

# Characteristics of Effluents from Large Municipal Wastewater Treatment Plants in 1989

**W**e summarized effluent constituent concentrations and mass emission estimates for Hyperion Wastewater Treatment Plant (City of Los Angeles), Joint Water Pollution Control Plant (County Sanitation Districts of Los Angeles County), County Sanitation Districts of Orange County Wastewater Treatment Plants 1 and 2, and Point Loma Wastewater Treatment Plant (City of San Diego) for 1989 (Figure 1). Effluents from these facilities constitute 90% of municipal effluents discharged directly into the Southern California Bight.

## Materials and Methods

We obtained the effluent data reported by each discharge agency under National Pollution Discharge Elimination System permits from the Regional Water Quality Control Boards (Los Angeles, Santa Ana, and San Diego). Annual mass emission estimates are the product of annual effluent volume and mean annual constituent concentration. The discharge agencies have measured the constituents featured in this report annually for 18 years. The long-term trends are also discussed.

## Results and Discussion

The combined volume of effluent discharged from the largest facilities increased 2% from



**Metridium attached to wastewater outfall pipe.**

1988 to 1989 (Table 1). The amount of effluent receiving secondary treatment increased from 42% of the combined discharge in 1988 to 45% of the combined discharge in 1989. The greatest change occurred at Hyperion—the amount of effluent receiving secondary treatment increased from 41% in 1988 to 48% in 1989.

The range of constituent concentrations in effluents from the four facilities varied from less than a factor of two to greater than 1000 (Table 2). Most constituent concentrations differed by a factor of five or less. The

differences are due to the type of wastes (domestic and industrial), source control, volume of water removed for reclamation or inland discharge, and efficiency and degree of treatment (advanced primary or secondary). The range of constituent mass emissions from the four facilities varied less than ten-fold (Table 3).

From 1988 to 1989, combined effluent emissions of suspended solids declined 14%, biochemical oxygen demand (BOD) declined 5%, and oil and grease declined 11% (Table 4). The mass emissions of suspended solids declined 32% at Hyperion and 11%

**Table 1.**

Volume of municipal wastewater discharged to the ocean in 1989 from the largest municipal wastewater treatment facilities in southern California.

	Treatment		Total Flow (mgd)	Distance of Discharge From Shore (m)	Depth of Discharge (m)
	Advanced Primary (mgd <sup>a</sup> )	Secondary (mgd)			
Hyperion <sup>b</sup>	188	177	365	8,300	57
JWPCP <sup>c</sup>	174	208	382	2,400-3,660	60
CSDOC <sup>d</sup>	122	140	262	7,250	60
Point Loma <sup>e</sup>	191	0	191	4,000	60
Total	675	525	1200		

<sup>a</sup>mgd=million gallons per day (1 mgd = 3,785,000 liters/day)

<sup>b</sup>City of Los Angeles

<sup>c</sup>Joint Water Pollution Control Plant, County Sanitation Districts of Los Angeles County

