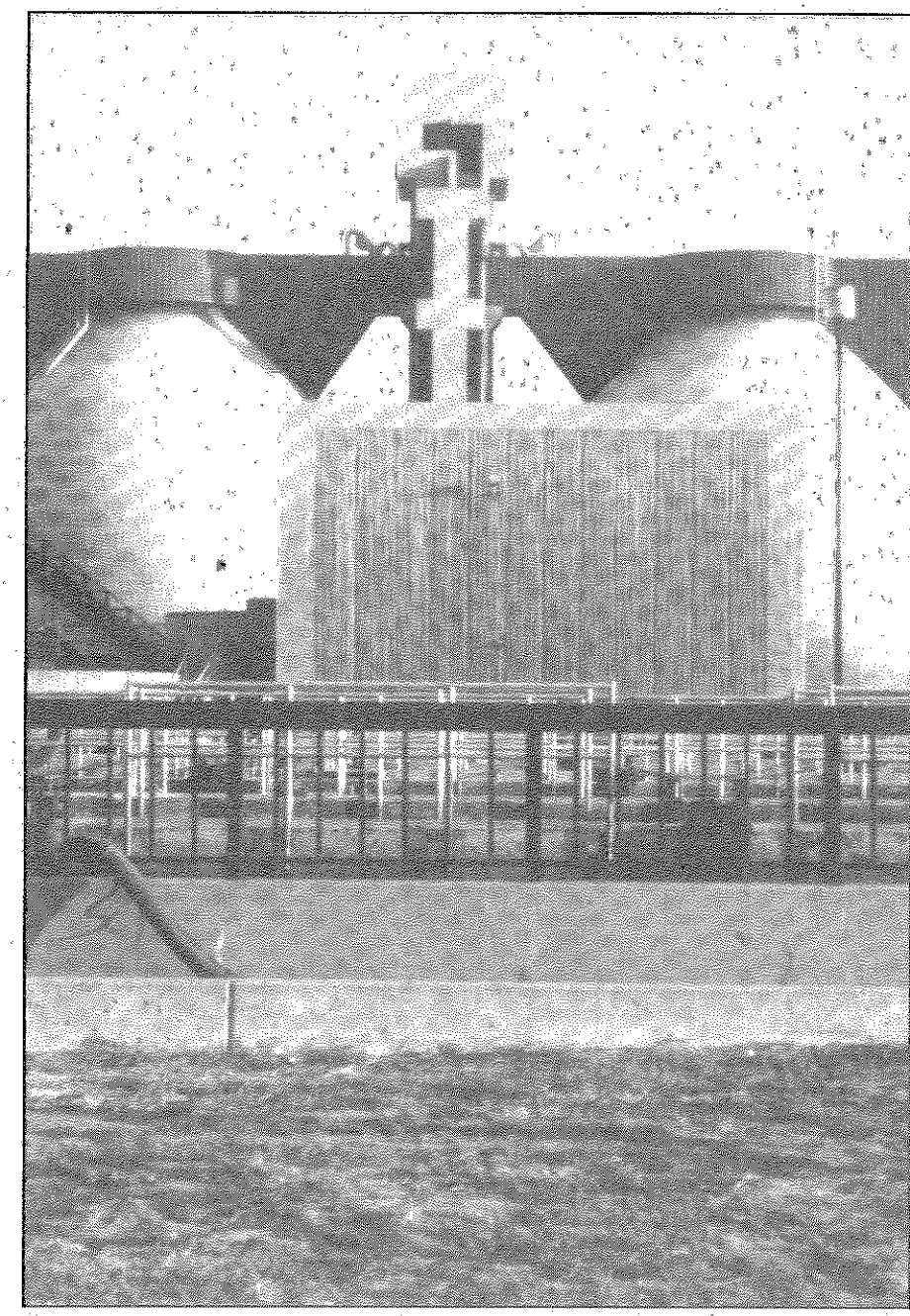
Characteristics of Effluents from Small Municipal Wastewater Treatment Plants, Electrical Generating Stations, and Industrial Facilities in 1989

Since the early 1970s, Hyperion Wastewater Treatment Plant (City of Los Angeles), the Joint Water Pollution Control Plant (Los Angeles County), County Sanitation Districts of Orange County, and Point Loma Wastewater Treatment Plant (City of San Diego) have been the source of 90% of the municipal effluents discharged to the Southern California Bight. SCCWRP has published effluent constituent concentrations and mass emissions for the four large dischargers annually for two decades. The smaller facilities that discharge into the Bight have received less attention. SCCWRP summarized mass emission data from these plants in 1973 (SCCWRP 1973) and in 1987 (SCCWRP 1989). The volume of flow from the smaller dischargers has increased in recent years.

