furnace, they are either air-cooled of water-quenched. About 40 percent of burning plants have the capability to quench, but not all this capability use all of the time. Some burning plants only operate the water quencher when smoky drums are being burned, or when there is a visible emission from the drum outlet opening.

The next two operations are shot blasting and dedenting, which can occur in either order. Shot blasting is essentially the same as for washing plants, except that burned drums (open-head) are shot blasted inside and out. Dedenting is different for burning operations than in washing plants. Open-head drums are dedented mechanically with an expander dedenter. In some plants, dust from shot blasting is removed by vibration, and is removed by a washing step in other plants. A few plants incorporate a step where an rust inhibitor is applied in water spray. This is not done when the drum is intended to have an interior liner.

After shot blasting and dedenting, the bottom chime is sealed on a chime roller. Then the drum is leak tested and inspected. Leak testing is similar to the testing conducted for tight-head drums, except instead of an expandable plug for a bung hole, a cap for the entire head is used. When leaks are detected, the drums are set aside for repair or discard.

After drying, drums receive an interior coating (epoxy and phenolic linings) and the outsides are painted. These finishes usually are baked on. Effective use of heat is made in some instances where the first bake for the interior coating is the preheat for the painting booth. Upon placement of the lid and ring, the drum is ready to be shipped.

4.3 INDUSTRY SUBCATEGORIZATION

The primary purpose of industry subcategorization is to establish groupings within the drum reconditioning industry such that each has a uniform set of effluent limitations. This requires that the elements of each group be capable of using similar treatment technologies to achieve effluent limitations. Thus, the same wastewater treatment and control technology is

applicable within a subcategory and a uniform treated effluent results from the application of a specific treatment and control technology.

The information presented in this section demonstrates that product type is a dominant aspect that can be used to subcategorize the industry with respect to wastewater generation, control, treatment, and discharge. Product type includes open- or tight-head drums. Drum type forces the reconditioning process selection. Reconditioning processes include burning for open-head drums and washing for either steel or plastic tight-head drums.

4.4 SUMMARY

- Steel and polyethylene drums are reconditioned for reuse at 450 facilities located throughout the Nation. The U.S. EPA Region with the largest number of reconditioners is Region 4, with 24 percent of Nation's facilities. New Jersey, California and Illinois are the states with the largest numbers of reconditioners.

- The status of the industry's wastewater discharges is as follows:

Discharge Status	Number of Facilities
Direct Discharge	50
Indirect Discharge	200
Zero Discharge	200
Total	450

- Drum reconditioning facilities are registered under 28 different SIC Codes. Two-thirds of the 40 million drums reconditioned, annually, are tight-head drums that are washed with caustic solution to remove residues. The remaining are open head drums that are burned in furnaces to remove viscous residues. The following list summarizes the major drum types received by reconditioners:

Drum Type	Percent
Petroleum	36
Chemicals	25
Resins and Adhesives	16
Paint and Ink	15
Other	8
Total	100

- Drum reconditioning facilities may be subcategorized by drum type: either open head or closed head.

5. WATER USES AND WASTEWATER CHARACTERIZATION

This section describes sources, volumes, and characteristics of wastewaters that are generated by drum reconditioning processes. Summary data are presented that can be used to characterize wastewater generated at an average facility. Also presented is a discussion of analytical methodology and factors affecting the recovery of pollutants and their quantification.

5.1 WATER USAGE

5.1.1 Tight-Head Drum Processing

Water is used in most stages of the tight-head drum washing process and the degree of water usage varies among facilities. In 1979, respondees to the National Barrel and Drum Association (NABADA) questionnaire indicated that their water use rate averaged 13.3 gallons per drum (Touhill 1981a). The U.S. Environmental Protection Agency (EPA) collected usage data from 10 facilities in 1987 and calculated an average water usage rate of 10 gallons per drum. The usage rates range from 2 to 30 gallons per drum. There is no apparent correlation of water usage rate to facility size (SAIC 1987b).

