Dredge Material Inputs into the Southern California Bight

Until the Ocean Dumping Act was passed in 1972, a variety of materials were legally dumped from barges and ships into the coastal waters of southern California. Dumping of industrial wastes, refuse and garbage, and munitions into coastal waters was regulated since 1967, but rarely accurately characterized, therefore only limited information about these practices is available (SCCWRP 1973; Chartrand et al. 1985). Dredged sediments are the only materials that may be dumped into the Southern California Bight in large quantities at this time. However, estimates of contaminant mass emissions are not available and routine monitoring of the disposal sites has not been conducted, which makes dredge dumping unique among regulated discharges to the Bight.

In this study, Henry Schafer and Karen Englehart determined the quantity and quality of material dumped at offshore dredge disposal sites, and estimated the inputs of trace contaminants contained in these sediments.

The data presented in this paper were not collected specifically to estimate emissions, therefore the estimates may not be accurate. However, the data collected for this paper are the only data available. This fact emphasizes the need for an increased effort to examine contaminant inputs and the effects of dredge disposal in the coastal waters of southern California.

Millions of metic tons (t) of sediments have been dredged in southern California since the turn of the century. Because most dredged sediment was dumped before the buildup of contaminants in nearshore sediments, dredging-related impacts were mostly limited to the physical changes made during dredging and dumping. Most recent dredging projects similarly have had limited potential impact because they primarily involved physical alterations. Dredging to remove beach sand from the mouths of river channels and the original nonmaintenance dredging of harbor channels removed sediments that were not likely to contain high levels of contaminants. Presently, dredged sediment is used for beach replenishment or landfill in harbors; dredge spoils are only dumped at sea when the material does not have an onshore useand meets Ocean Dumping Act requirements.

The potential for sediment contamination by trace elements usually has been associated with sediments deposited during the last 50 years. Most of the harbors are connected to major storm runoff channels

and fine-grained contaminated sediments from urban runoff accumulate in poorly flushed areas. Local industrial sources such as ship repair, bulk transfer, and industrial manufacturing facilities have released pollutants into channels that have contaminated parts of many harbors. The California State Mussel Watch Marine Water Quality Monitoring Program, which monitors the contaminant levels in mussels along the California coast, has found some of the highest levels of contaminants in the inner harbors (Hayes and Phillips 1987).

As a result of the enactment of the Marine Protection, Research, and Sanctuaries Act (aka. Ocean Dumping Act), dredge material must be submitted for chemical testing and bioassays to ascertain contaminant levels before a permit for ocean disposal is issued. The Army Corps of Engineers is responsible for issuing dumping permits, and Region 9 of the Environmental Protection Agency reviews all dredge dumping applications for southern California and is responsible for selecting and monitoring offshore dumpsites. Permits may be denied due to excessive contaminant concentrations, or significant bioaccumulation or mortality in test organisms during toxicity testing.

The Environmental Protection Agency designated three active dumpsites in 1977 that have been operational through 1988 in the Southern California Bight: LA2, located offshore of Los Angeles harbor; LA3, located offshore from Newport Beach; and LA5 located offshore of San Diego (Figure 1).