In this report, we summarized 1989 mass emission data for 14 small municipal facilities (13 marine outfalls), six marine outfalls associated with the petroleum industry, and 15 marine outfalls associated with electrical generating stations (Table 1). Names of the facilities appear in Appendix 1.



Terminal Island Treatment Plant discharges into Los Angeles Harbor.

Table 1.

Volume of discharge from all southern California marine outfalls in 1989. Type of treatment is given for municipal wastewater outfalls and type of discharge is given for industrial outfalls.

Municipal Wastewater	Flow (mgd[a])	Treatment
Goleta	5.7	Primary
Santa Barbara	6.2	Secondary
Montecito	1	Secondary
Summerland	0.2	Secondary
Carpinteria	1.3	Secondary
Oxnard	16.9	Secondary
Hyperion (City of Los Angeles)	365	Primary/Secondary
JWPCP (Los Angeles County)	382	Advanced Primary/Secondary
Terminal Island[b]	21	Secondary
Avalon	0.6	Secondary
CSDOC (Orange County)	262	Advanced Primary/Secondary
Aliso	15.7	Secondary
SERRA	18.2	Secondary
Encina	20.3	Secondary
Oceanside	11.7	Secondary
San Elijo + Escondido	18.2	Primary/Secondary
Point Loma (City of San Diego)	191	Advanced Primary
Total	1337	

Electrical Generating Stations	Flow (mgd)	Discharge
Mandalay	167	Cooling water
Ormond Beach	501	Cooling water
Scattergood	71	Cooling water
El Segundo	306	Cooling water
Redondo	541	Cooling water
Long Beach[b]	75	Cooling water
Harbor	27	Cooling water
Haynes[b]	193	Cooling water
Los Alamitos[b]	683	Cooling water
Huntington Beach	170	Cooling water
San Onofre	2467	Cooling water
Encina	400	Cooling water
Silver Gate[b]	5	Cooling water
Station "B"[b]	1	Cooling water
South Bay[b]	390	Cooling water
Total	5997	

Petroleum Refining	Flow (mgd)	Discharge
Union Oil Pt Conception	0.017	Process water
Chevron USA Gaviota	<0.06	Desalinization brine
Chevron USA Gaviota	0.1	Process water
Chevron USA Carpinteria	0.7	Process water
Chevron USA El Segundo	8.9	Process water/Refinery wastes
Shell/Western Huntington	3	Process water
Total	12.8	

[a]mgd=million gallons per day (1 mgd = 3,785,000 liters/day)
[b]Discharges into harbor or bay

Table 2.

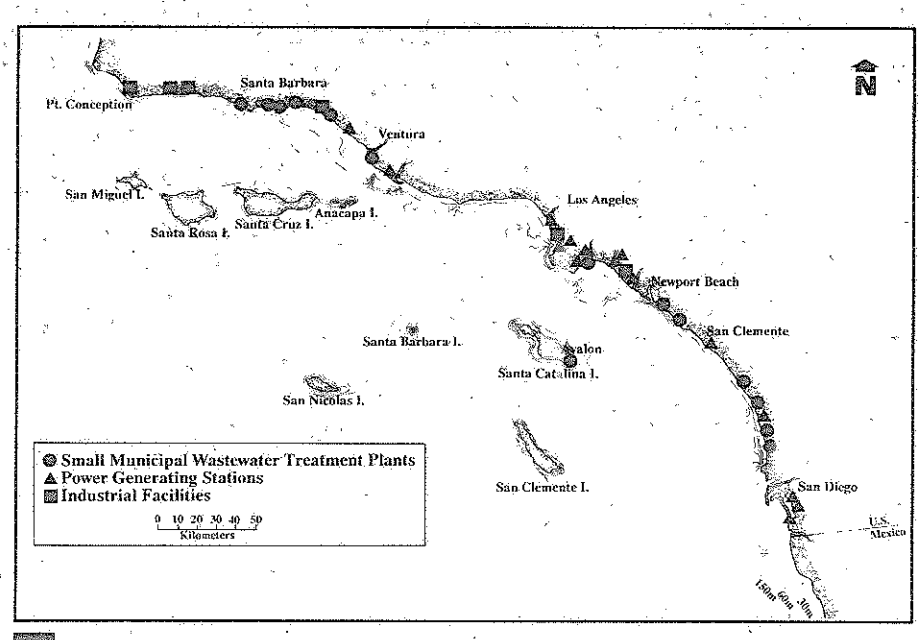
Mean annual effluent constituent concentrations for small municipal wastewater treatment facilities in 1989.

