

Sediment Metals by Site (for metals exceeding ERMs)

The sites outlined below exceeded the ERMs for sediment copper (Cu), mercury (Hg) and/or zinc (Zn) (Table 4). Sites were sampled in October 2012, March 2013 and August 2013. A number of sites were moved in March 2013 and resampled in August 2013. No other sites exceeded the sediment ERMs.

Marina Sites

Harbor Marina 1 (6053 → 6051)

Sediment copper (Cu), mercury (Hg) and zinc (Zn) exceeded the ERMs. Cu exceeded the ERM for all three sampling events: 306 µg/g in October, 385 µg/g in March, and 352.9 µg/g in August. Other ERM exceedences include Hg in August: 0.77 µg/g and Zn in March: 475 µg/g. Note that the 6053 site was located outside the marina where only sediment Cu exceeded the ERM (October). When the site was moved into the marina, sediment Cu, Hg and Zn exceeded the ERMs. Metals exceeding the ERL include Copper, Mercury, Zinc, Arsenic, Cadmium, Chromium, Lead, and Nickel.

Lido Village 1 (6062 → 6061)

Sediment Cu, Hg and Zn exceeded the ERMs in March and/or August 2013 at 6061: Cu, 422 µg/g in March and 275.10 µg/g in August; Hg, 1.28 µg/g in March, 0.75 µg/g in August; Zn, 515 µg/g in March. Note that no metals exceeded the ERMs at 6062 (October). Metals exceeding the ERL include Copper, Mercury, Zinc, Arsenic, Cadmium, Chromium, Lead and Nickel.

Lido Yacht Anchorage 1 (6073 → 6072)

Sediment Cu and/or Hg (but not Zn) exceeded the ERMs in all three sampling events. Hg exceeded the ERM for all three sampling events: 1.83 µg/g in October, 1.06 µg/g in March and 0.93 µg/g in August. Other ERM exceedences include Cu, 293.4 µg/g in October, 287.20 µg/g in August. Note that both sites exceeded the Cu and Hg ERMs Metals exceeding the ERL include Copper, Mercury, Zinc, Arsenic, Chromium, Lead and Nickel (but not Cadmium).

Dredging Sites

Balboa Island Channel (BC → BC2)

BC was sampled in October 2012. No sediment metals exceeded the ERM. Metals exceeding the ERL include Copper and Mercury.

BC2 was sampled in March and August 2013. Only sediment Hg exceeded the ERM in March and August 2013: 0.82 µg/g in March and 0.99 µg/g August. Metals exceeding the ERL include Copper, Mercury, Zinc, Arsenic, Lead and Nickel.

Note that BC2 is the same site as 6035 in the marina study, and is located just outside Balboa Yacht Basin marina shipyard, but still in the BC dredging area. When the site was moved from BC (closer to the middle of Balboa Channel) which had no ERM exceedences, to the marina study location outside BYB shipyard, Hg ERM exceedences were found.

III.2 Bottom Water Chemistry

CTR Dissolved Metal Exceedences

Dissolved Cu was the only metal to exceed the saltwater CTR criteria in bottom water samples in 4/15 sites including Lido Yacht Anchorge, Lido Island Reach North, Newport Channel and Balboa Island Channel. Dissolved Cu did not exceed the CTR criteria in August samples. Note that no bottom water sampes were collected in August 2013, and no surface samples were collected due to limited funds.

Comparison to marina study

In contrast, surface water samples in all marina sites in the marina study (2005-2006) exceeded the dissolved Cu saltwater CTR criterion demonstrating the high probability that most of the dissolved Cu is from boats rather than sediments.

Table 5 Metal Exceedences of the Saltwater CTR criteria in Bottom Water

Site	*Dissolved metals >CTR*	
	October 2012	*March 2013^*
Harbor Marina		
Lido Village		
Lido Yacht Anchorage	*Cu (5.2)*	
Lido Isle Reach North (West)	*Cu (3.2)*	
Lido Isle North East		
Lido Isle Reach South		
Upper Newport Channel	*Cu (3.2)*	
Balboa Island Channel	*Cu (3.2)*	
Collins Island		
Harbor Island Reach		
Balboa Reach		
West Lido Area A		
West Lido Area B		
Yacht Anchorage Area Middle		
Yacht Anchorage Area North		

^ There were no exceedences of dissolved metals CTR criteria in March 2013

Numbers in parentheses are dissolved Cu concentrations in ug/L

Dissolved Organic Carbon, Total Organic Carbon and Total Suspended Solids

Dissolved organic carbon (DOC) and total suspended solids (TSS) were measured in bottom water samples. TSS were higher in October (16.5 to 42.6 mg/L) compared to March 2013 (2.6 to 8.4 mg/L). This higher TSS in October could possibly be due to the dredging that was ongoing in the Lower Bay during the fall 2012. TSS were highest in the West Lido and Yacht Anchorage Areas in October. The DOC was less than 1 mg/L in both October 2012 and March 2013,which is a low DOC. The DOC was mostly non-detectable in October 2012 except for West Lido A, which is a little surprising since the mean TSS in October was 27.6 mg/L. In March 2013, the DOC was measurable but below 1 mg/L at all sites. These data show that the TSS is likely suspended sediments rather than organic matter. The total organic carbon (TOC) was measured in all sediment samples in October 2012 and March 2013, and a subset of samples in August 2013 (the subset run for toxicity). Sediment TOC was higher in March and August over October, and the mean TOC was 1.35, 1.52 and 2.32 % dry weight in October, March and August, respectively. Harbor Marina had the highest sediment TOC of any site for all sampling times, followed by Lido Village .

