TABLE 6-10. EPA-ITD SAMPLING PROGRAM
OIL/WATER SEPARATOR PERFORMANCE

Fraction: Conventionals and Nonconventionals

Sample Point:		Raw Wastewater	Treated Effluent	
Plant No.		A	A	
Episode No.		1128	1128	
Sample No.		15339	15340	Percent
Sample Date		Jul 23, 1986	Jul 23, 1986	Removed
Parameter	Units			
Aluminum	ug/l	7800	5900	24
Antimony	ug/l	562	562	0
Arsenic	ug/l	31	44	0
Barium	ug/l	2600	2100	19
Beryllium	ug/l	50	50	0
Boron	ug/l	880	960	0
Cadmium	ug/l	29	18	38
Calcium	ug/l	47000	36000	23
Chromium	ug/l	6700	5300	21
Cobalt	ug/l	210	200	5
Copper	ug/l	1400	1000	29
Iron	ug/l	10000	12000	0
Lead	ug/l	27000	20000	26
Magnesium	ug/l	14000	12000	14
Manganese	ug/l	700	480	31
Mercury	ug/l	0.2	0.2	0
Molybdenum	ug/l	340	640	0
Nickel	ug/l	120	130	0
Selenium	ug/l	5	5	0
Silver	ug/l	1	1	0
Sodium	ug/l	1800000	1800000	0
Thallium	ug/l	10	10	0
Tin	ug/l	240	220	8
Titanium	ug/l	59	93	0
Vanadium	ug/l	12	11	8
Yttrium	ug/l	10	10	0
Zinc	ug/l	13000	12000	8

NOTE: ug/l = micrograms per liter

6.3.3 Air Flotation

Air flotation is a wastewater treatment method that is used to break emulsions and to separate oil from water. First high pH, oily wastestreams are neutralized, then a flocculant and a coagulant are added. The mixed flow is sent to a clarifier where several hours detention are provided. At the bottom of the clarifier, fine bubbles of air are dispersed into the wastewater. The air bubbles rise and become enmeshed in oil agglomerations. The air-entrained agglomerations become bouyant and rise to the top of the clarifier where they are skimmed. Two facilities were sampled by EPA-ITD that used air flotation systems, Plants B and D.

Plant B is a small drum washing plant that recycles caustic wash. The process wastewater consists of rinse water and is treated by air flotation. The treated effluent is discharged. The system detention time is 3.5 hours and the operating shift lasts 4 to 5 hours. Since the total treatment system volume is flushed only once per day, it was not possible to obtain a matched pair of raw wastewater and treated effluent for a given day. Therefore, sampling was conducted for 2 days. The raw wastewater sample from the first day matches best with the treated effluent sample from the second day.

Raw wastewater treated effluent and percent removal data for the Plant B air flotation system are shown in Tables 6-11 through 6-13. The pollutant removals are calculated as the percent difference between the August 6 raw wastewater sample and the August 7 treated wastewater, since the system had a 1-day detention period. No or low pollutant removals are calculated for the majority of parameters measured. These observations may be the result of lag time in the system. However, suspended solids and volatile solids removals are reasonable at 85 and 76 percent, respectively. P-cymene and toluene removals are also good at 81 and 99 percent, respectively.

Plant D is a large drum washing and burning plant that recycles caustic wash. The process wastewater consists of washing process rinses and miscellaneous wastestreams (74 percent) and quench water from the burning process (26 percent). Receiving area drainage is a component of the process wastewater. The combined process wastewater is treated by air flotation and the effluent is reused as makeup to caustic wash. The system detention time

TABLE 6-11. EPA-ITD SAMPLING PROGRAM
AIR FLOTATION PERFORMANCE - PLANT B

Fraction: Conventionals and Nonconventionals

Sample Point:		Raw Wastewater	Treated Wastewater	Raw Wastewater	Treated Wastewater	
Plant No.		B	B	B	B	
Episode No.		1130	1130	1130	1130	
Sample No.		15344	15345	15348	15349	Percent
Sample Date		Aug 6, 1986	Aug 6, 1986	Aug 7, 1986	Aug 7, 1986	Removed
Parameter	Units					
Ammonia	mg/l	22.5	10.25	9.0	8.8	61
BOD-5, Total	mg/l	2200	1980	418	1860	15
BOD-5, Dissolved	mg/l	2550	2700	2160	2100	18
Chloride	mg/l	1500	1500	1400	800	47
COD, Dissolved	mg/l	3860	2772	4400	2300	40
COD, Total	mg/l	3860	3190	5400	2400	38
Dissolved Solids	mg/l	5710	6600	8940	6370	0
Fluoride	mg/l	40	NR	15	31	22
Oil & Grease	mg/l	4810	2450	2940	4950	0
Phenol	mg/l	1.51	.50	92	.58	62
Sulfide	mg/l	.1	.1	.1	.1	0
Suspended Solids	mg/l	1850	72	780	264	86
Suspended Vol Solids	mg/l	63	14	50	206	0
TKN	mg/l	1.75	6.7	46	40	0
Total Cyanide	mg/l	1.9	.60	.66	.58	69
Total Organic Carbon	mg/l	1600	1100	210	900	44
Total Vol Solids	mg/l	3170	926	1175	740	77
pH		12.6	5.8	12.7	5.9	53

Note: NR indicates no data reported
mg/l = milligrams per liter
Percent removed = percent difference between 15344 and 15349

TABLE 6-12. EPA-ITD SAMPLING PROGRAM
AIR FLOTATION PERFORMANCE - PLANT B

Fraction: Extractable and Volatile Organics

Sample Point:		Raw Wastewater	Treated Wastewater	Raw Wastewater	Treated Wastewater
Plant No.		B	B	B	B
Episode No.		1130	1130	1130	1130
Sample No.		15344	15345	15348	15349
Sample Date		Aug 6, 1986	Aug 6, 1986	Aug 7, 1986	Aug 7, 1986
Parameter	Units				
2-Butanone (MEK)	ug/l	ND	ND	1361630	1001760
2-Chloronaphthalene	ug/l	46	ND	46	48
2-Methylnaphthalene	ug/l	ND	11	24	16
2-Nitrophenol	ug/l	ND	64	ND	45
4-Nitrophenol	ug/l	ND	100	ND	ND
Acetone	ug/l	ND	ND	ND	1845
Benzene	ug/l	ND	ND	ND	182
Benzoic Acid	ug/l	ND	ND	94999	ND
Benzyl Alcohol	ug/l	ND	ND	59	ND
Biphenyl	ug/l	14	ND	ND	ND
Chlorobenzene	ug/l	ND	ND	ND	56
Ethylbenzene	ug/l	3179	1217	ND	2319
Hexanoic Acid	ug/l	383	24	ND	ND
Isobutyl Alcohol	ug/l	3517	ND	ND	ND
Methylene Chloride	ug/l	ND	ND	ND	500
Naphthalene	ug/l	382	ND	ND	ND
Nitrobenzene	ug/l	16	ND	ND	ND
o-Cresol	ug/l	143	ND	37	ND
P-Cymene	ug/l	72	ND	49	14
Styrene	ug/l	144	ND	98	61
Thoxanthone	ug/l	311	ND	ND	ND
Toluene	ug/l	55572	86987	262	799

NOTE: ND indicates not detected above detection limit
ug/l = micrograms per liter

TABLE 6-13. EPA-ITD SAMPLING PROGRAM
AIR FLOTATION PERFORMANCE - PLANT B

Fraction: Conventionals and Nonconventionals

Sample Point:		Raw Wastewater	Treated Wastewater	Raw Wastewater	Treated Wastewater	
Plant No.		B	B	B	B	
Episode No.		1130	1130	1130	1130	
Sample No.		15344	15345	15348	15349	Percent
Sample Date		Aug 6, 1986	Aug 6, 1986	Aug 7, 1986	Aug 7, 1986	Removed
Parameter	Units					
Aluminum	ug/l	9900	9900	9400	27000	0
Antimony	ug/l	16	50	15	50	0
Arsenic	ug/l	20	5	23	5	75
Barium	ug/l	1800	180	1500	410	77
Beryllium	ug/l	1	1	1	1	0
Boron	ug/l	34	16	13	27	21
Cadmium	ug/l	7	5	6	5	29
Calcium	ug/l	26000	26000	21000	22000	15
Chromium	ug/l	1000	120	830	230	77
Cobalt	ug/l	140	51	120	62	56
Copper	ug/l	400	57	390	110	72
Iron	ug/l	46000	4300	40000	15000	67
Lead	ug/l	2400	79	2400	510	79
Magnesium	ug/l	7600	2900	6100	3600	53
Manganese	ug/l	2100	840	1800	980	53
Mc cury	ug/l	1.3	0.2	1.1	.34	74
Mo.ybdenum	ug/l	100	90	110	83	17
Nickel	ug/l	34	170	36	150	0
Selenium	ug/l	25	5	25	5	80
Silver	ug/l	1	1	1	1	0
Sodium	ug/l	1500000	1600000	1800000	1600000	0
Thallium	ug/l	10	10	10	10	0
Tin	ug/l	120	130	150	130	0
Titanium	ug/l	700	26	580	200	71
Vanadium	ug/l	60	19	59	31	48
Yttrium	ug/l	10	10	10	10	0
Zinc	ug/l	17000	14000	18000	13000	24

NOTE: ug/l = micrograms per liter
Percent removed = percent difference between 15344 and 15349

is approximately 1 hour. Daily paired raw wastewater and treated effluent samples were obtained for a 5-day sampling episode.