5.1.2 Open-Head Drum Processing

Water is used primarily in the quenching stage of the open-head drum burning process. Some water is used in other stages, but to a much lesser degree. In 1979, respondees to the NABADA questionnaire indicated that their water use rate averaged 10.9 gallons per drum. EPA collected usage data from two facilities in 1987 and calculated an average water usage rate of 10.6 gallons per drum. The facility usage rates were 5.2 and 16 gallons per drum, respectively (SAIC 1987b).

5.2 WASTEWATER SOURCES

5.2.1 Tight-Head Drum Processing

Wastewater generated by tight-head drum washing processes is largely the result of direct contact of water washes, rinses, and sprays with drums and their contents. The Agency estimates that approximately 15 percent of the water used in tight-head plants is lost to evaporation; therefore, 9 gallons of wastewater are generated and discharged per drum. This generation rate is

the result of the comingling of numerous internal wastestreams, which may be classified as follows: caustic wash, rinse water, and combined plant discharges. Each of the three classes is described below.

- o Caustic Wash - This wastestream is generally recycled for reuse after screening and sedimentation. It results from preflushing, chaining, and caustic flushing.
- o Rinse Water - This wastestream usually is discharged to the sewer, but is sometimes treated and used as make up to the caustic wash system. It results from rinsing, rerinsing, leak testing, and siphon drying. Acid washing and corrosion inhibition wastewaters generally are recycled, but are sometimes discharged with rinse wastestreams.
- o Combined Plant - Discharges This wastestream usually is discharged to the sewer, but is sometimes treated and used as make up to the caustic wash system. It results from the combination of discharged caustic washes, rinses waters, air pollution scrubber blowdown, paint booth water curtain blowdown, boiler blowdown, cooling water sanitary wastewater, and runoff.

5.2.2 Open-Head Drum Processing

Water quenching, or furnace quenching, is unique to the open-head process and is the primary source of wastewater. Other wastewaters generated in the open-head process are similar to those found in the combined plant discharges generated at tight-head plants. These wastewaters include air pollution scrubber blowdown, paint booth water curtain blowdown, cooling water, sanitary wastewater, and runoff. EPA estimates that most of the water used in the quenching process is lost to evaporation and an average 2.8 gallons of wastewater is generated per drum (SAIC 1987b).

5.2.3 Industry Wastewater Flow

To estimate the total mass of pollutants discharged by this industry, a facility flow must be selected that is representative of industry practice. Some plants wash tight-head drums and some burn open-head drums, while other plants conduct both activities. If 50 million drums were reconditioned in 1986, then 427 drums were reconditioned daily per plant, assuming that each

plant operates 260 days per year. Since two-thirds of the drums reconditioned are tight-head drums, the following flow can be estimated for a statistically average drum plant: 2/3 x 9 gallons per tight-head + 1/3 x 2.8 gallons per open-head = 6.9 gallons per drum.

An average daily plant discharge can be calculated as the product of 427 drums times 6.9 gallons, or 3,000 gpd per facility. For the estimated 250 drum reconditioners that discharge wastewater, the total industry discharge is 0.75 million gallons per day.

5.3 WASTEWATER CHARACTERIZATION

Since most drum reconditioners accept a wide range of drum types, wastewater characteristics vary from month to month. Only a few drum reconditioners are dedicated to reconditioning a single drum type. For example, EPA visited one plant that only reconditioned petroleum drums and another that only reconditioned paint drums. Generally, however, the mix of drum types at a plant shifts with cyclical economic trends and the daily marketplace.

Data are available that can be used to characterize quantitatively drum reconditioning wastewater pollutants. Recent sampling and analysis conducted by the Industrial Technology Division (ITD) of EPA is the most comprehensive and representative data available. ITD sampled four facilities, which collectively represent the industry. Analyses were conducted for over 400 parameters, which include conventional and nonconventional pollutants, metals, and volatile and extractable organics, dioxins/furans, and pesticides/herbicides. Less comprehensive data are available from other sources that are compared to ITD data later in this section. In 1979, in response to the NABADA survey, wastewater analyses were compiled and reported (Touhill 1981a). In 1981, the EPA Office of Research and Development (ORD) conducted wastewater sampling and analyses at three drum reconditioning facilities as part of an impact assessment of multi-media emissions (Touhill 1981b). The results of these various data-gathering efforts are summarized below.