	Summerland	Avalon	Montecito	Carpinteria	San Elijo	Goleta	Santa Barbara
Flow (mgd[a])	0.18	0.58	1.0	1.26	3.12	5.69	6.15
Suspended solids (mg/l)	19.5	24	6.6	16	58.1	24.8	5.4
Settleable solids (ml/l)	-	0.2	-	<0.1	0.2	-	-
BOD[b] (mg/l)	6	14	5.6	10	124	37.5	42.5
Oil & grease (mg/l)	-	10.8	0.5	2	11.2	4.1	3
NH_3-N (mg/l)	28	0.33	0.74	29	22	-	-
Total N (mg/l)	-	-	0.9	-	-	-	-
Cyanide (µg/l)	-	7.0	-	<40	2.5	20	-
Phenol (µg/l)	-	-	-	-	1.0	-	-
non-chlorinated	-	-	-	<10	-	-	-
chlorinated	-	-	-	20	-	-	-
Turbidity (NTU[c])	-	3.9	1.1	6	43	21	-
Toxicity (TU[d])	-	-	-	1.5	0.97	-	-
Silver (µg/l)	-	<10	<1	<30	21	<20	10
Arsenic (µg/l)	-	<5	<5	<30	56	<10	7.0
Cadmium (µg/l)	-	<5	3	<5	2.3	<20	10
Chromium (µg/l)	-	<10	<10	<27	28	<40	10
Copper (µg/l)	-	32	26	150	71	<25	20
Mercury (µg/l)	-	0.2	<2	<2	0.45	<0.8	0.2
Nickel (µg/l)	-	-	14	<51	19	<50	40
Lead (µg/l)	-	10	<10	<33	66	<150	8
Zinc (µg/l)	-	72	57	<80	72	<45	60
DDT (µg/l)	-	<0.15	<10	<0.03	-	nd[e]	-
PCB (µg/l)	-	<0.1	<500	<0.2	-	<0.05	-

[a]mgd=million gallons per day (1 mgd = 3,785,000 liters/day)
[b]BOD=biochemical oxygen demand
[c]NTU=nephelometric turbidity units
[d]TU=toxicity units
[e]nd=not detectable and detection limits not reported

Figure 1.

Location of marine outfalls.



Materials and Methods

We obtained effluent data for each discharge agency from National Pollution Discharge Elimination System (NPDES) permit reports filed with the Regional Water Quality Control Boards (Central Coast, Los Angeles, Santa Ana, and San Diego). We obtained cooling water volumes for electrical generating stations from Southern California Edison, Los Angeles City Department of Water and

Oceanside	Escondido	Aliso	Oxnard	SERRA	Encina	Terminal Island
11.7	15.1	15.7	16.9	18.2	20.3	21
13.7	12.2	6.9	23.4	17.5	18.9	10
0.5	0.5	0.3	<0.1	1.6	0.2	0.04
36.1	33	5.0	24.0	18.1	33	7
2.3	1	2.5	3.8	2.2	0.7	2.3
20.5	21	19	11.8	19	22.3	0.1
-	-	-	-	-	-	15.3
<0.03	10	5	15	0.01	-	6
<200	<200	-	-	-	-	6
<40	<10	<10	<13	<55	-	-
<30	<10	<10	<10	<54	-	-
9.1	3.8	3.1	14.1	5.9	10	2
0.84	0.74	-	0.26	-	1.0	0
<10	<8	0.5	5.9	<45	8	1
<5	2.2	2.5	3.7	1.2	3.2	8
<10	4.8	2	<5.6	<40	4	6
<20	<9	<8	<10	<10	6	16
<20	20.5	20	36	<45	20	12
<1	<0.5	10.2	<1	<1	0.2	0.1
<20	19	9.5	20	<52	21	23
<30	10	8.5	<12	<85	30	46
60	112	86	39	<50	101	83
<0.1	-	<0.7	<0.3	<0.1	-	nd
<0.2	-	<0.5	<0.18	<0.8	-	nd