Raw wastewater, treated effluent, and percent removal data for the Plant D air flotation system are shown in Tables 6-14 through 6-17. Pollutant removals are calculated on a daily basis, since the system detention time is only 1 hour. The average percent removed is the mean of positive and zero removal. Pollutant removals for COD, oil and grease, and the various solids samples range between 45 and 63 percent. Positive removals are reported for most of the metals. The average removal calculated was 36 percent and the highest removal calculated was 77 percent. Positive average removals are calculated for all of the extractable and volatile organics found in the raw wastewater and the mean of the averages is 63 percent. However, 10 compounds are detected in treated effluents that were not detected in the raw wastewater. Eight pesticides/herbicides are removed and six are removed 100 percent. However, five compounds are found in the treated effluent that are not found in the raw wastewater.

6.4 ZERO DISCHARGE TECHNOLOGY

EPA-ITD sampled four wastewater treatment systems that are representative of the wastewater treatment technologies used in the industry: sedimentation, oil/water separation, and air flotation. Poor removals were observed, which is probably due to poor operational control during the sampling episodes rather than being indicative of industry-wide practice. Therefore, few positive conclusions can be drawn regarding treatment system performance for this industry.

EPA observed that zero discharge is achieved by a significant number of the facilities that were visited. Five of the 16 facilities generate significant volumes of wastewater and also achieve zero discharge. All drum reconditioners are prohibited from discharging process wastewater in the Chicago Metropolitan Sanitation District (MSD). EPA identified 19 facilities that are potentially active in the city of Chicago (Appendices A and B). Information is available on Plant D and four more facilities identified below as Plants N, O, P, and Q. The methods used to achieve zero discharge are described below for each facility.

TABLE 6-14. EPA-ITD SAMPLING PROGRAM AIR FLOTATION PERFORMANCE - PLANT D

Fraction: Conventionals and Nonconventionals

Sample Point:		Raw	Treated	Raw	Treated	Raw	Treated	Raw	Treated	Raw	Treated	
Plant No.		D	D	D	D	D	D	D	D	D	D	
Episode No.		1179	1179	1179	1179	1179	1179	1179	1179	1179	1179	
Sample No.		15713	15714	15715	15716	15718	15719	15722	15723	15725	15726	Average Percent Removed
Sample Date		Feb 2, 1987	Feb 2, 1987	Feb 3, 1987	Feb 3, 1987	Feb 4, 1987	Feb 4, 1987	Feb 5, 1987	Feb 5, 1987	Feb 6, 1987	Feb 6, 1987	
Parameter	Units											
Ammonia	mg/l	6.59	6.22	16.1	14.4	5.53	5.62	2.25	2.5	11.8	13.8	3
BOD-5, Total	mg/l	16800	9600	7500	4190	10900	4370	6300	4170	3140	2310	41
BOD-5, Dissolved	mg/l	9000	6600	4400	3500	4640	2760	2790	3240	4710	1820	30
Chloride	mg/l	2800	8000	5100	10800	4200	8800	3200	7400	3400	9100	0
COD, Dissolved	mg/l	45500	22100	26400	14900	15100	6890	19000	15000	22800	12500	43
COD, Total	mg/l	75600	40600	38100	18500	102000	16500	31800	22300	40600	9210	58
Dissolved Solids	mg/l	29900	26500	27200	23400	28200	18500	20000	21800	18800	20800	12
Fluoride	mg/l	89.7	.1	59	.1	53	.14	37.3	.52	29	.01	100
Oil & Grease	mg/l	12900	19850	5600	252	33000	1480	4940	4800	2540	900	52
Phenol	mg/l	169	347	87.4	44.5	68.8	58.4	64.7	71.5	53.2	23.4	24
Suspended Solids	mg/l	21800	6730	9270	3220	20600	2920	5220	3000	5710	6140	53
Suspended Vol Solids	mg/l	16000	5940	4033	3120	15500	2070	2675	1400	4700	210	63
TKN	mg/l	428	370	270	282	257	153	20.2	190	291	201	17
Total Cyanide	mg/l	.57	.55	.48	.32	.58	.50	.48	.58	.05	.43	10
Total Organic Carbon	mg/l	19300	14500	8500	4600	7200	4380	5650	4290	5690	3640	34
Total Vol Solids	mg/l	29940	12290	14280	20690	26370	5440	9880	7000	10590	4420	45

NOTE: mg/l = milligrams per liter
Average percent removed = mean of positive and zero removals

TABLE 6-15. EPA-ITD SAMPLING PROGRAM AIR FLOTATION PERFORMANCE - PLANT D

Fraction: Extractable and Volatile Organics

Sample Point:		Raw	Treated	Raw	Treated	Raw	Treated	Raw	Treated	Raw	Treated	
Plant No.		D	D	D	D	D	D	D	D	D	D	
Episode No.		1179	1179	1179	1179	1179	1179	1179	1179	1179	1179	
Sample No.		15713	15714	15715	15716	15718	15719	15722	15723	15725	15726	
Sample Date		Feb 2, 1987	Feb 2, 1987	Feb 3, 1987	Feb 3, 1987	Feb 4, 1987	Feb 4, 1987	Feb 5, 1987	Feb 5, 1987	Feb 6, 1987	Feb 6, 1987	Average Percent Removed
Parameter	Units											
1,1,1-Trichloroethane	ug/l	36179	4099	11825	2721	71613	6780	26035	14953	ND	1893	60
1,1-Dichloroethene	ug/l	25286	1007	ND	ND	ND	ND	ND	1225	ND	ND	46
1,2-Dichloroethane	ug/l	ND	ND	ND	631	ND	ND	315	194	ND	ND	19
1,2-Diphenylhydrazine	ug/l	ND	ND	ND	ND	ND	ND	ND	2451	ND	ND	0
2-Butanone (MEK)	ug/l	987690	174905	ND	ND	18823	19097	ND	ND	1351260	108185	58
2-Chloronaphthalene	ug/l	ND	ND	ND	ND	ND	ND	ND	44272	ND	ND	0
2-Hexanone	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	171	0
2-Nitrophenol	ug/l	ND	ND	ND	5359	3256	3379	2739	2082	2866	ND	8
4-Chloro-2-nitroaniline	ug/l	ND	ND	ND	ND	ND	2505	ND	ND	ND	ND	0
Acetone	ug/l	498139	147138	677250	ND	ND	ND	2046290	103907	209456	ND	91
Acrolein	ug/l	ND	ND	ND	ND	ND	ND	ND	1783	ND	1441	0
Benzyl Alcohol	ug/l	9817	2788	ND	ND	ND	4146	ND	ND	9051	ND	57
Biphenyl	ug/l	1266	ND	ND	ND	1394	ND	ND	ND	ND	ND	100
Bis(2-ethylhexyl) phthalate	ug/l	5419	ND	43747	3462	43078	6603	9285	ND	5718	800	93
Butyl Benzyl Phthalate	ug/l	ND	ND	ND	ND	3281	ND	ND	2675	ND	ND	50
Di-N-Butyl Phthalate	ug/l	2088	ND	ND	ND	13561	2736	ND	ND	5012	1095	86
Diphenyl Ether	ug/l	ND	ND	ND	ND	2457	ND	ND	ND	ND	ND	100
Ethylbenzene	ug/l	186495	4518	ND	ND	75039	3014	7857	4532	62143	6715	81
Isophorone	ug/l	5392	3489	25392	3822	3371	ND	ND	3081	22038	ND	64
Methacrylonitrile	ug/l	ND	ND	ND	ND	ND	25	ND	ND	ND	ND	0
Methylene Chloride	ug/l	ND	ND	15443	8161	ND	ND	ND	ND	ND	1870	24
N,N-Dimethylformamide	ug/l	ND	ND	ND	ND	ND	2690	ND	ND	ND	ND	0

TABLE 6-15. EPA-ITD SAMPLING PROGRAM AIR FLOTATION PERFORMANCE - PLANT D (Continued)

Fraction: Extractable and Volatile Organics

Sample Point:		Raw	Treated	Raw	Treated	Raw	Treated	Raw	Treated	Raw	Treated	
Plant No.		D	D	D	D	D	D	D	D	D	D	
Episode No.		1179	1179	1179	1179	1179	1179	1179	1179	1179	1179	
Sample No.		15713	15714	15715	15716	15718	15719	15722	15723	15725	15726	
Sample Date		Feb 2, 1987	Feb 2, 1987	Feb 3, 1987	Feb 3, 1987	Feb 4, 1987	Feb 4, 1987	Feb 5, 1987	Feb 5, 1987	Feb 6, 1987	Feb 6, 1987	Average Percent Removed
Parameter	Units											
N-Decane (N-C10)	ug/l	ND	ND	ND	ND	ND	2577	ND	1551	ND	ND	0
N-Docosane (N-C22)	ug/l	ND	ND	ND	4905	ND	ND	3424	6312	12309	ND	33
N-Hexacosane (N-C26)	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	805	0
N-Hexadecane (N-C16)	ug/l	ND	ND	ND	2642	ND	160	1178	ND	ND	ND	33
N-Octacosane (N-C28)	ug/l	ND	ND	ND	ND	ND	ND	28081	ND	ND	2068	50
N-Octadecane (N-C18)	ug/l	3983	ND	ND	ND	13354	ND	ND	ND	ND	320	67
N-Tetradecane (N-C14)	ug/l	ND	ND	44127	4924	ND	ND	5754	4657	ND	990	55
Naphthalene	ug/l	8842	ND	17954	2119	5503	1823	2775	ND	ND	318	71
P-Cymene	ug/l	ND	ND	ND	ND	1996	ND	ND	ND	ND	ND	100
Phenanthrene	ug/l	ND	ND	ND	ND	ND	ND	11577	ND	ND	ND	100
Phenol	ug/l	932	ND	ND	ND	ND	1127	ND	ND	ND	ND	50
Styrene	ug/l	34620	7379	30372	5193	18836	6395	ND	3248	4950	ND	66
Tetrachloroethene	ug/l	ND	ND	ND	ND	86267	2776	ND	5331	ND	1869	32
Toluene	ug/l	107977	7487	ND	ND	42672	1940	6159	4248	54123	ND	80
Trans-1,2-Dichloro-ethene	ug/l	ND	ND	ND	ND	ND	ND	917	ND	ND	ND	100
Trichloroethene	ug/l	ND	ND	ND	151	4038	104	1278	199	4575	156	70
Vinyl Acetate	ug/l	ND	1249	ND	ND	ND	ND	ND	ND	ND	ND	0