Table 6 Dissolved and total organic carbon (DOC, TOC) and total suspended solids (TSS)

Site	*Dissolved organic carbon (DOC) (mg/L) in bottom water*		*Total organic carbon In sediments (TOC) (% dry weight)*			*Total Suspended Solids (TSS) (mg/L)*	
	Oct. 2012	*Mar. 2013*	*Oct. 2012*	*Mar. 2013*	*Aug. 2013*	*Oct. 2012*	*Mar. 2013*
Harbor Marina	*ND*	*0.7*	*3.04*	*4.3*	*4.56*	*26.7*	*5.7*
Lido Village	*ND*	*0.84*	*1.72*	*2.37*	*2.97*	*16.5*	*3.1*
Lido Yacht Anchorage	*ND*	*0.76*	*1.52*	*1.06*	*2.59*	*17*	*6.2*
Lido Isle Reach North (West)	*ND*	*0.8*	*1.29 0.49*	*1.86*		*23.9 25*	*8.0*
Lido Isle North East	*NS*	*0.67*	*NS*	*1.5*	*1.98*	*NS*	*3.1*
Lido Isle Reach South	*ND*	*0.76*	*1.52*	*1.29*		*28.4*	*8.4*
Upper Newport Channel	*ND*	*0.71*	*1.16*	*0.95*		*21.7*	*6.4*
Balboa Island Channel	*ND*	*0.58*	*0.66*	*1.52*	*2.22*	*23.4*	*6.5*
Collins Island	*ND*	*0.62*	*1.24*	*1.19*		*23.9*	*6.1*
Harbor Island Reach	*ND*	*0.50 0.59*	*0.78*	*1.13 1.02*		*29.8*	*6.5 4.3*
Balboa Reach	*ND*	*0.56*	*1.16*	*0.98*		*31.1*	*5.5*
West Lido Area A	*0.87*	*0.77*	*1.27*	*1.42*		*42.6*	*2.6*
West Lido Area B	*ND*	*0.74*	*1.13*	*1.24*	*1.24*	*40.4*	*5.3*
Yacht Anchorage Area Middle	*ND*	*0.65*	*1.38*	*1.37*		*40.8*	*6.0*

Yacht Anchorage Area North	*NDx*	*0.68*	*1.41* *1.39*	*1.11*		*21.1* *19.9*	*6.0*
Mean		*0.68*	*1.32*	*1.52*	*2.59*	*28.7*	*5.6*

NS =not sampled; ND =nondetect

III.3 Sediment Toxicity

Toxicity was analyzed in a subset of surface sediment samples in August 2013 with a 10-day *Eohaustarius* survival test (Appendix 2). Only a subset of sites were run due to limited funds, and the sites were chosen based on exceedences of the Cu and Hg ERMs. No toxicity to *Eohaustarius* wwas found at any site tested. Note that *Eohaustarius* is used to determine general sediment toxicity, while the sediment-water interface (SWI) test is more specific to metals toxicity. *Eohaustarius* tests were conducted to compare with toxicity tests conducted for the marina study. SWI tests were not run with *Eohaustarius toxicity tests* due to limited funds.

Table 7 Sediment Toxicity Data -August 2013

Site	*Sediment Toxicity (Eohaustarius) % Survival*
Harbor Marina (6051)	*96*
Lido Village (6061)	*97*
Lido Yacht Anchorage (6072)	*95*
Lido Isle Reach North (West)	
Lido Isle North East (LE)	*98*
Lido Isle Reach South	
Newport Channel	
Balboa Island Channel (BC2)	*97*
Collins Island	
Harbor Island Reach	
Balboa Reach	
West Lido Area A	
West Lido Area B (WLB)	*95*
Yacht Anchorage Area Middle	
Yacht Anchorage Area North	

IV Conclusions

Sediment copper (Cu), mercury (Hg) and zinc (Zn) exceeded the ERM sediment guidelines. All ERM exceedences were in or near marina sites (Harbor Marina, Lido Village, Lido Yacht Anchorage and Balboa Island Channel (BC2)).

Exceedences of the ERL sediment guidelines were common. Sediment Cu exceeded the ERL in all samples at all sites throughout the Lower Bay. Sediment Hg, Zn, arsenic (As) and nickel (Ni) exceeded the ERLs at most sites: Hg at 14/15 sites with no exceedences at Harbor Island Reach; Zn at 13/15 sites with no exceedences at Harbor Island Reach or Balboa Reach; and As and Ni at 14/15 sites with no exceedences at Upper Newport Channel. Sediment cadmium (Cd) exceeded the ERL at 8/15 sites, and sediment chromium (Cr) and lead (Pb) exceeded the ERLs at 3/15 sites at the marina sites, Harbor Marina, Lido Village and Lido Yacht Anchorage.

In bottom water samples, only dissolved Cu exceeded the metals CTR criteria only in October 2012 at 4/14 sites. There were fewer CTR exceedences in bottom water in this study compared to surface water exceedences in the marina study. No other metal exceeded the CTR criteria in this study or the marina study.

Sediment toxicity was determined in 6/15 surface sediment samples in August 2013 only. No toxicity to *Eohaustarius* survival was determined at any site tested, and percent survival ranged from 95 to 98%. These toxicity results were different from toxicity determined in the marina study. In August 2006, eight out of ten (8/10) marina sites were toxic to *Eohaustarius* survival. In addition, reduced percent survival was found at 3/10 sites with sediment-water interface (SWI) mussel embryo development tests, Additional tests for the marina study, in November 2006, also showed toxicity in 6/6 *Eohaustarius* survival tests, SWI and pore water tests were not run for this study due to limited funding.

Reference:

Orange County Coastkeeper and L.M.Candelaria. July 2007. Lower Newport Bay Copper-Metals Marina Study. Report for Santa Ana Regional Water Board.