<sup>d</sup>County Sanitation Districts of Orange County

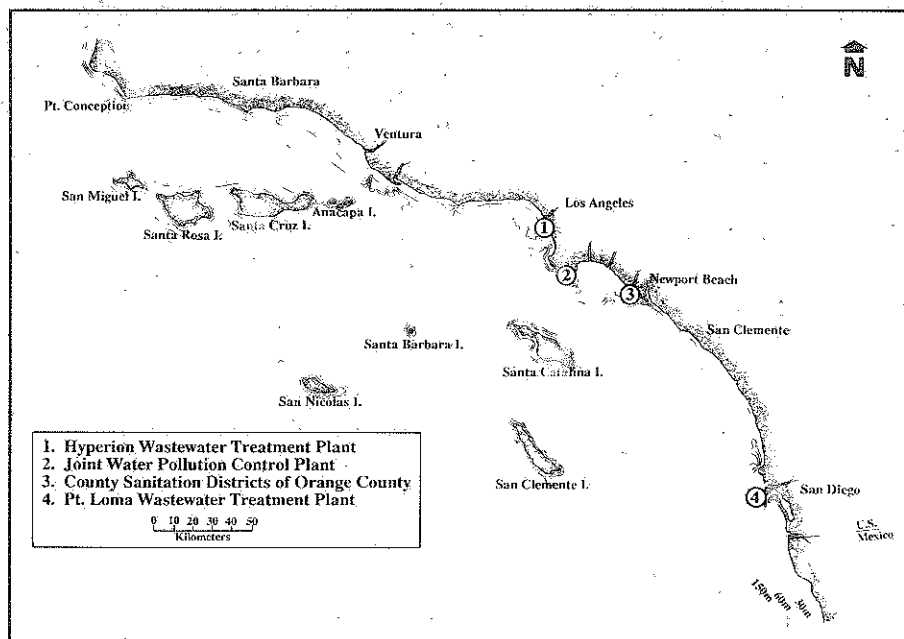
<sup>e</sup>City of San Diego

at Point Loma. The mass emissions of oil and grease declined 11% at JWPCP and 20% at Point Loma. The combined emissions of cadmium and lead declined about 45%. The combined emissions of arsenic, chromium, copper, and nickel declined 10-25%. The combined emissions of silver, mercury, and zinc remained virtually unchanged. Effluent concentrations of DDT and PCB were often below method detection limits. Based on detectable concentrations, the estimated mass emission of DDT declined 23%. The estimated mass emission of PCBs was zero in both years.

The number of reported analyses with masses below detection limits (BDL) has increased in recent years. Concentrations have declined due to source control and improved treatment; some contaminant

**Figure 1.**

Map of the Southern California Bight showing the location of the four largest municipal wastewater dischargers. Hyperion Wastewater Treatment Plant (City of Los Angeles), Joint Water Pollution Control Plant (JWPCP; County Sanitation Districts of Los Angeles County), County Sanitation Districts of Orange County (CSDOC), and Point Loma Wastewater Treatment Plant (City of San Diego).



**Table 2.**

Mean annual constituent concentrations in effluents from the largest facilities in southern California in 1989.

	Hyperion <sup>a</sup>	JWPCP <sup>b</sup>	CSDOC <sup>c</sup>	Point Loma <sup>d</sup>
Flow (mgd <sup>e</sup> )	365	382	262	191
Suspended solids (mg/l)	33	65	46	60
Settleable solids (ml/l)	0.3	0.3	0.48	0.3
BOD <sup>f</sup> (mg/l)	90	109	74	119
Oil & Grease (mg/l)	13	12.1	13.2	18.4
NO <sub>3</sub> -N (mg/l)	0.54	0.12	-	-
NO <sub>2</sub> -N (mg/l)	-	<0.15	-	-
NH <sub>3</sub> -N (mg/l)	19	38.2	24	25.4
Organic N (mg/l)	-	8.2	-	-
PO <sub>4</sub> -P (mg/l)	4.07	7.34	-	3.8
MBAS <sup>g</sup> (mg/l)	-	3.7	-	5.2
Cyanide (mg/l)	0.018	<0.01	<0.02	0.004
Phenols				
Non-chlorinated (µg/l)	0.7	1500	14	8.6
Chlorinated (µg/l)	1.1	34.6	8	<15.3
Turbidity (NTU <sup>h</sup> )	36	50	27	69
Toxicity (TU <sup>i</sup> )	0.71	1.83	0.48	1.48
Silver (µg/l)	7	8	8	<10
Arsenic (µg/l)	6	5	2.2	3.5
Cadmium (µg/l)	0.4	2	1.8	<5
Chromium (µg/l)	4	31	11	<50
Copper (µg/l)	38	35	56	37
Mercury (µg/l)	0.2	0.4	0.21	0.19
Nickel (µg/l)	28	50	25	15
Lead (µg/l)	18	25	13	<50
Selenium (µg/l)	-	13	1.3	1.0
Zinc (µg/l)	74	130	60	68
Total DDT (µg/l)	nd <sup>j</sup>	0.02	<0.05	0.036
Total PCB (µg/l)	nd	nd	<0.3	nd