NOTE: ND indicates not detected above detection limits
Average percent removed = mean of positive and zero removals

TABLE 6-16. EPA-ITD SAMPLING PROGRAM AIR FLOTATION PERFORMANCE - PLANT D

Fraction: Metals

Sample Point:		Raw	Treated	Raw	Treated	Raw	Treated	Raw	Treated	Raw	Treated	
Plant No.		D	D	D	D	D	D	D	D	D	D	
Episode No.		1179	1179	1179	1179	1179	1179	1179	1179	1179	1179	
Sample No.		15713	15714	15715	15716	15718	15719	15722	15723	15725	15726	
Sample Date		Feb 2, 1987	Feb 2, 1987	Feb 3, 1987	Feb 3, 1987	Feb 4, 1987	Feb 4, 1987	Feb 5, 1987	Feb 5, 1987	Feb 6, 1987	Feb 6, 1987	Average Percent Removed
Parameter	Units											
Aluminum	ug/l	90800	91500	71700	64700	61300	57400	37900	75700	36100	150000	3
Antimony	ug/l	33600	30100	9780	8980	10200	4140	6820	5640	6140	4650	24
Arsenic	ug/l	500	103	62	100	72	100	16	19	78	19	31
Barium	ug/l	1230	170	2200	2680	1500	1930	7510	2930	5260	599	47
Beryllium	ug/l	7	5	5	5	5	5	5	5	5	5	6
Boron	ug/l	7700	4870	6100	6170	7270	3960	6320	6640	7390	5650	21
Cadmium	ug/l	695	138	285	229	4690	1170	1340	1270	883	909	36
Calcium	ug/l	120000	52700	77000	72400	97000	46200	40600	46900	50000	43600	25
Chromium	ug/l	6430	2490	3360	1570	4720	1060	3420	1160	4120	977	67
Cobalt	ug/l	1700	448	760	500	1170	410	1090	582	1320	587	55
Copper	ug/l	4810	1540	4780	3020	5940	1610	2640	1270	3240	1350	58
Iron	ug/l	693000	74900	201000	84500	529000	96600	180000	88600	216000	43000	72
Lead	ug/l	37600	8730	18200	5380	34600	4760	16500	4970	19300	3050	78
Magnesium	ug/l	40400	20600	22600	22700	28300	13100	11600	12600	13800	11600	24
Manganese	ug/l	5130	1810	3250	2470	6890	1840	2510	2290	2720	1980	40
Mercury	ug/l	41	27	20	11	28	.5	8.5	3.8	10	.6	65
Molybdenum	ug/l	853	362	1040	705	1880	830	1540	1170	2230	1030	45
Nickel	ug/l	991	161	376	286	1030	319	363	287	419	280	46
Selenium	ug/l	5	5	50	50	5	125	5	5	5	25	0
Silver	ug/l	18	63	8.4	10	5.7	14.6	1	9.2	7.3	1	17
Sodium	ug/l	8800000	8690000	9090000	8190000	9510000	6100000	7290000	7130000	6720000	6730000	10
Thallium	ug/l	100	100	100	50	50	100	50	50	50	50	10
Tin	ug/l	5730	692	4190	1220	6390	2180	5620	2550	4230	495	74
Titanium	ug/l	2610	578	860	434	1190	289	577	287	666	175	65
Vanadium	ug/l	82	50	50	50	95	50	50	50	50	58	17
Yttrium	ug/l	50	50	50	50	50	50	50	50	50	50	0
Zinc	ug/l	80400	23200	54300	37400	108000	27900	44300	30600	43500	17900	53

NOTE: ug/l = micrograms per liter
Average percent removed = mean of positive and zero removals

TABLE 6-17. EPA-ITD SAMPLING PROGRAM
AIR FLOTATION PERFORMANCE - PLANT D

Fraction: Pesticides/Herbicides

Plant No.		D	D	D	D	
Episode No.		1179	1179	1179	1179	Average
Sample No.		15713	15714	15718	15719	Percent
Sample Point		Raw	Treated	Raw	Treated	Removed
Sample Date		Feb. 2, 1987	Feb. 2, 1987	Feb. 4, 1987	Feb. 4, 1987	
Parameter	Units					
Dichloran	ug/l	ND	ND	ND	282	0
Endosulfan I	ug/l	296	ND	ND	ND	100
Endosulfan Sulfate	ug/l	ND	ND	528	951	0
Heptachlor	ug/l	284	1738	ND	ND	0
Etridazone	ug/l	252	ND	ND	ND	0
Isodrin	ug/l	ND	2829	ND	ND	0
Trifluralin	ug/l	ND	ND	ND	322	0
Azinphos Ethyl	ug/l	4260	ND	ND	ND	100
Azinphos Methyl	ug/l	6207	50466	4689	3769	9
Fensulfothion	ug/l	5795	ND	7859	4148	74
Phosmet	ug/l	ND	30972	ND	ND	0
Diazinon	ug/l	ND	ND	1035	ND	100
Dimethoate	ug/l	ND	ND	1500	ND	100
Leptophos	ug/l	ND	ND	3959	ND	100
TEPP	ug/l	ND	ND	ND	2323	0

NOTE: ND indicates not detected
ug/l = micrograms per liter
Average percent removed = mean of positive and zero removals

- Plant D - 15,000 gpd are generated as a result of the washing and burning of 6,000 drums. The process wastewater is treated by air flotation and reused as makeup to caustic wash and intermediate rinses and as furnace quench. Most of the wastewater is lost from the system through evaporation at the furnace or from the hot caustic wash. City water used as final rinse is the source of makeup to the total system. Solids are removed by screening and as air floating sludge.

- Plant N - This facility washes 700 tight-head drums and burns 500 open-head drums. Process wastewater is treated by air flotation and then reused as an intermediate rinse or as furnace quench.

- Plant O - About 1,000 open- and tight-head drums are reconditioned daily. Open-head drums are not burned, but are instead shot blasted. Hence, no wastewater is generated. Wastewater is generated by tight-head washing processes and is treated by air flotation. The treated wastewater is reused as an intermediate rinse or as caustic makeup.

- Plant P - 1,500 open-head drums are burned daily. Quench water is treated by sedimentation only before being reused. Because of high evaporation losses, the quench water supply is made up by wastewater trucked in from Plant Q.

- Plant Q - This tight-head plant washes 600 drums daily. Sedimentation and oil/water skimming are provided to the process wastewater. Some wastewater is reused onsite as caustic makeup and the remainder is trucked to Plant P.

6.5 RESIDUALS GENERATION AND DISPOSAL

Nonaqueous liquid wastes and solids are generated in several plant areas. Liquid residues are sometimes dumped into process wastewater floor drains, but are usually contract hauled. Petroleum residues are sometimes sold for use in fuel blends. Oil and grease removed from oil/water separators is also sold for the same purpose. Solids generated include wastewater treatment sludges and furnace ash.

Limited data do not allow a precise estimate of the total volume of sludge and ash disposed of by the industry. Data from three plants that use air flotation show that approximately 0.7 kilograms, or 0.17 gallons of air flotation sludge are generated per drum reconditioned. Two of the three plants comingle ash quench with washing wastestreams; therefore, the 0.7 kilogram estimate reflects both tight- and open-head wastestreams. Caustic wash sediments are also comingled with the wastestreams. The Agency believes that this estimate is the best available for estimating the total mass of solids disposed of by the industry (SAIC 1987c).

NABADA (Touhill 1981a) reports that 51.2 percent of the industry used air flotation or flocculation/sedimentation. Therefore, the annual industry solids generation rate is 18 million kilograms (51.2 percent x 0.7 kilogram per drum x 50,000,000 drums), or 153,000 pounds daily, if 260 working days per year are assumed. Facilities that do not use air flotation or sedimentation are assumed to dispose of solids through their wastewater discharge. The high levels of solids observed in raw wastewaters support this assumption.

Data collected by EPA-ITD and EPA-ORD are presented below for caustic clarifier sludges, furnace ash, and air flotation sludges. EPA ITD collected air flotation sludge samples at Plants B and D. A sedimentation sludge sample was collected at Plant C. EPA-ORD collected caustic clarifier sludge samples at Plants E and F and a furnace ash sample was obtained from Plant G.