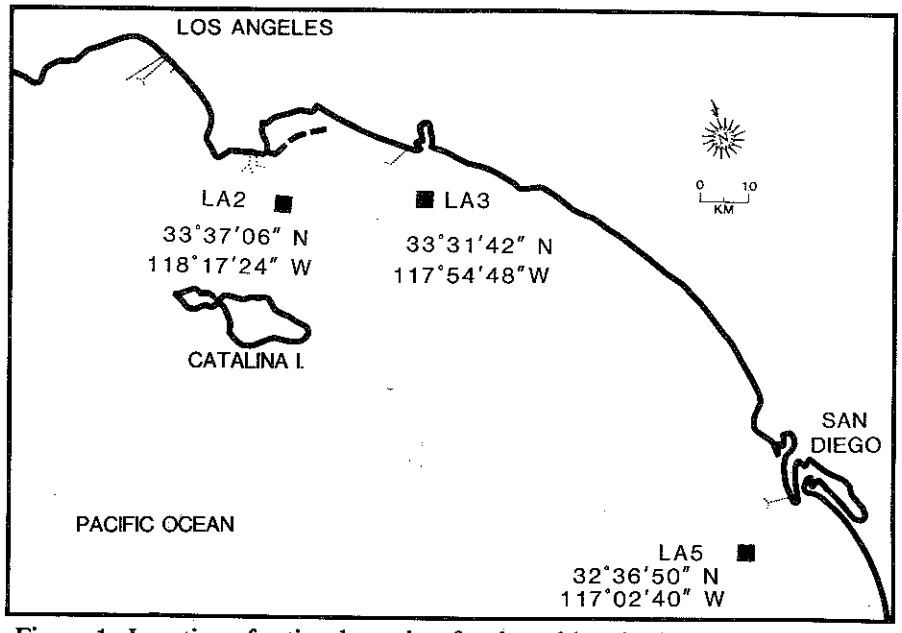

Figure 1. Location of active dumpsites for depositing dredge materials in the Southern California Bight.

Methods

Permit applications filed with the Army Corp of Engineers were examined for the five year period from 1984 through 1988 to collect information about contaminant levels of dredged materials deposited in southern California offshore dumpsites. Additional information about dredging has been summarized in recent Environmental Impact Statements for dumpsites LA2 and LA5 (U.S. Environmental Protection Agency 1988a; U.S. Environmental Protection Agency 1988b), however data describing contaminant levels of dredge materials are only available from individual permit applications.

Our data base was limited to the information contained in permit applications on file with the Los Angeles office of the Army Corps of Engineers from 1984 to 1988. These data only provide order of magnitude estimates of inputs. Sampling at many dredge sites has been inadequate to accurately characterize all of the dredge material; usually a few surface samples are collected, but permits have allowed dredging of deeper sediments.

Results

A total of 20 permit applications for depositing dredged material into ocean dumpsites was reviewed (six for LA2, four for LA3, and 10 for LA5). Chemical data were available for nine permits (one for LA2, four for LA3, and four for LA5), covering about 80% of the total material deposited. In this study we assumed that the volume of dredged material discharged was equal to the amount requested to be dumped in the permit application, although in some cases the actual volume discharged may have been less than the amount requested.

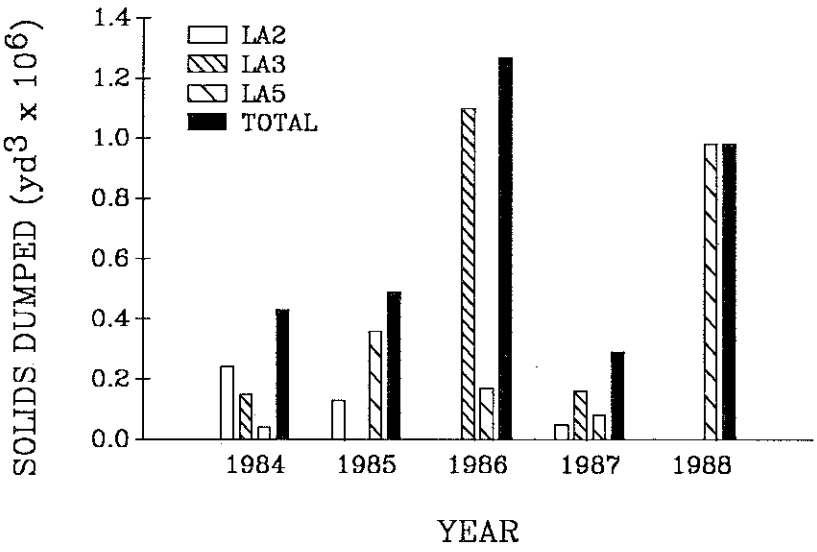

Figure 2. Total dredge solids dumped at offshore dumpsites, 1984-88.

We also assumed that all dredged material was dumped during the year the application was approved.

From 1984-88, permits were issued for the offshore discharge of 3.3 million yd³ (1 yd³ = 1.3 m³) of sediment. A mean of 660,000 yd³ of solid emissions per year were dumped in the LA2, LA3, and LA5 dump during this period, but solid emissions varied substantially from year to year (Figure 2) due to the operation or absence of large dredging projects.