Power, and San Diego Gas and Electric.

We calculated mean annual constituent concentrations for each facility by averaging the values in the monitoring reports. Annual mass emission estimates are the product of annual effluent volume and mean annual constituent concentration. Flow is generally measured continuously; suspended solids, settleable solids, oil and grease, and biochemical oxygen demand (BOD) are measured daily or weekly; and trace organics and trace metals are measured from one to 12 times per year. Facility size and the type of sewage treated (residential or industrial) determine the frequency of some measurements.

Results and Discussion

In 1989, 18 municipal wastewater facilities discharged 1,337 million gallons per day (mgd) of treated effluent into the Southern California Bight, 15 electrical generating stations discharged 5,997 mgd of cooling water, and six petroleum processing plants discharged 13 mgd of treated brines and refinery wastes (Table 1; Figure 1). The combined flow from the 14 small municipal wastewater facilities (13 submarine outfalls) was 137 mgd—10% of the total wastewater discharged. More than 90% of the effluent from the small facilities received secondary treatment compared to about 45% of the effluent from the four large facilities.

Most small municipal wastewater treatment facilities measure trace constituents two to four times per year while the large treatment facilities measure trace constituents every month. Effluent concentrations for small

Table 3.
Estimated mass emissions from small municipal wastewater treatment facility marine outfalls for 1989.

	Summerland	Avalon	Montecito	Carpinteria	San Elijo	Goleta	Santa Barbara
Flow (liter x 10^9)	0.25	0.80	1.3	1.7	4.3	7.9	8.5
Suspended solids (mt[a])	4.8	19	9.1	28	250	195	46
BOD[b] (mt)	1	11	7.7	17	534	295	361
Oil & grease (mt)	-	8.6	0.7	3.4	48	32	25
NH_3-N (mt)	7	0.3	1.0	50	95	-	-
Total N (mt)	-	-	1.2	-	-	-	-
Cyanide (kg)	-	5.6	-	-	11	157	-
Phenol (kg)	-	-	-	-	4.3	-	-
non-chlorinated	-	-	-	-	-	-	-
chlorinated	-	-	-	35	-	-	-
Silver (kg)	-	-	-	-	89	-	85
Arsenic (kg)	-	-	-	-	241	-	59
Cadmium (kg)	-	-	4.1	-	9.6	-	85
Chromium (kg)	-	-	-	-	123	-	85
Copper (kg)	-	26	36	261	307	-	170
Mercury (kg)	-	0.16	-	-	1.9	-	1.7
Nickel (kg)	-	-	19	81	-	340	-
Lead (kg)	-	8	-	-	283	-	68
Zinc (kg)	-	58	79	-	310	-	510
DDT (kg)	-	-	-	-	-	-	-
PCB (kg)	-	-	-	-	-	-	-

[a]mt=metric tons
[b]BOD=biochemical oxygen demand

facilities that seem high— considering the source of material and type of treatment—do not exceed NPDES permit values.

In recent years, the number of effluent monitoring analyses reporting concentrations below detection limits (BDL) has increased. Effluent constituent concentrations are decreasing due to source control and improved treatment. If detection limits of the recommended or required techniques are below discharge permit requirements, then BDL results are in compliance with permit requirements. However, BDL results complicate mass emissions estimates. We include detection limits (when reported) in the table of concentrations (Table 2), but we did not use BDL results to estimate mass emissions (Table 3).

The small facilities account for 10% of the total municipal wastewater discharge to the Southern California Bight, but only 2-3% of the suspended solids, oil and grease, and BOD (Table 4). The small discharges contribute a disproportionately low share of the total amount of cyanide, silver, chromium, copper, nickel, zinc, and DDT discharged to the Bight. They contribute a proportionate share of arsenic and lead, and a disproportionately high share of cadmium and mercury.