5.3.1 EPA ITD Sampling Data

EPA ITD conducted presampling site visits at 16 drum reconditioners to select candidates for its wastewater and sludge sampling program. Four facilities were selected for sampling, since they are representative of the industry in terms of plant size, types of drums reconditioned, and wastewater flow. Each of the four facilities treats wastewater prior to discharge. Capsule descriptions of each facility, identified here as Plants A, B, C, and D, are presented below.

- Plant A is a medium-sized drum washing plant that processes 900 drums per day. Drum types processed are petroleum (60 percent), solvent (30 percent), and others. No caustic wash is recycled. All process wastewater is treated by oil/water separation prior to discharge. The sampled wastestream did not contain nonprocess wastes such as boiler blowdown and sanitary wastewater.

- Plant B is a small washing plant that only reconditions 200 drums per day, 95 percent of which are paint drums. Caustic wash is recycled. All process wastewater is treated by air flotation prior to discharge. The sampled, untreated wastestream did not contain nonprocess wastewater.

- Plant C is small washing plant that only reconditions 100 petroleum drums per day. Process wastewater is treated by sedimentation prior to discharge. Caustic wash is recycled after sedimentation. The sampled, untreated wastestream did not contain nonprocess wastewater.

- Plant D is a large facility that washes 3,000 drums per day and burns 3,000 drums per day. The tight-head drums washed are petroleum, (30 percent), chemicals (30 percent), resins (20 percent), paint (10 percent), and others. The open-head drums processed are paint (80 percent), adhesives (10 percent) and others. Caustic wash is recycled after sedimentation and screening. Quench water from the burning process is comingled with wastewater from the washing operation. Quench water constitutes 26 percent of the total flow to the facility's air flotation treatment system. No nonprocess wastestreams, such as boiler blowdown or sanitary wastewater, are comingled with process wastewater. Treated process wastewater is recycled for reuse as caustic wash make up water, since much of the caustic wash is lost to evaporation.

Plants A, B, C, and D are representative of typical industry practice with respect to wastewater flow and drum type. The respective plant flows are 13,700 gpd, 2,700 gpd, 300 gpd, and 15,000 gpd. The total flow is 32,450 gpd or 4.5 gallons per drum. This estimate is only 35 percent less than the

6.9 gallon per drum flow estimated in Section 5.2. About 4,000 gpd, or 12 percent of the total flow is attributable to open-head processing. As mentioned in Section 5.2, a statistically average drum plant discharges 6.9 gallons per drum, of which 0.9 gallons, or 14 percent, is attributable to open-head processing. Since these values compare closely, EPA believes that its summarized pollutant data represent industry raw wastewater. In addition, the percentage of drum types reconditioned at Plants A, B, C, and D compare well with the industry wide distribution shown in Table 4-1.

5.3.1.2 Raw Wastewater

The facilities mentioned above were sampled for internal wastestreams, treated effluent, and wastewater treatment sludges, in addition to raw wastewater. Only raw wastewater characteristics are discussed here. Treated effluent characteristics and internal wastestreams are discussed in Section 6. Sludge characteristics are discussed in Section 8. The samples were analyzed for conventional, nonconventional, and priority pollutants, as well as compounds on the ITD List of Analytes. The discussion below focuses on the analytical fractions reported for all of the untreated, raw wastewater samples collected by ITD. These fractions are: (1) conventionals and nonconventionals, (2) volatile and extractable organics, (3) metals, and (4) pesticides/herbicides.

Nine raw wastewater samples were taken at four facilities. From these nine samples, an industry mean concentration is calculated as the mean of plant means.

- Conventionals and Nonconventionals - Raw wastewaters sampled by EPA ITD exhibited a pH greater than 11.0 and high levels of all of the parameters listed in Table 5-1. The mean (BODs) is 374 mg/l; total suspended solids (TSS) is 4,708 mg/l; and oil and grease is 13,227 mg/l. The high concentrations reflect the fact that 10 gallons of wastewater typically are generated per drum and each drum is permitted by 40 CFR 261.7 to contain up to 1 inch, about 1.6 gallons, of residue.