6.5.1 EPA-ITD Data

The data collected by EPA-ITD are the best available for estimating the characteristics of sludge disposed of by the industry. Sludges at three plants were sampled. Plant B used air flotation to treat tight-head process wastewater generated by paint drum reconditioning facilities. Plant C used sedimentation to remove solids from the washing and stripping of petroleum drums. Two samples were obtained from Plant D where air flotation is used to treat wastewaters generated by tight- and open-head processing. A wide range of drum types are processed at Plant D and the furnace quench constitutes 27 percent of the treatment system influent. Sludge analyses were conducted for conventional and nonconventional pollutants, metals, extractable and volatile organics, and dioxins/furans. Analytical results are summarized below.

- Conventional and Nonconventional - The data in Table 6-18 show that sludges are composed mainly of oil and grease (15 percent) and suspended solids (7 percent), which are mostly volatile solids.

- Extractable and Volatile Organics - The data in Table 6-19 show detected values. Only a few conclusions can be drawn about the presence of organics in the four sludge samples, since detection limits in many cases are greater than 1 mg/l. 2-Butanone (MEK), biphenyl, bis(2-ethylhexyl)phthalate, ethylbenzene, napthalene, and toluene were found in samples at two of the three plants. No single compound is found at all three sites and no site-specific patterns are evident.

TABLE 6-18. EPA-ITD SAMPLING PROGRAM SEDIMENTATION AND AIR FLOTATION SLUDGES

Fraction: Conventionals and Nonconventionals

Sample Point:		Sludge	Sludge	Sludge	Sludge
Plant No.		B	C	D	D
Episode No.		1130	1130	1130	1130
Sample No.		15347	15359	15721	15724
Sample Date		Aug 6, 1986	Sep 10, 1986	Feb 4, 1987	Feb 5, 1987
Parameter	Units				
Ammonia	mg/kg	68	NR	9.52	33.1
BOD-5, Total	mg/kg	2280	6600	160000	100000
BOD-5, Dissolved	mg/kg	1800	1440	26600	18400
Chloride	mg/kg	2800	1000	66700	26500
COD, Dissolved	mg/kg	2300	1430	112000	77900
COD, Total	mg/kg	84000	339000	1190000	1090000
Dissolved Solids	mg/kg	784	18000	20000	15400
Fluoride	mg/kg	500	570	.95	2.79
Oil & Grease	mg/kg	167	21000	51000	827000
Phenol	mg/kg	.37	4.96	914	870
Sulfide	mg/kg	1	7.4	NR	NR
Suspended Solids	mg/kg	58000	53050	84600	118000
Suspended VOL Solids	mg/kg	23000	37875	16600	103100
TKN	mg/kg	330	NR	950	897
Total Cyanide	mg/kg	284	120	6.09	1.91
Total Organic Carbon	mg/kg	330	4000	5.5	227000
Toal VOL Solids	mg/kg	33000	21000	77460	124330

NOTE: mg/kg = milligrams per kilogram
NR indicates not reported

TABLE 6-19. EPA-ITD SAMPLING PROGRAM SEDIMENTATION AND AIR FLOTATION SLUDGES

Fraction: Extractable and Volatile Organics

Sample Point:		Sludge	Sludge	Sludge	Sludge
Plant No.		B	C	D	D
Episode No.		1130	1133	1179	1179
Sample No.		15347	15359	15721	15724
Sample Date		Aug 7, 1986	Sep 18, 1986	Feb 4, 1987	Feb 5, 1987
Parameter	Units				
1,1,1-Trichloroethane	ug/l	ND-10	NR	15710	4140
2-Butanone (MEK)	ug/l	164278	NR	1938	ND-50
Acetone	ug/l	ND-50	NR	20785	9507
Acrolein	ug/l	ND-50	NR	ND-50	160
Biphenyl	ug/l	ND-33333	3829	414	ND-3333
Bis(2-Ethylhexyl)Phthlate	ug/l	ND-33333	3115	2502	ND-3333
Di-N-Butyl Phthlate	ug/l	ND-33333	ND-333	2416	4257
Ethyl Methacrylate	ug/l	ND-10	NR	ND-10	33
Ethylbenzene	ug/l	1981	NR	17900	133057
Fluorene	ug/l	ND-33333	2109	ND-333	ND-3333
Isophorone	ug/l	ND-33333	ND-333	889	ND-3333
N-Docosane (N-C22)	ug/l	ND-33333	ND-333	6741	ND-3333
N-Hexadecane (N-C16)	ug/l	ND-33333	127003	ND-333	ND-3333
N-Octadecane (N-C18)	ug/l	ND-33333	ND-333	2494	ND-3333
N-Tetradecane (N-C14)	ug/l	ND-33333	ND-333	2271	ND-3333
Naphthalene	ug/l	ND-33333	5425	1692	ND-3333
P-Cymene	ug/l	ND-33333	5380	ND-333	ND-3333
Phenanthrene	ug/l	ND-33333	1754	ND-333	ND-3333
Pyrene	ug/l	ND-33333	478	ND-333	ND-3333
Styrene	ug/l	ND-33333	ND-333	5120	ND-3333
Tetrachloroethene	ug/l	ND-10	NR	174	ND-10
Toluene	ug/l	1257	NR	12954	ND-10
Trichloroethene	ug/l	ND-10	NR	1571	695

Note: ug/l = micrograms per liter
ND indicates not detected. Detection limit shown.
NR indicates not reported

TABLE 6-21. EPA-ITD SAMPLING PROGRAM
SEDIMENTATION AND AIR FLOTATION SLUDGES

Fraction: Dioxins/Furans

Sample Point:		Sludge	Sludge	Sludge	Sludge
Plant No.		B	C	D	D
Episode No.		1130	1133	1179	1179
Sample No.		15347	15359	15721	15724
Sample Date		Aug 7, 1986	Sep 18, 1986	Feb 4, 1987	Feb 5, 1987
Parameter	Units				
1234678-HpCDD	ppt	ND	226.11	260.89	496.799
1234678-HpCDF	ppt	ND	ND	114.55	ND
123478-HxCDF	ppt	ND	ND	40.10	ND
234678-HxCDF	ppt	ND	ND	44.31	ND
OCDD	ppt	ND	41954.20	2774.67	5619.11
OCDF	ppt	143.73	ND	ND	330.89
Total HpCDD	ppt	ND	4044.62	537.35	1002.79
Total HpCDF	ppt	ND	112.99	187.33	171.61
Total HxCDD	ppt	ND	ND	168.52	138.87
Total HxCDF	ppt	ND	ND	139.62	ND
Total PCDF	ppt	ND	ND	92.46	ND
Total TCDF	ppt	ND	ND	37.06	32.67

NOTE: ppt = parts per trillion
ND indicates not detected above detection limits

TABLE 6-22. EPA-ITD SAMPLING PROGRAM
TOXICITY CHARACTERISTIC LEACHING PROCEDURE

Fraction: Extractable and Volatile Organics

Sample Point:		Sludge	Sludge	Sludge	Sludge
Plant No.		B	C	D	D
Episode No.		1130	1133	1179	1179
Sample No.		15347	15359	15721	15724
Sample Date		Aug 7, 1986	Sep 18, 1986	Feb 4, 1987	Feb 5, 1987
Parameter	Units				
1,1,1-Trichloroethane	ug/l	ND-10	NR	7527	669
1,1-Dichloroethene	ug/l	ND-10	NR	144	ND-10
2-Butanone (MEK)	ug/l	109078	NR	611	670
2-Chloronaphthalene	ug/l	47	ND-10	ND-10	ND-100
Acetone	ug/l	ND-50	NR	16067	1038
Acetophenone	ug/l	ND-10	NR	18	ND-100
Acrolein	ug/l	ND-50	NR	197	87
Alpha-Terpineol	ug/l	28	54	ND-10	ND-100
Bis(2-Ethylhexyl) Phthalate	ug/l	ND-10	ND-10	128	ND-100
Di-N-Butyl Phthalate	ug/l	ND-10	ND-10	115	ND-100
Ethylbenzene	ug/l	642	NR	1965	1419
Hexanoic Acid	ug/l	162	NR	ND-100	ND-10
Isobutyl Alcohol	ug/l	ND-10	NR	ND-10	80
Isophorone	ug/l	ND-10	ND-10	38	ND-100
Methylene Chloride	ug/l	117	NR	ND-10	82
N-Dodecane (N-C12)	ug/l	ND-10	ND-10	377	ND-100
N-Eicosane (N-C20)	ug/l	ND-10	ND-10	162	342
N-Hexacosane (N-C26)	ug/l	ND-10	ND-10	593	ND-100
N-Octadecane (N-C18)	ug/l	ND-10	ND-10	38	ND-100
Naphthalene	ug/l	63	21	76	ND-100
P-Cymene	ug/l	ND-10	ND-10	15	ND-100
Styrene	ug/l	ND-10	ND-10	ND-10	172
Tetrachloroethene	ug/l	ND-10	NR	1712	ND-10
Thioxanthone	ug/l	379	NR	ND-20	ND-200
Toluene	ug/l	1518	NR	2396	ND-10
Trichloroethene	ug/l	ND-10	NR	167	82

NOTE: ug/l = micrograms per liter
ND indicates not detected. Detection limit shown.
NR indicates not reported