<sup>a</sup>City of Los Angeles<sup>b</sup>Joint Water Pollution Control Plant, County Sanitation Districts of Los Angeles County<sup>c</sup>County Sanitation Districts of Orange County<sup>d</sup>City of San Diego<sup>e</sup>mgd=million gallons per day (1 mgd = 3,785,000 liters/day)<sup>f</sup>BOD=biochemical oxygen demand<sup>g</sup>MBAS=methylene blue active substances<sup>h</sup>NTU=nephelometric turbidity units<sup>i</sup>TU=toxicity units<sup>j</sup>nd=not detectable and detection limit not reported.

measurements are consistently below detection limits. If detection limits of the recommended techniques are below discharge permit requirements, then BDL results are in compliance. But, BDL results complicate mass emission estimates. We report detection limits in the table of concentrations (Table 2), but we did not use BDL results to estimate mass emissions (Table 3).

Concerns about the reliability of trace contaminant analyses, especially trace organic analyses,

in early monitoring programs complicate interpretation of long-term trends. Analytical methods for quantifying chlorinated hydrocarbons evolved during the 1970s and techniques were not standardized among laboratories. The older data reported herein are the best available for past discharges, but the old methods would be unacceptable today. The accuracy and precision of contaminant analyses have improved over the years because of advancements in methods, instru-

mentation, and intercalibration techniques among laboratories.

The combined flow from the largest facilities increased nearly 30% between 1971 and 1989 as a result of population increases (Figure 2). This is a mean annual increase of 1.4% (sd=2.0, n=18). The volume of wastewater discharged by the CSDOC and Point Loma facilities doubled during this time, while the volume discharged from JWPCP and Hyperion increased only slightly (Figure 2). Differences among the

**Table 3.**

Estimated mass emissions from the largest facilities in southern California in 1989.

	Hyperion <sup>a</sup>	JWPCP <sup>b</sup>	CSDOC <sup>c</sup>	Point Loma <sup>d</sup>
Flow (liter x 10 <sup>9</sup> )	504	528	362	264
Suspended solids (mt <sup>e</sup> )	16,640	34,303	16,650	15,832
BOD <sup>f</sup> (mt)	45,383	57,524	26,785	31,401
Oil & grease (mt)	6,555	6,386	4,778	4,855
NO <sub>3</sub> -N (mt)	272	63	-	-
NO <sub>2</sub> -N (mt)	-	-	-	-
NH <sub>3</sub> -N (mt)	9,581	20,160	8,688	6,702
Organic N (mt)	-	4,300	-	-
PO <sub>4</sub> -P (mt)	2,052	3,874	-	1,003
MBAS <sup>g</sup> (mt)	-	1,953	-	1,372
Cyanide (mt)	9.1	-	-	1.1
Phenols (mt)	-	-	-	-
Non-chlorinated	0.35	792	5.1	2.3
Chlorinated	0.55	18	2.9	-
Silver (mt)	3.5	4.2	2.9	-
Arsenic (mt)	3.0	2.6	0.80	0.92
Cadmium (mt)	0.20	1.1	0.65	-
Chromium (mt)	2.0	16.4	4.0	-
Copper (mt)	19.2	18.5	20.3	9.8
Mercury (mt)	0.101	0.211	0.076	0.050
Nickel (mt)	14.1	26.4	9.0	4.0
Lead (mt)	9.1	13.2	4.7	-
Selenium (mt)	-	6.9	0.47	0.26
Zinc (mt)	37.3	68.6	21.7	17.9
Total DDT (kg)	-	10.6	-	9.5
Total PCB (kg)	-	-	-	-

<sup>a</sup>City of Los Angeles

<sup>b</sup>Joint Water Pollution Control Plant, County Sanitation Districts of Los Angeles County