From 1987 to 1989, combined flow from the small dischargers increased slightly while suspended solids, oil and grease, BOD, and seven of the nine metals declined (Table 5). From 1973 to 1989, the number of small treatment facilities declined from 20 to 14. During this period, total flow doubled, but suspended solids, oil and grease, and BOD decreased (Table 5).

Eight electrical generating stations have cooling water intakes on the open coast and seven stations have intakes in harbors and tidal prisms (Table 1). The volume of seawater used for cooling declined 19% from 1987 to 1989 due partly to reduced electrical output. Utilities are importing more power generated outside southern California. The volume discharged in 1989 was similar to the volume discharged in 1973. The heat input from the 1973 discharge was equivalent to solar input over

Oceanside	Escondido	Aliso	Oxnard	SERRA	Encina	Terminal Island	Total
16	21	22	23	25	28	29	189
221	255	150	546	440	530	290	2,984
584	688	109	560	455	925	203	4,751
37	21	54	89	55	20	67	460
331	438	412	276	478	625	2.9	2,716
-	-	-	-	-	-	444	445
-	209	108	-	0.3	-	174	665
-	-	-	840	-	-	174	1,018
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	35
-	-	11	138	-	224	29	576
-	47	54	86	31	90	232	840
-	99	43	-	-	112	174	527
-	-	-	-	-	168	464	840
-	427	440	841	-	561	348	3,417
-	-	221	-	-	5.6	2.9	233
-	396	206	467	-	589	667	2,765
-	209	184	-	-	841	1,335	2,908
970	2,336	1,865	911	-	2,833	2,408	12,280
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-

Table 4.

Estimates of constituent mass emissions from large (>200 mgd) and small (<25 mgd) municipal wastewater treatment facilities that discharge into the Southern California Bight for 1989.

	Large[a]	Small[b]	Small as % of Total
Flow (mgd[c])	1,200	137	10
Suspended solids (mt[d])	83,400	2,984	3
BOD[e] (mt)	161,100	4,751	3
Oil & grease (mt)	22,600	460	2
NH_3-N (mt)	45,500	2,716	6
Cyanide (mt)	10.0	0.67	6
Silver (mt)	10.6	0.58	5
Arsenic (mt)	7.4	0.84	10
Cadmium (mt)	1.9	0.53	22
Chromium (mt)	22	0.84	4
Copper (mt)	68	3.4	5
Mercury (mt)	0.44	0.23	34
Nickel (mt)	54	2.8	5
Lead (mt)	26.8	2.9	10
Zinc (mt)	146.0	12.3	8
DDT (kg)	20	nd[f]	0
PCB (kg)	nd	nd	

[a] Hyperion, JWPCP, CSDOC, and Point Loma
[b] facilities covered in this report
[c] mgd=millions of gallons per day (1 mgd = 3,785,000 liters/day)
[d] mt=metric tons
[e] BOD=biochemical oxygen demand
[f] nd=nondetectable

20 km^2 of sea surface (SCCWRP 1973).

Petroleum industry effluents are the only industrial wastes currently discharged to the Bight (Table 1). Process waters are associated with the extraction of crude oil; refinery wastes are associated with oil refining and cooling water. The combined discharge from the five process water facilities is less than 4 mgd and solids emissions are about 50 mt/yr (Table 6). The concentrations of trace metals in petroleum industry effluents are generally higher than concentrations in municipal effluents, but petroleum industry mass emissions are lower because of small discharge volumes (Table 7). In 1989, the Chevron El Segundo Refinery discharged 9 mgd of process water and refinery wastes, 88% of the total volume of process water discharged to the Bight. The estimated mass emission of oil and grease (91 mt) was about 30% higher than the 1987 estimate. In 1973, industrial and refinery facilities discharged 72 mgd of process water and refinery wastes, and 1,290 mt of oil and grease (SCCWRP 1973).