TABLE 6-23. EPA-ITD SAMPLING PROGRAM
TOXICITY CHARACTERISTIC LEACHING PROCEDURE

Fraction: Metals

Sample Point:		Sludge	Sludge	Sludge	Sludge
Plant No.		B	C	D	D
Episode No.		1130	1133	1179	1179
Sample No.		15347	15359	15721	15724
Sample Date		Aug 7, 1986	Sep 18, 1986	Feb 4, 1987	Feb 5, 1987
Parameter	Units				
Aluminum	ug/l	147000	7000	17686	17266
Antimony	ug/l	20	20	250	213
Arsenic	ug/l	220	20	4	3
Barium	ug/l	534	183	1126	2159
Beryllium	ug/l	5	5	25	25
Boron	ug/l	260	731	20	20
Cadmium	ug/l	44	17	224	435
Calcium	ug/l	4550	118000	5232	6265
Chromium	ug/l	390	355	118	144
Cobalt	ug/l	50	286	35	30
Copper	ug/l	120	25	202	220
Iron	ug/l	1230	120000	1124	858
Lead	ug/l	2120	200	1400	1465
Magnesium	ug/l	732	5920	1440	1583
Manganese	ug/l	425	1060	314	462
Mercury	ug/l	.2	.6	.2	.2
Molybdenum	ug/l	100	100	260	260
Nickel	ug/l	78	91	95	83
Selenium	ug/l	200	100	4	4
Silver	ug/l	20	20	0.6	0.6
Sodium	ug/l	1640000	2360000	1490960	1992204
Thallium	ug/l	20	20	4.2	4.2
Tin	ug/l	100	125	316	299
Titanium	ug/l	10	50	7	7
Vanadium	ug/l	50	50	24	24
Yttrium	ug/l	50	50	4	4
Zinc	ug/l	10500	1930	7186	11079

NOTE: ug/l = micrograms per liter

TABLE 6-24. ANALYTICAL DATA FOR CAUSTIC CLARIFIER SLUDGES PLANTS E AND F

Parameter	Concentration (mg/l)		
	Plant E	Plant F	Other Data*
Acenaphthalene	--	165	--
Acenaphthalenes, C1	--	135	--
Acenaphthalenes, C2	--	25	--
Acenaphthene	7.6	--	--
Aliphatics, C7-C18	--	12,500	--
Anthracene/phenanthrene	50	--	--
Benzenex, C3-C4	--	1,625	--
Bis-(2-ethylhexyl)-Phthalate	--	13	--
2-chlorophenol	14	--	--
Chrysene/benzo(a)anthracene	5.4	--	--
Dicyclohexylamine	59	--	--
Diethyl phthalate	--	13	--
Fluoranthrene	5.5	--	--
Fluorene	12	--	--
Isopropyl diphenyl amine	17	--	--
Naphthalene	47	360	--
Naphthalenes, C1	--	330	--
Naphthalenes, C2	--	335	--
n-nitrosodiphenylamine	1,200	--	--
Pyrene	5	--	--
Silicones	--	4,350	--
Aluminum	11.0	--	--
Antimony	3.77	--	--
Arsenic	0.076	--	1.6
Barium	0.520	--	651
Beryllium	0.060	--	--
Boron	23.1	--	--
Cadmium	1.16	--	9.6
Calcium	50.8	--	1,687
Chromium	0.880	--	199
Cobalt	0.960	--	--
Copper	0.990	--	2,393
Cyanides	--	--	10
Iron	8.98	--	24,922
Lead	4.28	--	4,554
Magnesium	21.7	--	--
Manganese	1.21	--	290
Mercury	0.178	--	0.48
Molybdenum	3.41	--	--
Nickel	0.48	--	29.2
Phosphorus	36.7	--	7,500
Selenium	0.023	--	30.5
Silicon	22.9	--	5,325
Silver	<0.005	--	2.3
Sodium	23,400	--	8,455
Strontium	0.250	--	--

solids. Metals data are also listed in Table 6-24 for plants that supplied data in response to the NABADA survey. The data are the average of sludges from several plants and show significantly higher levels than the data from Plant E.

Table 6-25 shows metals data for dried caustic sludge samples from Plant G that contain about 30 percent water. If a solids level of 1 percent were assumed for the undried sludge, then the data would be representative of a sludge that had been concentrated about 70 times. An extrapolation of the data with the use of a divisor of 70 would yield metals levels that are lower than those reported by NABADA respondents.

6.5.2.2 Furnace Ash

Ash removed from the surfaces of burned open-head drums is likely to contain high amounts of metal as well as incompletely combusted organics. In Table 6-26, hydrocarbons and extractable organics are shown to be present in an ash sample collected from Plant B.

6.6 SUMMARY

The following list summarizes the major points that were discussed in this section:

- Zero discharge is demonstrated to be a practical control technology for open-head facilities. Furnace quench water typically is reused after simple sedimentation.
- Tight-head facilities generally discharge wastewater and nearly half of the dischargers do not treat wastewater.
- Wastewater treatment pollutant removal efficiencies were poor at the four plants sampled by the Agency.
- Sedimentation, oil/water separation, and air flotation are the dominant treatment technologies at tight-head plants. Reuse of treated effluent is possible; however, zero discharge is only attainable if wastestreams are segregated and water conservation measures are implemented.
- Approximately 124 million pounds of residue are contained in drums received by reconditioners, annually.
- Wastewater treatment sludges generated by the industry are composed mainly of oil and grease (15 percent) and suspended solids (7 percent). High concentrations of 23 organics are observed.

TABLE 6-25. ANALYTICAL DATA FOR DRIED CAUSTIC SLUDGE PLANT G

	Sample 1	Sample 2	Sample 3
Moisture Content, wt.%	27.66	14.63	45.20
		Concentration, mg/kg	
Aluminum	8,500	12,700	7,800
Antimony	889	975	828
Arsenic	6.6	11.7*	6.8
Barium	3,100	4,900	3,000
Beryllium	1.94	1.90	<1
Boron	378	539	405
Cadmium	65.2	95.2	73.6
Calcium	23,000	33,400	22,800
Chromium	1,500	2,300	1,400
Cobalt	209	548	293
Copper	990	1,900	919
Iron	81,500	134,000	80,000
Lead	5,900	10,300	5,800
Magnesium	3,600	6,200	3,800
Manganese	779	1,200	771
Mercury	3.1	1.7	3.5
Molybdenum	269	202	60.1
Nickel	1,900	2,100	1,600
Phosphorus	4,200	5,600	4,000
Selenium	1.0	1.3	1.4
Silicon	1,600	1,600	1,400
Silver	231	230	198
Sodium	55,600	87,600	58,800
Strontium	127	194	126
Thallium	<10	<10	<10*
Tin	265	320	227
Titanium	1,300	6,800	1,800
Vanadium	290	341	289
Zinc	1,900	3,300	2,000

*Average values for two analyses.

TABLE 6-26. ANALYTICAL DATA FOR FURNACE ASH PLANT F

Parameter	Concentration mg/kg ash
Aluminum	9,700
Antimony	105
Arsenic	9.2
Barium	9,460
Beryllium	<2
Boron	78.7
Cadmium	11
Calcium	7,840
Chromium	1,250
Cobalt	24.5
Copper	1,880
Iron	5,330
Lead	8,740
Magnesium	1,110
Manganese	35.9
Mercury	2.8
Molybdenum	320
Nickel	79.6
Phosphorus	606
Selenium	1.0
Silicon	156
Silver	<30
Sodium	1,450
Strontium	953
Thallium	<98.0
Tin	199
Titanium	426
Vanadium	98.3
Zinc	700
C7-C25 Aliphatics	4,200
Anthracene	40
C1 Anthracene	30
C2 Anthracene	50
C3-C4 Benzene	900
Bis (ethylhexyl) phthalate	170
Butyl benzl phthalate	5
Diisobutyrate	100
Fluoranthene	10
Naphthalene	90
C^5 phenol	60
Pyrene	30
Silicones	10

7. COST OF WASTEWATER CONTROL AND TREATMENT

The purpose of this section is to describe appropriate technology and costs for controlling industry wastewater discharges. An economic assessment of possible regulations affecting the solvent recovery industry is presented.

7.1 INTRODUCTION

This section provides cost estimates for installing and operating wastewater treatment technology that is currently in-place in the drum reconditioning industry. In 1979, about half of the respondees to the National Barrel and Drum Association (NABADA) survey responded that they treat process wastewater prior to discharge. In this study, 13 out of 16 plants contacted provide wastewater treatment prior to discharge. However, as demonstrated in Section 6, the pollutant removal efficiencies of currently installed equipment are low. Therefore, a U.S. Environmental Protection Agency (EPA) decision to regulate the drum reconditioning industry will likely result in a significant investment in equipment and personnel.

7.2 MODEL TREATMENT SYSTEM

Physical/chemical treatment is the prevailing technology in the drum reconditioning industry. This technology takes the forms of sedimentation, oil/water separation, and air flotation. These technologies and related costs have been studied by the Industrial Technology Division (ITD) of EPA for numerous other industries. The Final Development Document for Effluent Limitations Guidelines and Standards for the Metal Finishing Point Source Category report costs for an emulsion breaking system that can be used as a model for estimating physical/chemical treatment costs for the drum reconditioning industry (EPA 1983).

Emulsion breaking is a demonstrated zero discharge technology for the drum reconditioning industry. The Agency visited three washing facilities that use air flotation, a variation of emulsion breaking, to achieve zero discharge. Each plant reconditions a variety of drum types that total between 500 and 3,000 drums daily per facility. Treated wastewater is used as makeup to caustic wash and as a intermediate stage rinse water.