<sup>c</sup>County Sanitation Districts of Orange County

<sup>d</sup>City of San Diego

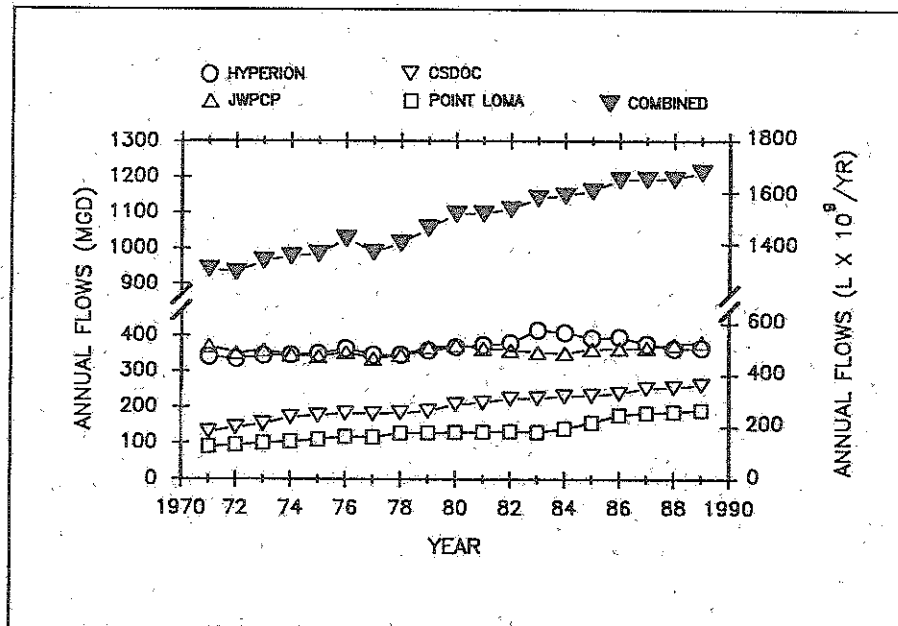
<sup>e</sup>mt=metric tons

<sup>f</sup>BOD=biochemical oxygen demand

<sup>g</sup>MBAS=methylene blue active substances

**Figure 2.**

Combined effluent flow and individual effluent flows from the four largest municipal wastewater treatment facilities in Southern California (MGD = Millions of gallons per day, L = Liters).



agencies are related to population growth patterns, water reclamation, and inland discharge. Orange, San Diego, and Riverside counties have grown faster than Los Angeles County. Los Angeles County and the City of Los Angeles expanded their upstream treatment and reclamation facilities. The County reclaims 137 mgd of water — double the amount reclaimed 10 years ago. The volume of effluent discharged to the Los Angeles River by the Los Angeles-Glendale and Donald C. Tillman water reclamation plants increased from 25 mgd in 1985 to 60 mgd in 1988. Rainfall has little effect on effluent volumes because sewer and storm drain systems are not connected. Water conservation efforts during droughts (e.g., 1975-77 and 1985-1991) may reduce the rate of increase in flows.

**Table 4.**

Combined mass emissions from City of Los Angeles Hyperion Treatment Plant, County Sanitation Districts of Los Angeles County Joint Water Pollution Control Plant, County Sanitation Districts of Orange County Wastewater Treatment Plants 1 and 2, and City of San Diego Point Loma Wastewater Treatment Plant from 1971 through 1989.