Conclusions

Concern about the effects of waste inputs to the coastal waters has increased with the expanding population in southern California. That concern has prompted substantial long-term efforts to reduce constituent emissions. While the volume of effluents discharged through marine outfalls has increased by more than 30% since 1973, the mass emission of solids has declined by 70%. The input of many trace constituents has declined by an equal or greater amount. ■

References

SCCWRP. 1973. The Ecology of the Southern California Bight: Implications for Water Quality Management. Technical report, Southern California Coastal Water Research Project, El Segundo , CA. 531 p.

SCCWRP. 1989. Marine outfalls: 1987 inputs from wastewater treatment plants, power plants, and industrial facilities. *In*: Southern California Coastal Water Research Project Annual Report 1988-89. Southern California Coastal Water Research Project, Long Beach, CA. pp. 30-37.

Acknowledgements

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Table 5.
Combined effluent mass emission estimates for 14 small municipal wastewater treatment facilities for 1973, 1987, and 1989.

	1989	1987[a]	1973[b]	Percent Change 87-89	Percent Change 73-89
Flow (mgd[c])	137	132	69	4	99
Suspended solids (mt[d])	2,984	4,193	8,200	-29	-64
BOD[e] (mt)	4,751	5,178	11,000	-8	-57
Oil & grease (mt)	460	708	4,200	-35	-89
NH_3-N (mt)	2,716	1,757	1,600	55	70
Cyanide (mt)	0.67	1.73	8	-61	-92
Silver (mt)	0.58	0.87		-50	
Arsenic (mt)	0.84	0.43		95	
Cadmium (mt)	0.53	1.7		-69	
Chromium (mt)	0.84	2.3		-63	
Copper (mt)	3.4	6.9		-51	
Mercury (mt)	0.23	0.18		28	
Nickel (mt)	2.8	5.5		-49	
Lead (mt)	2.9	6.5		-55	
Zinc (mt)	12	16		-25	
DDT (kg)	nd[f]	nd			
PCB (kg)	nd	nd			

[a] data from SCCWRP (1988)
[b] data from SCCWRP (1973)
[c] mgd=millions of gallons per day (1 mgd = 3,785,000 liters/day)
[d] mt=metric tonse
[e] BOD=biochemical oxygen demand
[f] nd=not detectable

Table 6.

Mean concentrations for constituents in industrial effluents for 1989.

	Union Process Water[a] Pt. Conception	Chevron Process Water Gaviota	Chevron Desalinization Gaviota	Chevron Process Water Carpinteria	Chevron Oil Refinery El Segundo	Shell/Western[b] Process Water Huntington Bch
Flow (mgd[c])	0.017	0.06	0.06	0.7	8.9	3.1
Suspended solids (mg/l)	15.2	12	<7	37	15.9	-
Settleable solids (ml/l)	-	<0.1	<0.01	0.3	<0.2	<0.1
BOD[d] (mg/l)	-	-	-	-	20.1	-
Oil & grease (mg/l)	17.3	7.9	<13	41	7.4	23.4
NH_3-N (mg/l)	7	1	-	48	7	82
Cyanide (µg/l)	16.7	9	10	-	79	<0.02
Phenols (µg/l)	100	3	-	2,540	102	49
Turbidity NTU[e]	12.9	11	1.21	15	8	60
Toxicity TU[f]	0.9	0.05	0.015	3.4	0.2	-
Silver (µg/l)	14.7	0.25	<2	<30	<10	<30
Arsenic (µg/l)	10	<2	<3	<10	12.1	0.6
Cadmium (µg/l)	50	1	<1	<50	<30	53
Chromium (µg/l)	83.3	<2	<3	<100	<50	51
Copper (µg/l)	50	65	41	195	<20	<20
Mercury (µg/l)	10	<0.2	<0.2	<10	<6	<1
Nickel (µg/l)	100	20	8.8	60	39.2	662
Lead (µg/l)	200	2	<1	<110	<130	<140
Zinc (µg/l)	43.3	96	42	<50	30	25

[a]Oil and gas process water treatment plant
[b]Discharge terminated in February 1989
[c]mgd=million gallons per day (1 mgd = 3,785,000 liters/day)
[d]BOD=biochemical oxygen demand
[e]NTU=nephelometric turbidity units
[f]TU=toxicity units

Table 7.

Mass emission estimates for constituents in industrial effluents in 1989.