Open-head drum reconditioners also have achieved zero discharge of process wastewater through the use of physical/chemical treatment. EPA visited a facility that recycles quench water after it is treated by sedimentation. Minor process wastestreams, such as paint booth water curtain overflow, also are treated and recycled. Because of evaporation losses in the quench process, the makeup water supply is supplemented with tap water. Two other drum burning plants discharge their quench water to emulsion breaking treatment systems that are employed to achieve zero discharge of their combined open- and tight-head wastewaters.

The model emulsion breaking system is identified as treatment system - Option 1 for the Metal Finishing Category. The system was designed to treat raw wastewater with oil and grease and toxic organic levels in excess of those observed in drum reconditioning wastewaters. Figures 7-1 and 7-2 are capital cost and operating cost curves, respectively, for the model system. All costs are reported in 1979 dollars, and a detailed discussion is presented in Appendix D.

Wastewater flows found in the drum reconditioning industry range from 100 to 20,000 gallons per day; therefore, the cost curves shown in Figures 7-1 and 7-2 are appropriate for the drum reconditioning industry. An average drum washing plant discharges 2,950 gallons of wastewater per day. In terms of 1979 dollars, an average plant that installs batch mode treatment would incur a capital cost of $70,000 and an annual operating expense of $25,000. Based on the use of cost indices, these costs would be $97,000 and $35,000, respectively, in 1985 (Engineering News Record 1985). A wastewater recycle system would add $13,000 to the capital cost (Means 1986). The cost of land and retrofit of existing process could add 20 percent to capital and operating costs. The cost of collecting volatile organic carbon air emissions and venting to an existing control device would also increase cost 20 percent (EPA 1985). Sludge residuals would average about 2.5 percent of the wastewater volume or 78 gallons per day. Daily sludge disposal costs would be less than $200 if a contract hauling and incineration cost of $2.50 per gallon is assumed. Discharge compliance monitoring costs would be $5,000 per year. In summary, the total system capital cost would be $154,000 with an operating cost of $47,000.

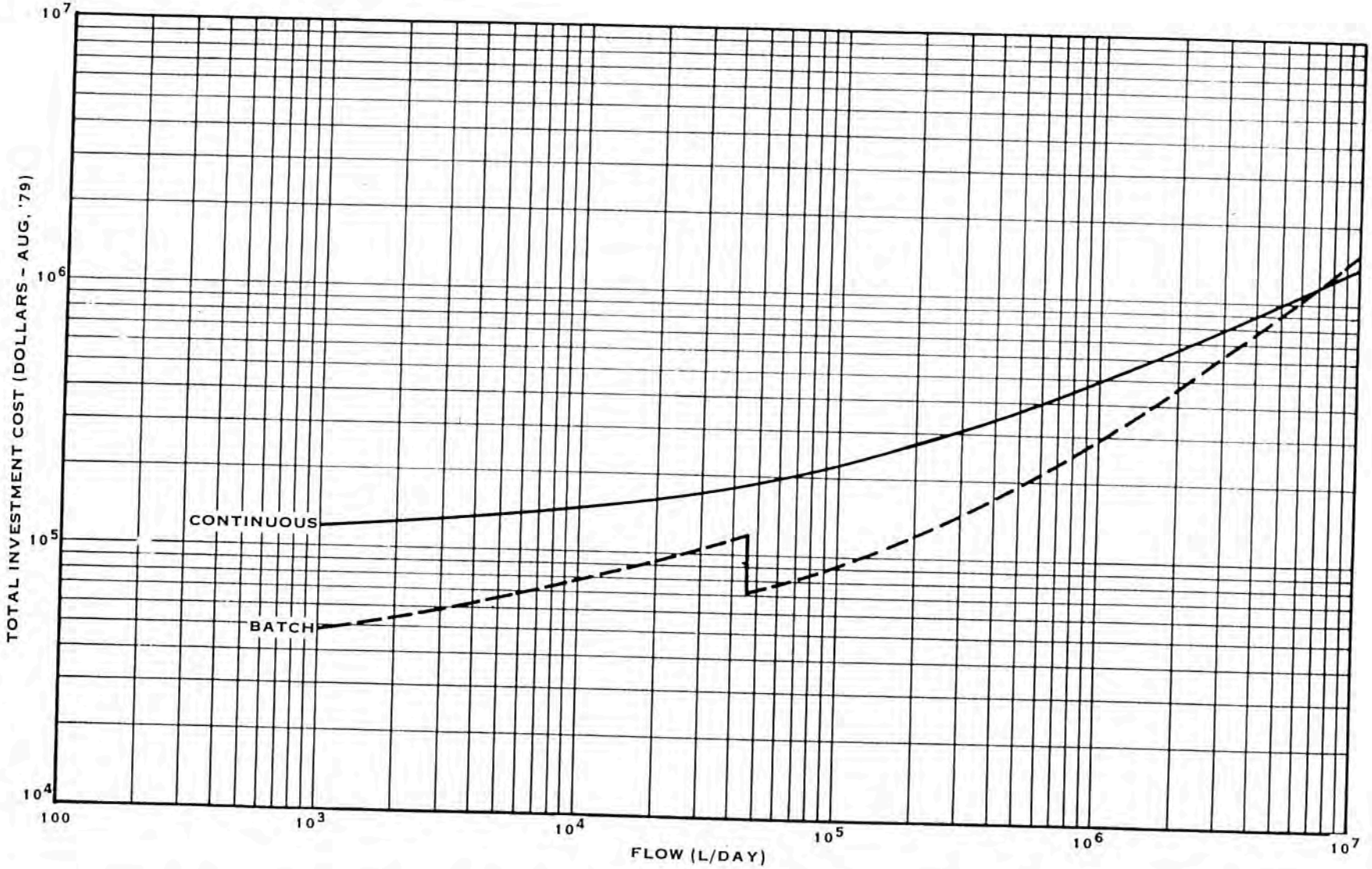

FIGURE 7-1. TOTAL INVESTMENT COSTS VS. FLOW RATE FOR OPTION 1 TREATMENT SYSTEM, CASE 6

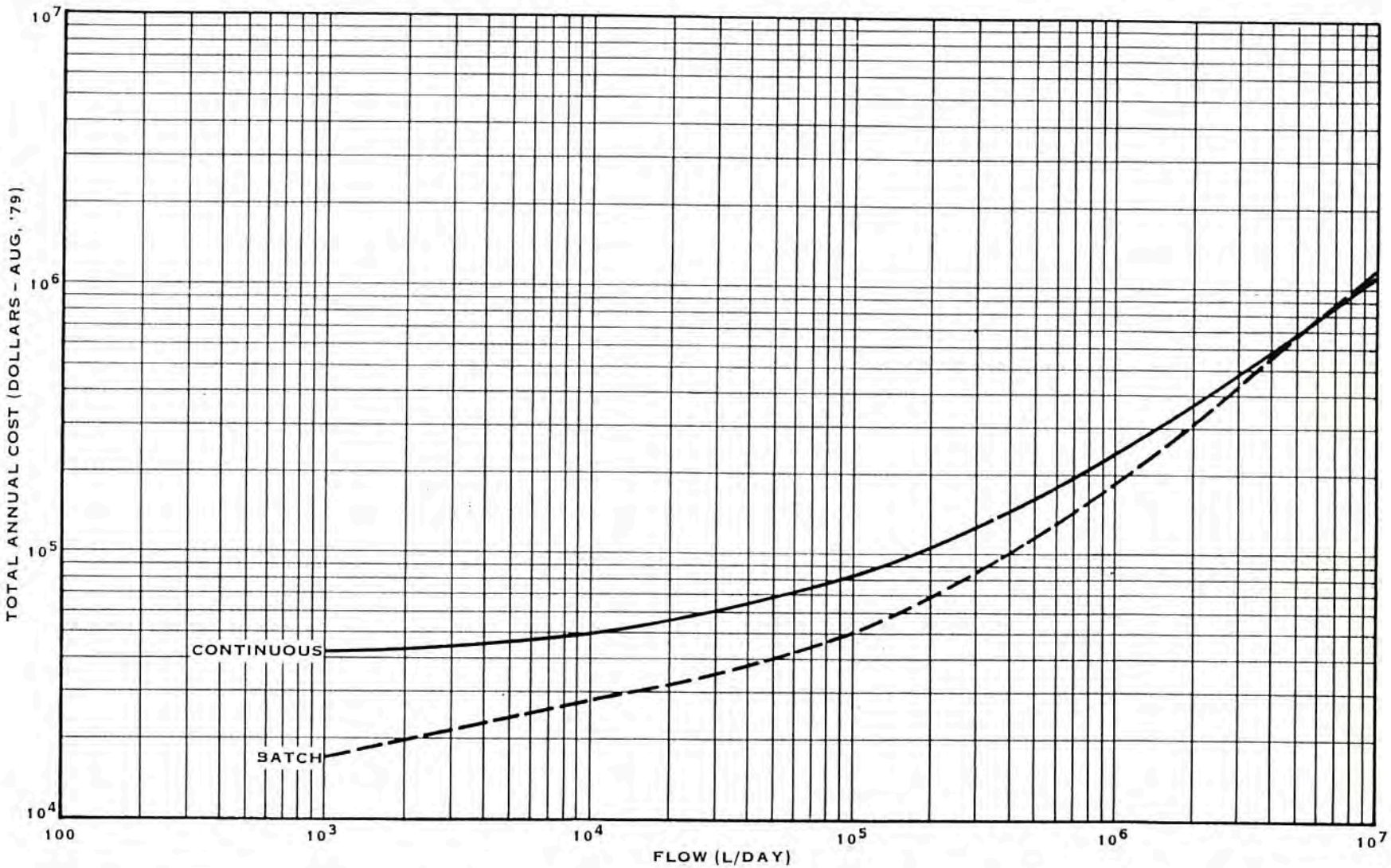

FIGURE 7-2. TOTAL ANNUAL COST VS. FLOW RATE FOR OPTION 1 TREATMENT SYSTEM, CASE 6

7.3 ECONOMIC ASSESSMENT AND COST-EFFECTIVENESS

This subsection presents a preliminary economic assessment of possible regulations affecting the drum reconditioning industry. The first part of the subsection describes the treatment technology and costs analyzed, and presents the results of the economic impact analysis. The second part of the subsection provides an analysis of the cost-effectiveness of the treatment option.