- Volatile and Extractable Organics - The data in Table 5-2 show that 42 extractable and volatile organic compounds were detected at the 4 plants sampled. The compounds detected at more than two plants are 1,1,1-trichloroethane, 2-butanone (MEK), 2-chlononaphthalene, benzoic acid, benzyl alcohol, biphenyl, ethylbenzene, hexanoic acid,

TABLE 5-1
EPA-ITD SAMPLING PROGRAM
COMPARISON OF RAW WASTEWATER

FRACTION : CONVENTIONALS AND NONCONVENTIONALS

SAMPLE POINT: RAW WASTEWATER

PARAMETER	UNITS	A	B	B	C	D	D	D	D	D	MEAN
PLANT NO.		A	B	B	C	D	D	D	D	D	
EPISODE NO.		1128	1130	1130	1133	1179	1179	1179	1179	1179	
SAMPLE NO.		15339	15344	15348	15357	15713	15715	15718	15722	15725	
SAMPLE DATE		Jul 23, 1986	Aug 6, 1986	Aug 7, 1987	Sep 18, 1986	Feb 2, 1987	Feb 3, 1987	Feb 4, 1987	Feb 5, 1987	Feb 6, 1987	
AMMONIA	mg/l	13	22.5	9.0	.10	6.59	16.1	5.53	2.25	11.8	9.3
BOD-5, TOTAL	mg/l	3900	2200	418	720	16800	7500	10900	6300	3140	3714.2
BOD5, DISSOLVED	mg/l	1980	2550	2160	480	9000	4400	4640	2790	4710	2480.7
CHLORIDE	mg/l	50	1500	1400	200	2800	5100	4200	3200	3400	1360.0
COD, DISSOLVED	mg/l	3140	3860	4400	800	45500	26400	15100	19000	22800	8457.5
COD, TOTAL	mg/l	6110	3860	5400	1330	75600	38100	102000	31800	40600	17422.5
DISSOLVED SOLIDS	mg/l	8850	5710	8940	21000	29900	27200	28200	20000	18800	15498.7
FLUORIDE	mg/l	30	40	15	26	89.7	59	53	37.3	29	34.3
OIL & GREASE	mg/l	3240	4810	2940	34000	12900	5600	33000	4940	2540	13227.7
PHENOL	mg/l	1.61	1.51	92	2.2	169	87.4	68.8	64.7	53.2	34.8
SUSPENDED SOLIDS	mg/l	4980	1850	780	20	21800	9270	20600	5220	5710	4708.7
SUSPENDED VOL SOLIDS	mg/l	880	63	50	8	16000	4033	15500	2675	4700	2381.5
TKN	mg/l	5	1.75	46	1.6	428	270	257	20.2	291	70.9
TOTAL CYANIDE	mg/l	8.3	1.9	.66	6.8	.57	.48	.58	.48	.85	4.2
TOTAL ORGANIC CARBON	mg/l	1520	1600	210	269	19300	8500	7200	5650	5690	2990.5
TOTAL VOL SOLIDS	mg/l	3200	3170	1175	392	29940	14280	26370	9880	10590	5934.1
pH			12.6	12.7	11.4	12.4	12.6	12.6	12	12	

NOTE: BLANK = NO VALUE REPORTED
MG/L = MILLIGRAMS PER LITER
UG/L = MICROGRAMS PER LITER
PPT = PARTS PER TRILLION
MEAN = MEAN OF PLANT MEANS