	1971	1972	1973	1974	1975	1976	1977	1978	1979
Flow (liter x 10 <sup>6</sup> )	1,286	1,289	1,319	1,336	1,346	1,406	1,319	1,382	1,438
Flow (mgd <sup>a</sup> )	931	931	954	967	975	1,015	955	1,001	1,041
Suspended solids (mt <sup>b</sup> )	263,400	279,000	269,700	263,700	284,900	286,400	233,500	253,800	243,900
BOD <sup>c,d</sup> (mt)	281,000	250,000	217,900	221,600	233,500	255,900	241,500	234,200	241,900
Oil & Grease (mt)	61,500	60,600	57,300	54,800	56,500	58,800	49,200	48,500	45,400
NH <sub>3</sub> -N (mt)	53,800	36,600	45,900	36,900	36,300	35,600	40,000	38,900	41,100
Total P (mt)	32,900	36,000	40,600	34,200	32,000	28,400	10,400	10,100	10,000
MBAS <sup>e</sup> (mt)	5,800	5,400	5,900	6,800	6,100	6,100	5,300	5,800	6,300
Cyanide (mt)	186	240	244	303	251	401	213	176	145
Silver (mt)	15	21	29	22	25	20	34	32	43
Arsenic (mt)	3	13	16	18	6	10	27	15	15
Cadmium (mt)	53	34	49	55	51	44	41	44	43
Chromium (mt)	648	673	694	690	579	592	368	279	239
Copper (mt)	560	485	508	576	510	506	402	416	361
Mercury (mt)	2.8	3.0	3.1	1.8	2.2	2.5	2.6	1.9	2.6
Nickel (mt)	307	273	318	315	282	302	262	318	256
Lead (mt)	211	226	180	199	198	189	150	216	224
Selenium (mt)	44	49	16	18	11	22	22	23	7.9
Zinc (mt)	1,676	1,210	1,189	1,324	1,087	1,061	834	833	728
DDT <sup>d</sup> (kg)	21,527	6,558	3,818	1,562	1,158	1,626	855	1,121	839
PCB <sup>d</sup> (kg)	8,730	9,830	3,389	5,421	3,065	2,829	2,183	2,540	1,170

<sup>a</sup>mgd=million gallons per day (1 mgd = 3,785,000 liters/day)

<sup>b</sup>mt=metric tons

<sup>c</sup>BOD=biochemical oxygen demand

<sup>d</sup>Hyperion 7-mile outfall not included

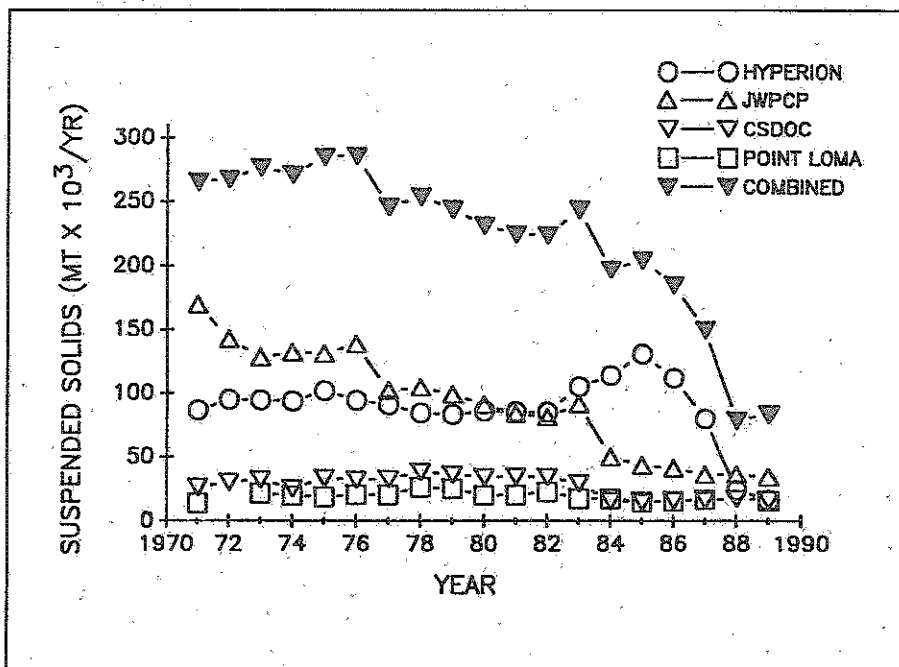
<sup>e</sup>Estimates for 1971 through 1975 are based on SCCWRP analyses of effluents; estimates for 1976 through 1989 are based on discharger data.

Despite increases in population and volume of wastewater discharged, the combined mass emission of most constituents have declined over the past two decades. The combined mass emission of suspended solids declined 68%, BOD declined 43%, and oil and grease declined 64% (Table 4; Figures 3-5). The decline in solids emissions from JWPCP between 1971 and 1989 accounted for 65% of the reduction. Termination of sludge discharge from the Hyperion 7-mile outfall (November 1987) accounted for a 40% reduction in combined emissions from 1987 to 1988. Most of the decline in BOD occurred after 1985. Reductions by JWPCP account for about 75% of the decline in oil and grease.