7.3.1 Economic Assessment

This preliminary assessment of the possible economic impacts is based on an analysis of model plants. The impacts are measured by comparing unit control costs to service fees and drum value.

The Agency has determined, tentatively, that the model end-of-pipe treatment system for the drum reconditioning industry is air flotation. For a typical plant reconditioning 427 drums per day, this control option would result in a capital cost of $154,000 and an annual operating and maintenance cost of $47,000. If capital costs are annualized using a capital recovery factor of 0.26, the total annualized cost is $87,000.

For the model plant processing 427 drums per day and operating 260 days per year, the annualized control cost is about $0.78 per drum served. Based on the Agency data (SAIC 1986), laundry/service fees are about $6.50 per drum. Therefore, control costs are about 12 percent of the service fee. A second impact measure compares the control cost to the price of a reconditioned drum. Since the price is about $12.00, control costs are about 6.5 percent of the price of a reconditioned drum. Table 7-1 summarizes the calculations. By either measure, the impact of this control option is very low.

7.3.2 Cost-Effectiveness

Cost-effectiveness is defined as the incremental annualized cost of a pollution control option in an industry, or an industry subcategory, per incremental pound equivalent of pollutant removed by that control option. The analysis accounts for differences in toxicity among the pollutants with toxic weighting factors (TWF). Because concentration data are not always available

TABLE 7-1. IMPACT ON DRUM RECONDITIONING INDUSTRY

	Totals	Cost Impact Measure
Annualized Cost	$87,000	
Capacity	427 drums per day	$0.78/drum
Laundry/Service Fee	$6.50*/drum	12% of service fee
Reconditioned Drum Price	$12.00*/drum	6.5% of drum price

*SAIC, Mid-Project Report, 1987.

for many priority and nonpriority pollutants, incremental removal may be underestimated for this preliminary cost-effectiveness calculation.

The control technology consists of sedimentation, oil/water separation, and air flotation followed by partially recycling treated wastewater. In passing through a publicly owned treatment works (POTW) or any treatment system using an aeration operation, a volatile chemical can be either volatilized to the air, decomposed, removed in sludge, or discharged via outfalls. In this calculation, it is assumed that the volatilized portion of VOCs is captured and removed.

Table 7-2 shows the data used and the step-by-step calculation. For 250 drum reconditioners generating wastewater, each producing 3,000 gallons per day, the annual wastewater flow is 195 million gallons. The pounds equivalent (PE) removed for each pollutant is calculated on the basis of flow, concentration of that pollutant, and removal efficiencies. As described in Chapter 5, the Agency estimated the concentration of each pollutant based on sample data. Method I concentrations are appropriate for the cost effectiveness analysis and are used in this document. Total loadings for each pollutant are calculated by applying the Method I concentrations and the proportion of sample plants with detectable levels of the pollutant (labeled probability on the table) to the total number of plants. In total, 166,551 pound equivalents of priority pollutants are removed. The annualized cost per plant is $87,040, or $21.76 million for 250 plants. Therefore, the cost-effectiveness of this treatment option is $130.65 per pound equivalent. The high cost-effectiveness value probably is a result of the fact that the control technology, while effective for removing conventional and nonconventional pollutants, is not specifically known for removing priority pollutants.

7.4 SUMMARY

- A model wastewater treatment system would include emulsion breaking technology and treated wastewater reuse. A typical facility would incur a capital cost of $154,000 and an annual operating cost of $47,000 to maintain and operate such a system.
- The annualized wastewater control cost is $0.78 per drum reconditioned which represents about 12 percent of the reconditioning fee.
- The cost-effectiveness of treating the process wastewater is $130 per pound equivalent of pollutant removed.

TABLE 7-2. COST-EFFECTIVENESS CALCULATION FOR DRUM RECONDITIONING WASTEWATER TREATMENT

Number of plants (N)	250
Wastewater flow (gpd) @ each plant (q)	3,000
Number of days/year in operation (d)	260
Annual flow (mgy) for all plants = N x q x d	195

Pollutant	TWF	Observed sample Proba-bility	conc. (ppb)	Raw waste Expected conc. (ppb)	wtd.	R	Wastewater treatment system effluent (ppb)	conc. wtd.	annual (lb)	removal (PE)
1,1,1-TCA	0.000300	0.5	18384	9192	3	0.6	3677	1	8969	3
1,1-Dichloroethene	16.970000	0.25	25286	6322	107276	0.46	3414	57929	4729	80253
1,2-Dichloroethane	0.596000	0.25	315	79	47	0.19	64	38	24	15
2-Chloronaphthalene	0.350000	0.5	2323	1162	407	0	1162	407	0	0
2-Nitrophenol	0.001700	0.25	2953	738	1	0.08	679	1	96	0
Acetone	0.000000	0.25	857784	214446	0	0.91	19300	0	317366	0
Bis(2-eh) phthalate	2.186700	0.25	21449	5362	11726	0.93	375	821	8110	17735
Butyl benzyl phthal	0.025400	25	3281	82025	2083	0.5	41013	1042	66699	1694
D-N-Butyl phthalate	0.000165	0.25	6887	1722	0	0.86	241	0	2408	0
Ethylbenzene	0.004000	1	21598	21598	86	0.81	4104	16	28451	114
Isophorone	0.000010	0.25	14048	3512	0	0.64	1264	0	3655	0
Methylene chloride	2.947000	0.5	9820	4910	14470	0.24	3732	10997	1916	5648
Naphthalene	0.009030	0.75	3108	2331	21	0.71	676	6	2692	24
Phenanthrene	0.028100	0.25	11577	2894	81	1	0	0	4707	132
phenol	0.002190	0.25	932	233	1	0.5	117	0	189	0
Tetrachloroethene	0.707000	0.25	86267	21567	15248	0.32	14665	10368	11224	7935
Toluene	0.000400	1	20295	20295	8	0.8	4059	2	26405	11
T-1,2-Dichloroethen	0.000500	0.25	917	229	0	1	0	0	373	0
Trichloroethene	0.207000	0.5	1135	568	117	0.7	170	35	646	134
Endosulfan I	100.035000	0.25	296	74	7403	1	0	0	120	12039
Endosulfan sulfate	100.035000	0.25	528	132	13205	0	132	13205	0	0
Heptachlor	3438.600000	0.25	284	71	244141	0	71	244141	0	0
Sum (organic)				399,461	416,323		98,914	339,009	488,780	125,736
Antimony	0.003620	1	3481	3481	13	0.24	2646	10	1359	5
Arsenic	32.029000	1	54	54	1730	0.31	37	1193	27	872
Cadmium	5.090000	1	405	405	2061	0.36	259	1319	237	1207
Chromium	0.026700	1	3163	3163	84	0.67	1044	28	3446	92
Copper	0.467000	1	1581	1581	738	0.58	664	310	1491	696
Lead	1.750000	1	14485	14485	25349	0.78	3187	5577	18374	32155
Nickel	0.114000	1	201	201	23	0.46	109	12	150	17
Zinc	0.119000	1	24975	24975	2972	0.53	11738	1397	21527	2562
Beryllium	5.840000	0.5	20	10	58	0.06	9	55	1	6
Mercury	505.026000	0.75	8	6	3030	0.65	2	1061	6	3203
Sum (metals)				48,361	36,059		19,695	10,962	46,620	40,815
Organics plus metals				447,822	452,382		118,608	349,970	535,400	166,551
Annualized costs for all plants										21,760,000
CE ($/PE)										130.65

@ each plant: investment ($)	110,000
land costs (20% of above) ($)	22,000
O&M cost ($/y)	35,000
monitoring cost ($/y)	5,000
annualized cost ($) including 20% of investment & O&M for capturing VOCs.	87,040

8. ENVIRONMENTAL ASSESSMENT

The purpose of this section is to present the results of environmental impacts analysis. The methodology used to estimate human health and aquatic life water quality impacts is described and results are discussed. Non-water quality impacts on emissions to the air, solid waste generation, and energy usage are also discussed.

8.1 METHODOLOGY USED TO ESTIMATE HUMAN HEALTH AND AQUATIC LIFE WATER QUALITY IMPACTS

An environmental assessment of water quality impacts was performed for both direct and indirect wastewater dischargers. Average plant raw waste concentrations and discharge flows for this industry/subcategory were used to project impacts on receiving streams. Water quality impacts for treated effluents were not performed because of the lack of pollutant-specific data.

8.1.1 Direct Discharge Analysis

The following analyses were performed for direct dischargers: (1) criteria comparisons, (2) stream flows with potential impacts, and (3) loading comparisons. The raw waste concentrations from wastestreams were compared to available water quality criteria (acute and chronic aquatic life criteria/ toxicity levels); human health criteria (ingesting water and organisms), including criteria for carcinogenicity protection or toxicity protection; and existing or proposed drinking water standards. A value greater than one indicates a criteria exceedance. The numerical values associated with these exceedances (exceedance factors) represent instream dilutions needed to eliminate projected water quality impacts.