TABLE 5-2
EPA-ITD SAMPLING PROGRAM
COMPARISON OF RAW WASTEWATER

FRACTION : EXTRACTABLE AND VOLATILE ORGANICS

SAMPLE POINT: RAW WASTEWATER

PARAMETER	UNITS	A	B	B	C	D	D	D	D	D	MEAN
PLANT NO.		A	B	B	C	D	D	D	D	D	
EPISODE NO.		1128	1130	1130	1133	1179	1179	1179	1179	1179	
SAMPLE NO.		15339	15344	15348	15357	15713	15715	15718	15722	15725	
SAMPLE DATE		Jul 23, 1986	Aug 6, 1986	Aug 7, 1987	Sep 18, 1986	Sep 18, 1986	Feb 3, 1987	Feb 4, 1987	Feb 5, 1987	Feb 6, 1987	
O-CRESOL	UG/L		143	37							90
1,1,1-TRICHLOROETHANE	UG/L	355				36179	11825	71513	25035		2920
1,1-DICHLOROETHENE	UG/L					25286					25286
1,2-DICHLOROETHANE	UG/L								315		315
2,4-DINITROTOLUENE	UG/L				11						11
2-BUTANONE (MEK)	UG/L	534		1361630		987133		18823		1351260	743987
2-CHLORONAPHTHALENE	UG/L	4609	46	46							1567
2-METHYLNAPHTHALENE	UG/L			24							24
2-NITROPHENOL	UG/L							3256	2739	2866	2954
ACETONE	UG/L					496139	677250		2046290	209456	857784
ALPHA-TERPINEOL	UG/L	4745									4745
BENZOIC ACID	UG/L			94999	230						47615
BENZYL ALCOHOL	UG/L			59		9817				9051	6309
BIPHENYL	UG/L		14		71	1266		1394			686
BIS (2-ETHYLHEXYL) PHTHALATE	UG/L					5419	43747	43078	9285	5718	21449
BUTYL BENZYL PHTHALATE	UG/L							3281			3281
DI-N-BUTYL PHTHALATE	UG/L					2088		13561		5012	6887
DIPHENYL ETHER	UG/L							2457			2457
ETHYLBENZENE	UG/L	221	3179		110	186495		75039	7857	62143	47863
FLUORENE	UG/L				12						12
HEXANOIC ACID	UG/L		383		1165						774
ISOBUTYL ALCOHOL	UG/L		3517								3517
ISOPHORONE	UG/L					5392	25392	3371		22038	14048
METHYLENE CHLORIDE	UG/L				4197		15443				9820
N-DECANE (N-C10)	UG/L	11750									11750
N-DOCOSANE (N-C22)	UG/L								3424	12309	7867
N-DODECANE (N-C12)	UG/L	6952									6950
N-HEXADECANE (N-C16)	UG/L	1066							1178		1122
N-OCTACOSANE (N-C28)	UG/L								28081		28081
N-OCTADECANE (N-C18)	UG/L					3983		13354			8669
N-TETRADECANE (N-C14)	UG/L						44127		5754		24941
NAPHTHALENE	UG/L		382		174	8842	17954	5503	2775		5938
NITROBENZENE	UG/L		16		12						14
P-CYMENE	UG/L		72	49	83			1996			550
PHENANTHRENE	UG/L								11577		11577
PHENOL	UG/L					932					932
STYRENE	UG/L		144	98		34620	30372	18836		4850	14837
TETRACHLOROETHENE	UG/L							86267			86267
THIOXANTHONE	UG/L		311								311
TOLUENE	UG/L	507	55572	262	25	107977		42672	6159	54123	33412
TRANS-1,2-DICHLOROETHENE	UG/L								917		917
TRICHLOROETHENE	UG/L	95			13			4038	1278	4575	2476

NOTE: BLANK = NO VALUE REPORTED
MG/L = MILLIGRAMS PER LITER
UG/L = MICROGRAMS PER LITER
PCT = PARTS PER MILLION
MEAN = MEAN OF INDIVIDUAL SAMPLES

methlenechloride, naphthalene, n-hexadecane, nitrobenzene, p-cymene, styrene, toluene, and trichloroethene. Means greater than 10 mg/l appear for one-third half of the detected pollutants. The two highest means are 2-butanone at 744 mg/l, and acetone at 858 mg/l.

- Metals - The data in Table 5-3 show high levels for numerous metals in the raw wastewater. Seven of the 27 compounds are detected at levels over 10 mg/l. These are aluminum, iron, lead, magnesium, sodium, calcium, and zinc. In addition to the quantitative analyses, qualitative analyses were run to determine the presence of additional metals. Results are shown in Table 5-4. Only iodine, phosphorus, potassium, and sulfur are detected at more than one plant.