The combined mass emission

**Figure 3.**

Combined suspended solids emissions and individual suspended solids from the four largest municipal wastewater treatment facilities (MT = Metric tons).



1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1,493	1,492	1,511	1,549	1,565	1,579	1,623	1,629	1,632	1,658
1078	1080	1094	1122	1129	1143	1175	1179	1178	1200
232,100	224,900	224,200	244,700	197,700	204,500	184,900	148,500	97,000	83,400
255,100	260,900	266,100	251,800	230,100	253,500	181,900	166,500	168,800	161,100
38,400	36,700	37,300	35,700	30,000	34,300	29,000	25,700	25,300	22,600
42,000	40,500	41,800	40,100	40,500	44,500	42,900	44,500	44,600	45,500
10,000	9,500	9,000	9,000	9,200	8,500	10,900	9,000	10,400	6,000
6,400	5,600	5,700	5,200	4,600	5,100	3,400	3,900	3,900	3,400
116	98	77	46	39	26	22	27	26	10
30	28	25	26	24	26	22	15	11	11
11	12	5.8	10	18	16	12	11	8.9	7.4
39	32	21	23	16	16	14	9.0	3.4	1.9
275	187	203	163	140	110	88	57	29	22
335	337	284	272	251	239	202	125	76	68
1.8	1.8	1.2	1.1	0.9	0.9	0.7	0.4	0.4	0.4
224	167	168	163	133	118	127	76	63	54
175	130	122	98	87	118	105	61	50	27
11	15	6.4	6.5	6.5	5.6	8.2	7.2	6.7	7.6
729	538	545	497	369	375	336	260	151	146
671	480	290	223	310	48	51	53	26	20
1,127	1,252	785	628	1,209	46	37	5	0	0

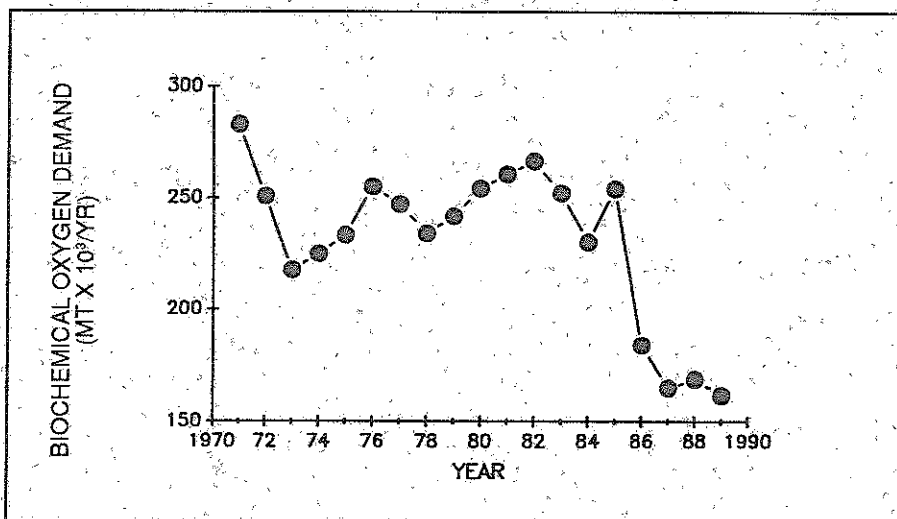
of trace metals declined 90% from 1971 to 1989 (Table 4; Figure 6). Declines of individual metals averaged 55% (sd=81%, n=10). The greatest reductions were for cadmium, chromium, copper, mercury, nickel, lead, and zinc. Arsenic was the only metal that increased in mass. From 1987 to 1988, the combined emissions of trace metals declined 36%. Termination of discharge from the Hyperion 7-mile outfall accounted for about 60% of the decline.