One large dredging project in Newport Bay (dumped at LA3) and one in San Diego Bay (dumped at LA5) accounted for over 1.8 million yd³ of sediment. These infrequent but very large dredging projects have a major impact on annual calculated averages. For example, the LA2 1984-88 annual mean value equals only about one-third of the 1978-84 mean for this dumpsite (U.S. Environmental Protection Agency 1988a) because no large dredging projects have dumped at LA2 since 1982.

Mean concentrations of material discharged at each dumpsite were calculated from available chemistry data when included in the permit reports. Nine permits (one for LA2, four for LA3, and four for LA5) were grouped by receiving dumpsite. Within each dumpsite group, project concentrations were weighted by the volume of sediment listed on permits, and a mean value was calculated (Table 1).

Mass emissions at each dumpsite over the five year period were estimated by multiplying the weighted mean concentrations (listed in Table 1) by the total volume, including permits with and without chemistry data, dumped at each site from 1984-88 (Table 2). (We assumed that one cubic yard (yd³) = one metric ton (t) of dry sediment in our calculations.)

To estimate the relative effect of dredge inputs on the Southern California Bight, we calculated annual dredge inputs and compared them to annual effluent inputs from

Table 1. Dredge material characteristics of material dumped at LA2, LA3, and LA5 in 1984 and 1985 based on available permit data.

	LA2	LA3	LA5
No. permits examined	6	4	11
No. permits with chemistry	1	4	4
Material (yd^3) with chemistry data	46,000	1,258,430	1,146,000
Total yd^3 discharged	295,000	1,258,000	1,757,000
Percent total discharge with chemistry data[a]	16	100	65
Weighted mean concentrations of constituents (mg/kg)			
As	16.7	0.3	1.5
Ag	-	-	1.9
Cd	0.8	1.8	0.74
Cr	28	17.1	30.6
Cu	137	15.8	69
Hg	0.27	0.83	0.56
Pb	67	40.4	24
Zn	171	189	73
Organic Tin	-	-	1.7
TEH	-	<5	0.5
TEO	-	-	10700
O&G	-	5	308
Petroleum Hydrocarbons	50	<5.5	13
Total Organic Halides	96	-	-
Pesticides	<.007	0.07	0.02
Arochlor 1242	-	<3	-
Arochlor 1254	0.47	<3	-
Arochlor 1260	-	<3	0.5
Total PCB	-	-	0.52
Chlorinated Hydrocarbons (CHC)	-	-	-
DDT	-	<0.3	-

[a] Permits with chemistry data did not always report all of these constituents, thus some constituent concentrations may be based on less than the percentage listed.

municipal wastewater outfalls, which have been extensively monitored and are a major source of most anthropogenic contaminants to the Bight. Contaminants common to both sources are listed in Table 3. Combined outfall emissions of trace metals exceed the estimated combined dredge inputs. The outfalls account for two to six times more arsenic, cadmium, chromium, copper, lead, and zinc than dredge disposal inputs. Silver emissions were 16 times greater for wastewater outfalls than dredge inputs, which is noteworthy because the California State Mussel Watch Program has identified silver as a good indicator of municipal effluent discharges.

PCB emissions from dredge dumping could exceed outfall emissions; the high detection limits reported in some dredging permits indicate that large quantities of PCBs may have been dumped

Table 2. Estimated mass emissions from all dredge discharges deposited at LA2, LA3, and LA5 from 1984 to 1988.[a]

Trace Constituents	LA2	LA3	LA5	5 Yr Total
As	4.9	0.48	2.6	8
Ag	-	-	3.3	3.3
Cd	0.24	2.3	1.3	3.8
Cr	8.3	22	54	84
Cu	40.4	20	120	180
Hg	0.08	1	1	2
Pb	20	51	42	113
Zn	50	238	130	418
Organic Tin	-	-	3	3
Tin	-	-	1.5	1.5
TEH	14.7	<6	0.9	15.6
TEO	-	-	19,000	19,000
O&G	-	6.3	541	547
Petroleum Hydrocarbons	15	<7	23	38
Total Organic Halides	28	-	-	28
Pesticides	<0.002	0.09	0.03	.12
Arochlor 1242	-	<3.8	-	
Arochlor 1254	0.14	<3.8	-	0.14
Arochlor 1260	-	<3.8	0.9	0.9
Total PCB	-	-	0.9	0.9
CHC	-	0.09	-	0.09
DDT	-	<0.4	-	

[a] Measurements were listed in metric tons.