Because actual receiving streams flow data were not available for this industry/subcategory, the stream flows with potential impacts also were projected using stream dilution factors and average plant flows.

Specific pollutant loadings were calculated based on the raw waste concentrations and total industry/subcategory flow and summed. The pollutant loadings were grouped into four categories: (1) total priority organics,

(2) total nonpriority organics, (3) total priority inorganics, and (4) total nonpriority inorganics. The total priority organics and inorganics were compared to the total raw waste pollutant loadings from regulated BAT industries to evaluate the significance of pollutant loadings from the industry/-subcategory considered in this document.

8.1.2 Indirect Discharge Analysis

The following analyses were performed for indirect dischargers: (1) criteria comparisons using a POTW model and stream dilution analysis, (2) impacts to POTWs, and (3) loading comparisons.

A simplified POTW model and stream dilution analysis were performed to project receiving stream impacts from indirect dischargers. Actual receiving stream flow and POTW flow data were not available for this industry/subcategory. In order to project receiving stream impacts, a statistical analysis was performed on the EPA's In-House Software (IHS) Industrial Facilities Discharge File and GAGE File to determine a POTW plant flow and a POTW receiving stream flow for use in the analyses. The 25th, 50th, and 75th percentile flows for POTWs with industrial indirect dischargers were 0.35, 1.1, and 3.0 milion gallons per day (MGD), respectively. For this study, a 1.0 MGD plant flow is used. This is approximately the 50th percentile (median) flow and representative of the typical POTW plant flow (the 75th percentile flow was only 3.0 MGD). Twenty-one POTWs receiving industrial discharge had a plant flow of 1.1 MGD. The median receiving stream flow for the 21 POTWs was 12 MGD at low flow conditions and was used in the analysis to determine the diluted POTW effluent concentration.

Potential water quality impacts on receiving streams were determined using criteria comparisons. The POTW effluent pollutant concentrations calculated using Equation 1 were compared to acute aquatic criteria/toxicity levels to determine impacts in the mixing zone.

Equation 1:

POTW Effluent (ug/l) = POTW Influent (ug/l) x (1-Treatment Removal Efficiency)

A calculated instream diluted POTW effluent concentration using Equation 2 was compared to chronic aquatic life criteria/toxicity levels, human health criteria, and drinking water standards.

Equation 2:

$$\text{In-Stream Diluted POTW Effluent (ug/l)} = \frac{\text{POTW Effluent (ug/l)} \times \text{POTW Flow (MGD)}}{\text{POTW Receiving Stream Flow (MGD)}}$$

Impacts on POTW operations were calculated in terms of inhibition of POTW processes and contamination of POTW sludges. Inhibition of POTW operations were determined by comparing POTW influent levels (Equation 3) with inhibition levels, when available.

Equation 3:

$$\text{POTW Influent (ug/l)} = \text{Average Plant Concentration} \times \frac{\text{Total Industry Flow (MGD)}}{\text{POTW Flow (MGD)}}$$

Contamination of sludge (thereby limiting its use) was evaluated by comparing projected pollutant concentrations in sludge (Equation 4) with sludge contamination levels, when available.

Equation 4:

Pollutant Concentration in Sludge (mg/kg) = POTW Influent (ug/l) x Partition Factor x Tmt. Removal Efficiency x 5.96 x Conversion Factors

The partition factor is a measure of the tendency for the pollutant to partition in sludge when it is removed from wastewater. For metals, this factor was assumed to be one. For predicting sludge generation, the model assumed the Metcalf and Eddy rule of thumb that 1,400 pounds of sludge is generated for every million gallons of wastewater processed. This results in a sludge generation factor of 5.96 (that is, for every 1 ppb of pollutant removed, the concentration in sludge is 5.96 ppm dry weight).

To evaluate the significance of pollutant loadings from untreated indirect discharges, loading comparisons from indirect dischargers were

performed using the same approach as with the direct dischargers. The total raw waste priority pollutant organic and inorganic loadings were compared to the total raw waste pollutant loadings from regulated industries with Pretreatment Standards for Effluent Sources (PSES).

8.2 RESULTS OF ENVIRONMENTAL ASSESSMENT

This industry discharges 78 pollutants, of which 57 were detected at levels that may be harmful to human health and/or aquatic life if discharged untreated directly into surface waters. Of these 57 pollutants, 26 would exceed human health criteria (10 for carcinogenicity protection, 16 for human toxicity protection), 27 would exceed acute, short-term aquatic life criteria/toxicity levels, and 50 would exceed chronic or long-term aquatic criteria/ toxicity levels. In addition, 17 pollutants in untreated effluents are discharged at levels exceeding EPA (existing or proposed) drinking water criteria. Most of the 57 pollutants have both human health and aquatic life impacts. Appendix E presents the results of a detailed assessment of the impacts of direct discharges on aquatic life and human health criteria. Appendix F presents the results of a detailed assessment of the impacts of indirect discharges on aquatic life and human health criteria. Both appendices also show pollutant-by-pollutant loadings.

Untreated direct discharges of the most toxic pollutant, azinphos methyl (pesticide), alone would require more than 16,000 MGD of receiving stream flow to dilute discharge concentration below levels harmful to aquatic life. To eliminate the human health impacts of the carcinogen heptachlor, a receiving stream flow of more than 3,000 MGD is required. The potential drinking water impacts from discharge of the carcinogen 1,1-dichloroethene are projected for stream flows up to 11 MGD.

Indirect discharges of untreated wastewater were evaluated using a model 1 MGD POTW (the median size of POTWs with indirect industrial dischargers). Indirect dischargers are not expected to inhibit POTW treatment, or have an impact on POTW sludges (based on limited POTW inhibition data and sludge criteria), but may cause POTWs to exceed human health criteria in receiving streams for four pollutants (all carcinogens), drinking water

criteria for one pollutant, and aquatic criteria/toxicity levels (acute and chronic) for seven pollutants.

Environmental impacts of treated effluents from direct and indirect dischargers were not projected because of the lack of data.

The discharge flow for this industry is small, averaging 3,000 gallons per day per plant. The total direct discharge flow is 150,000 gallons per day, and the total indirect discharge flow is 600,000 gallons per day.

Total loadings of priority pollutant inorganics from direct discharge (61 lbs/day), and indirect discharge (244 lbs/day), are low, when compared to too low raw waste loadings of priority inorganics from regulated BAT/PSES industries (e.g., comparable to regulated industries with lowest raw waste loadings). Total direct and indirect discharge of priority pollutant organics from untreated wastewaters (339 lbs/day and 1,356 lbs/day, respectively), is more significant when compared to the raw waste loadings from regulated industries (e.g., comparable to the pollutant loadings in the lower third).

8.3 NON-WATER QUALITY ENVIRONMENTAL IMPACTS

The elimination or reduction of one form of pollution may create or aggravate other environmental problems. Therefore, Sections 304(b) and 306 of the CWA require EPA to consider non-water quality environmental impacts of certain regulations. In compliance with these provisions, EPA has considered the effect of possible regulations on air pollution, solid waste generation, and energy consumption. The non-water quality environmental impacts associated with this regulation are described below.

8.3.1 Air Pollution

Implementation of the model cost technology, air flotation, would result in a net reduction of air emissions. This conclusion is based on information developed during a study of dissolved air flotation (DAF) systems used in the petroleum refining industry (USEPA 1985). Installation of fixed roofs on DAF systems was shown to result in a 69 percent reduction in volatile organic carbon (VOC) emissions compared with uncovered systems. Collection of VOC

emissions and venting to a control device was shown to result in 95 percent reduction. Similar percent reductions are potentially achievable in the drum reconditioning industry, although data are not available to accurately estimate the VOC mass potentially reduced.

8.3.2 Solid Waste

EPA considered the effect that implementation of the model control technology could have on the production of solid waste, including hazardous waste defined under Section 3001 of the Resource Conservation and Recovery Act (RCRA). EPA estimates that increases in total solid waste of 9,700 metric tons of sludge per year, including hazardous waste, resulting from implementation of the model technology, will double current levels (SAIC 1987). The Agency included sludge incineration in the estimated engineering costs of compliance for any incremental sludge generated by the model treatment systems. Therefore, the net residual solid waste, in the form of ash, will be negligible.

8.3.3 Energy Requirements

EPA estimated that implementation of the model control technology would double energy consumption from present industry use, since only half of the industry is believed to have any technology currently in place. With the exception of sludge incineration, the estimated increased energy consumption is 250 barrels of No. 2 fuel per year (SAIC 1987). The energy consumption associated with incineration is assumed to be small, since air flotation sludges are composed of oil, greases, and other organics that have high-energy values.

Such sludges can be used in fuel blends in existing furnaces, and therefore, disposal costs are minimal.

8.4 SUMMARY

The following list summarizes the major points that were discussed in this section:

- Total loadings of priority pollutant inorganics from untreated wastewater are low when compared to raw waste loadings of priority inorganics from regulated BAT/PSES industries.

- Total loadings of priority pollutant organics from untreated wastewater are significant when compared to raw waste loadings from regulated industries.

- Implementation of the model cost technology would result in a net reduction of air emissions, a doubling of the volume of sludge generated from wastewater treatment systems, and a doubling of energy consumption.

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APPENDIX A. DEPARTMENT OF TRANSPORTATION LIST OF 770 DRUM RECONDITIONERS