The combined emissions of

chlorinated hydrocarbons declined more than 99% from 1971 to 1989 (Table 4; Figure 7). Montrose Chemical Corporation, the largest manufacturer of DDT in the world and the only manufacturer in California, discharged DDT wastes into the Los Angeles County sewer system from 1947 to 1971. Residual waste in the sanitation system was the principal source of DDT in JWPCP effluent after that time. Concentrations of DDT in JWPCP effluent are now near or below detection limits (tens of pg/l).

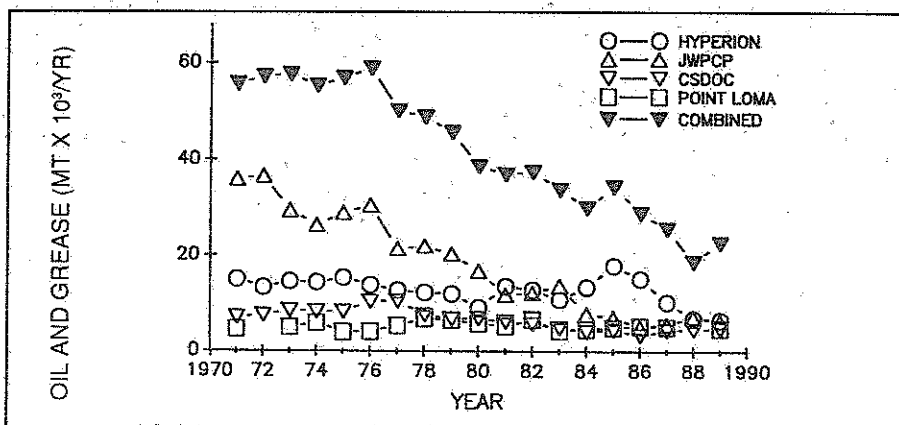
**Figure 4.**

Combined mass emission of biochemical oxygen demand from the four largest municipal wastewater treatment facilities (MT = Metric tons).



**Figure 5.**

Combined oil and grease emissions and individual oil and grease from the four largest municipal wastewater treatment facilities (MT = Metric tons).



The combined emission of PCBs, which have generally exceeded emissions of DDT since 1972, have dropped to zero (Table 4; Figure 7). There is some uncertainty about the quantity of PCBs discharged to the Bight since 1985. County Sanitation Districts of Orange County, the largest source of PCBs, discovered discrepancies between their analytical results and the results of independent laboratories. After an extensive investigation, they concluded that an unknown source of contamination in the CSDOC laboratory resulted in high PCB concentrations in effluent samples. An independent laboratory has analyzed CSDOC effluents for PCBs since 1986. Mean annual PCB concentrations in CSDOC effluent for 1985 to 1987 have been corrected as follows.