(Table 2). Other permits with much lower detection limitsreported values in the 0.1 - 0.01 mg/kg range which would mean that tens of kilograms to hundreds of kilograms of PCBs were discharged. However, our data base is very small and PCB emissions from dumping dredged materials will require further examination.

In the southern part of the Southern California Bight, dredge emissions to LA5 may be a more important input when compared to the major municipal discharge from the City of San Diego through the Point Loma Wastewater Treatment Plant outfall (Table 3). Emissions from both sources are generally within a factor of two to four, with dredging contributing higher emissions of five of the eight metals. PCB emissions are nondetectable in Point Loma effluents while dumping at LA5 may be contributing up to 200 kg/yr.

Discussion

The emission estimates presented in this paper have many weaknesses, because only limited data are available. However, these estimates indicate that dredging emissions are a significant source of some anthropogenic contaminants into the Southern California Bight, and dredged material disposal may be a major source of contaminants in some areas. Future sampling programs to fulfill dredge disposal permit requirements should be designed to adequately estimate contaminant mass emissions so that more accurate estimates of inputs can be calculated. Regular monitoring with sufficient sampling and analyses to detect the extent and degree of impacts from dredge discharges would help clarify the significance of these inputs.

Accurate measure-

Table 3. Estimated annual mass emissions to the Southern California Bight from the discharge of dredge material and municipal wastewater effluents. Measurements in metric tons except as noted.

Constituents	Totals for Region		San Diego Area	
	Dredge Discharges	Municipal Outfalls	LA5	Point Loma
Solids	603,000[a]	97,400	351,000[a]	17,800
As	1.6	9	0.5	1
Ag	0.7	11	0.7	0.8
Cd	0.8	4	0.3	0.3
Cr	17	30	11	1.3
Cu	37	77	54	12
Hg	0.4	<1	0.2	0.05
Pb	22	51	8	2.6
Zn	83	153	26	18

[a] The original measurements were listed in cubic yards (we assumed one cubic yard = one metric ton in this study.

ments of major inputs is a first step in judging their importance to the ecology of the Southern California Bight. We will then be able to accomplish our objective of characterizing all point and nonpoint anthropogenic inputs to coastal waters.

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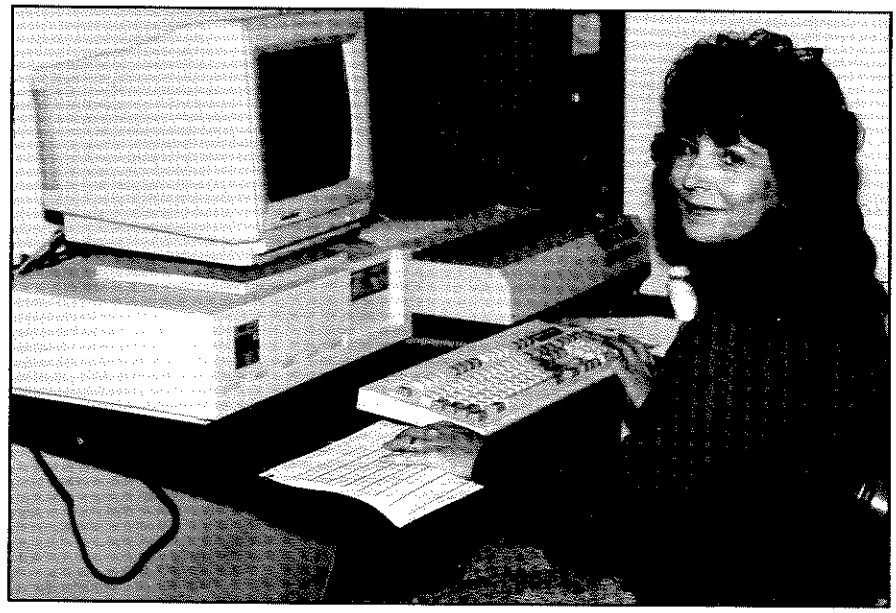

Karen Englehart processing dredge material data.