- Pesticides/Herbicides - Analyses were conducted for 99 pesticide/herbicide parameters on samples collected from Plants A, B, and C. No pesticides or herbicides were detected. Two samples were collected at Plant D and a total of 10 parameters were detected as shown in Table 5-5. The following compounds were detected at levels greater than 1.0 mg/l: azinphos ethyl, azinphos methyl, fensulfothion, diazinon, dimethoate, and leptophos.

5.3.1.2 Quench Water

A sample of quench water was obtained from Plant D to characterize raw wastewater generated by open-head processes. As mentioned previously, this wastewater is combined with tight-head process wastestreams at Plant D and is reflected in the data presented in Tables 5-1 through 5-5. The data discussed here are for a segregated wastewater flow of 2.7 gallons per drum. The open-head drum types reconditioned were paint (90 percent) and adhesives (10 percent). The discussion below focuses on the analytical fractions reported and comparisons are made between open-head and tight-head wastewater.

- Conventional/Nonconventional Parameters - The open-head process wastewater exhibits high levels of all of the parameters listed in Table 5-6. The levels are high and are in general only slightly less than the levels reported for tight-head process wastewater. The pH level is lower at 8.2. The high levels reflect the fact that water in the open-head process is only used to extinguish burning residue on drums after incineration. Values for selected parameters are presented below to demonstrate the comparability of the tight-head and open-head process wastewaters.

TABLE 5-3
EPA-ITD SAMPLING PROGRAM
COMPARISON OF RAW WASTEWATER

FRACTION : METALS

SAMPLE POINT: RAW WASTEWATER

PARAMETER	UNITS	A	B	B	C	D	D	D	D	D	MEAN
PLANT NO.		A	B	B	C	D	D	D	D	D	
EPISODE NO.		1128	1130	1130	1133	1179	1179	1179	1179	1179	
SAMPLE NO.		15339	15344	15348	15357	15713	15715	15718	15722	15725	
SAMPLE DATE		Jul 23, 1986	Aug 6, 1986	Aug 7, 1987	Sep 18, 1986	Feb 2, 1987	Feb 3, 1987	Feb 4, 1987	Feb 5, 1987	Feb 6, 1987	
ALUMINUM	UG/L	7800	9900	9400	3100	90800	71700	61300	37900	36100	20027.5
ANTIMONY	UG/L	562	16	15	41	33600	9780	10200	6820	6140	3481.6
ARSENIC	UG/L	31	20	23	18	500	62	72	16	78	54.0
BARIUM	UG/L	2600	1800	1500	89	1230	2200	1500	7510	5260	1969.7
BERYLLIUM	UG/L	50	1	1	2	7	5	5	5	5	14.6
BORON	UG/L	880	34	13	480	7700	6100	7270	6320	7390	2084.9
CADMIUM	UG/L	29	7	6	7	695	285	4690	1340	883	405.3
CALCIUM	UG/L	47000	26000	21000	9200	120000	77000	97000	40600	50000	39155.0
CHROMIUM	UG/L	6700	1000	830	630	6430	3360	4720	3420	4120	3163.7
COBALT	UG/L	210	140	120	68	1700	760	1170	1090	1320	484.0
COPPER	UG/L	1400	400	390	250	4810	4780	5940	2640	3240	1581.7
IRON	UG/L	10000	46000	40000	9000	693000	201000	529000	180000	216000	106450.0
LEAD	UG/L	27000	2400	2400	3300	37600	18200	34600	16500	19300	14485.0
MAGNESIUM	UG/L	14000	7600	6100	3900	40400	22600	28300	11600	13800	12022.5
MANGANESE	UG/L	700	2100	1800	63	5130	3250	6890	2510	2720	1703.2
MERCURY	UG/L	0.2	1.3	1.1	.5	41	20	28	8.5	10	5.8
MOLYBDENUM	UG/L	340	100	110	280	853	1040	1880	1540	2230	558.4
NICKEL	UG/L	120	34	36	16	991	376	1030	363	419	201.7
SELENIUM	UG/L	5	25	25	11	5	50	5	5	5	13.7
SILVER	UG/L	1	1	1	1	18	8.4	5.7	1	7.3	2.8
SODIUM	UG/L	1800000	1500000	1800000	9000000	8800000	9090000	9510000	7290000	6720000	5183000.0
THALLIUM	UG/L	10	10	10	10	100	100	50	50	50	25.0
TIN	UG/L	240	120	150	230	5730	4190	6390	5620	4230	1459.2
TITANIUM	UG/L	59	700	580	24	2610	860	1190	577	666	475.9
VANADIUM	UG/L	12	60	59	2	82	50	95	50	50	34.7
YTTRIUM	UG/L	10	10	10	10	50	50	50	50	50	20.0
ZINC	UG/L	13000	17000	18000	3300	80400	54300	108000	44300	43500	24975.0