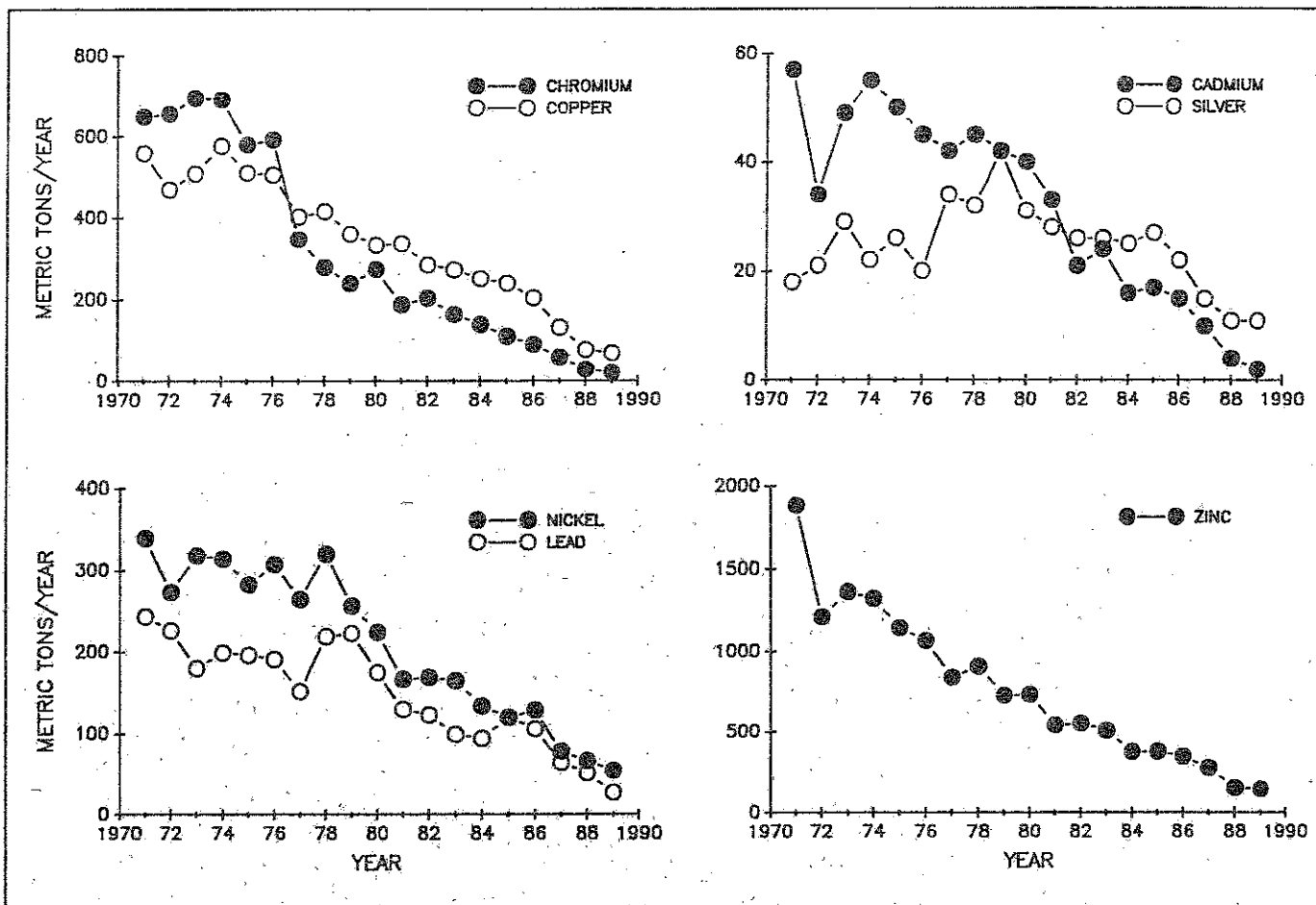
Year	Old Value (µg/l)	Corrected Value (µg/l)
1985	2.8	<1.0
1986	1.4	<0.3
1987	0.7	<0.3

The PCB values in Table 4 reflect these changes.

Despite increases in the volume of municipal effluents discharged to the Southern California Bight, the concentrations and mass emissions of most constituents decreased from 1988 to 1989. Reductions were the result of improved primary treatment, increased secondary treatment, and improved source control. Municipal effluent contaminant concentrations and mass emissions have declined significantly during the past 20 years. The declines are due to increased source control and solids removal (land disposal of sludge), improved sludge and primary treatment, and increased secondary treatment. Further

**Figure 6.**

Combined mass emissions of trace metals from the four largest municipal wastewater treatment facilities.



reductions in mass emissions on a comparable scale are not possible. Nominal reductions will occur due to planned increases in the volume of wastewater receiving secondary treatment, increased inland reclamation of water, and more effective source control. ■

### Acknowledgements

Author Henry Schafer thanks the Los Angeles, Santa Ana, and San Diego Regional Water Quality Control Boards; Hyperion Wastewater Treatment Plant; County Sanitation Districts of Los Angeles County; County Sanitation Districts of Orange County; and Point Loma Wastewater Treatment Plant for their cooperation.

**Figure 7.**

Combined mass emissions of chlorinated hydrocarbons from the four largest municipal wastewater treatment facilities (BDL = below detection limits).