	Union Process Water[a] Pt. Conception	Chevron Process Water Gaviota	Chevron Process Water Carpinteria	Chevron Oil Refinery El Segundo	Shell/Western[b] Process Water Huntington Beach
Flow (liter x 10^9)	0.023	0.08	1.0	12.3	0.51
Suspended solids (mt[c])	0.3	1.0	37	196	-
BOD[d] (mt)	-	-	-	247	-
Oil & grease (mt)	0.4	0.6	41	91	12
NH_3-N (mt)	0.2	0.1	48	86	42
Cyanide (kg)	0.4	0.7	-	972	-
Phenols (kg)	2.3	0.2	2540	1255	25
Silver (kg)	0.3	<0.1	-	-	-
Arsenic (kg)	0.2	-	-	149	<1
Cadmium (kg)	1.2	0.1	-	-	27
Chromium (kg)	1.9	-	-	-	26
Copper (kg)	1.2	5.2	195	-	-
Mercury (kg)	0.2	-	-	-	-
Nickel (kg)	2.3	1.6	58	482	338
Lead (kg)	4.6	0.2	-	-	-
Zinc (kg)	1.0	7.7	-	369	13

[a]Oil and gas process water treatment plant
[b]Discharge terminated in February 1989
[c]mt=metric tons
[d]BOD=biochemical oxygen demand

Appendix 1.

Names of wastewater treatment plants, power plants, and industrial facilities.

Wastewater Treatment Plants

Goleta Sanitary District Wastewater Treatment Plant
City of Santa Barbara El Estero Wastewater Treatment Plant
Montecito Sanitary District
Summerland Sanitary District
Carpinteria Sanitary District
City of Oxnard - Perkins Wastewater Treatment Plant
City of Los Angeles - Hyperion Wastewater Treatment Plant
County Sanitation Districts of Los Angeles County - Joint Water Pollution Control Plant
City of Los Angeles - Terminal Island Wastewater Treatment Plant
County Sanitation Districts of Orange County
Reclamation Plant No. 1 and Wastewater Treatment Plant No. 2
Aliso Water Management Agency
Joint Regional Water Reclamation Facilities
Coastal Water Treatment Plant
Los Alisos Wastewater Treatment Plant
El Toro Wastewater Treatment Plan
South East Regional Reclamation Authority
Jay B. Latham Regional Wastewater Treatment Plant
City of San Clemente Wastewater Treatment Plant
Capistrano Beach Wastewater Treatment Plant
Santa Margarita Water District Wastewater Treatment Plant
City of Oceanside
La Salina Wastewater Treatment Plant
San Luis Rey Wastewater Treatment Plant
Encina
Encina Water Pollution Control Facility
Meadow Lark Water Reclamation Plant
Shadow Ridge Water Reclamation Plant
Gafner Water Reclamation Plant
San Elijo
San Elijo Water Pollution Control Facility
Escondido Hale Avenue Wastewater Treatment Facilities
City of San Diego - Point Loma Wastewater Treatment Plant
City of Avalon Wastewater Treatment Plant

Power Generating Plants

Mandalay Generating Station (SCE[a])
Ormond Beach Generating Station (SCE)
Scattergood Generating Station (LADWP[b])
El Segundo Generating Station (SCE)
Redondo Generating Station (SCE)
Harbor Generating Station (LADWP)
Long Beach Generating Station (SCE)
Haynes Generating Station (LADWP)
Los Alamitos Generating Station (SCE)
Huntington Beach Generating Station (SCE)
San Onofre Nuclear Generating Station (SCE)
Encina Generating Station (SDGE[c])
Silver Gate Generating Station (SDGE)
Station "B" Power Generating Station (SDGE)
South Bay Generating Station (SDGE)

Industrial Facilities and Outfalls

Union Oil Company of California, Produced Water Treatment Facility
Chevron USA, Inc. - Gaviota Produced Water Treatment Facility
Chevron USA, Inc. - Gaviota Desalinization Facility
Chevron USA, Inc. - Carpinteria Produced Water Treatment Facility
Shell/Western E and P Inc. - Huntington Beach Oil Production Field Outfall[d]

[a]Southern California Edison Company
[b]Los Angeles Department of Water and Power
[c]San Diego Gas and Electric Company
[d]Discharge terminated in February 1989