NOTE: BLANK = NO VALUE REPORTED
MG/L = MILLIGRAMS PER LITER
UG/L = MICROGRAMS PER LITER
PPT = PARTS PER TRILLION
MEAN = MEAN OF PLANT MEANS

TABLE 5-4. EPA ITD SAMPLING PROGRAM COMPARISON OF PROCESS WASTEWATER

FRACTION: SUPERSCAN METALS
SAMPLE POINT: RAW WASTEWATER

Metal	Plant Code			
	A	B	C	D
Bismuth		D		
Cerium				
Dysprosium		D		
Erbium		D		
Europium				
Gadolinium				
Gallium				
Germanium		D		
Gold				
Hafnium				
Holminum				
Indium				
Iodine	D			D
Iridium				D
Lanthanum				D
Lithium				D
Lutatium				D
Neodymium				
Niobium				
Osmium				
Palladium				
Phosphorus	D	D	D	D
Platinum				D
Potassium	D	D		D
Praseodymium				
Rhenium				
Rhodium				
Ruthenium				
Samarium				
Scandium				
Silicon				D
Strontium				D
Sulfur	D	D	D	D
Tantalum				
Tellurium				
Terbium				

TABLE 5-4. EPA ITD SAMPLING PROGRAM COMPARISON OF PROCESS WASTEWATER

FRACTION: SUPERSCAN METALS
SAMPLE POINT: RAW WASTEWATER

Metal	Plant Code			
	A	B	C	D
Thorium				
Thulium				
Tungston		D		
Uranium				
Ytterbium				
Zirconium				D

Notes: D = Detected
Blank indicates Not Detected.

TABLE 5-5. EPA-ITD SAMPLING PROGRAM COMPARISON OF RAW WASTEWATER

FRACTION: PESTICIDES/HERBICIDES
SAMPLE POINT: RAW WASTEWATER

PLANT:		D	D
EPISODE NO.:		1179	1179
SAMPLE NO.:		15713	15718
SAMPLE DATE:		FEB. 2, 1987	FEB. 4, 1987
PARAMETER	UNITS		
Endosulfan I	µg/l	296	--
Endosulfan Sulfate	µg/l	--	528
Heptachlor	µg/l	284	--
Etridazone	µg/l	252	--
Azinphos Ethyl	µg/l	4260	--
Azinphos Methyl	µg/l	6207	4689
Fensulfothion	µg/l	5795	7859
Diazinon	µg/l	--	1035
Dimethoate	µg/l	--	1500
Leptophos	µg/l	--	3959

NOTE: Blank = no value reported
µg/l = Micrograms per liter

TABLE 5-6
EPA-ITD SAMPLING PROGRAM

FRACTION : CONVENTIONALS AND NONCONVENTIONALS

PARAMETER	UNITS	PLANT NUMBER: D SAMPLE POINT: FURNACE QUENCH SAMPLE NO. 15720 SAMPLE DATE Feb 5, 1987	RAW WASTEWATER MEAN
AMMONIA	mg/l	33	9
BOD-5, TOTAL	mg/l	2600	3714
BOD 5, DISSOLVED	mg/l	1520	2480
CHLORIDE	mg/l	333	1360
COD, DISSOLVED	mg/l	18000	8457
COD, TOTAL	mg/l	51900	17422
DISSOLVED SOLIDS	mg/l	6170	15498
FLUORIDE	mg/l	10.8	34
OIL & GREASE	mg/l	5300	13227
PHENOL	mg/l	38.7	34
SUSPENDED SOLIDS	mg/l	9470	4708
SUSPENDED VOL SOLIDS	mg/l	13600	2381
TKN	mg/l	564	70
TOTAL CYANIDE	mg/l	.28	4
TOTAL ORGANIC CARBON	mg/l	4040	2990
TOTAL VOL SOLIDS	mg/l	19100	5994
PH	mg/l	8.2	11

NOTE: MG/L = MILLIGRAMS PER LITER
UG/L = MICROGRAMS PER LITER
PPT = PARTS PER TRILLION

	Concentration (mg/l)	
	Tight-Head	Open-Head
BOD_5	374	2,600
COD, total	17,422	51,900
TSS	4,708	9,470
Oil and Grease	13,227	5,300
TOC	2,990	4,040

- Volatile and Extractable Organics - The data in Table 5-7 show that 14 volatile and extractable compounds were detected and 13 were measured at levels over 1.0 mg/l. Most of the compounds detected are also found in open-head process wastewater; however, 4-methyl-2-pentanone and o-cresol are not. The two highest measurements are for methylene chloride at 103 mg/l and 2-butanone (MEK) at 67 mg/l.

- Metals - The data in Table 5-8 show that metals are found at high levels in quench water as they are in tight-head process wastewater. Eight of the 27 compounds are detected at levels over 10 mg/l. These are aluminum, calcium, chromium, iron, lead, magnesium, sodium, and zinc. Except for chromium, the same is true for tight-head process wastewater. A qualitative metals analysis showed that iodine, lithium, phosphorus, potassium, silicon, strontium, and sulphur were present. These compounds also are present in drum washing wastewater.

- Pesticides/Herbicides - Two pesticide/herbicide compounds were detected. These are heptachlor at 73 µg/l and TEPP at 6,900 µg/l.

- Dioxins/Furans - In addition to the analyses above, analyses also were conducted for dioxins/furans, since these compounds are sometimes associated with high-temperature wastestreams. Of the 25 parameters analyzed for, 17 compounds were detected. Only one compound, OCDD, was detected at a level greater than 100 parts per trillion. Data for all compounds are shown in Table 5-9. No dioxin/furan analyses were conducted on raw wastewater samples.

EPA ITD data presented here for tight- and open-head process wastewaters are representative of the industry wastestreams. In the discussion that follows, other sources of data are presented. Finally, at the end of this section, the EPA ITD data are compared to these other sources.

5.3.2 NABADA Survey Data

Data obtained in the NABADA survey from drum reconditioners are collated in Table 5-10 (Touhill 1981a). The analyses are for a variety of wastewater

TABLE 5-7
EPA-ITD SAMPLING PROGRAM
QUENCH WATER COMPARISON TO RAW WASTEWATER

FRACTION : EXTRACTABLE AND VOLATILE ORGANICS

PLANT NUMBER:	D		
EPISODE NUMBER:	1179		
SAMPLE POINT:	FURNACE QUENCH	RAW WASTEWATER	
SAMPLE NO.	15720	MEAN	
SAMPLE DATE	Feb 5, 1987		

PARAMETER	UNITS		
1,1,1-TRICHLOROETHANE	UG/L	16720	36413
2-BUTANONE (MEK)	UG/L	67663	785924
4-METHYL-2-PENTANONE	UG/L	17787	
ACETONE	UG/L	15630	857784
BENZYL ALCOHOL	UG/L	4636	9434
BIS (2-ETHYLHEXYL) PHTHALATE	UG/L	881	21449
ETHYLBENZENE	UG/L	12130	82884
ISOPHORONE	UG/L	14437	14048
METHYLENE CHLORIDE	UG/L	103233	15443
NAPHTHALENE	UG/L	5345	8769
O-CRESOL	UG/L	2586	
P-CYMENE	UG/L	1002	1996
STYRENE	UG/L	12678	22195
TOLUENE	UG/L	16598	52733

NOTE: MG/L = MILLIGRAMS PER LITER
UG/L = MICROGRAMS PER LITER
PPT = PARTS PER TRILLION
RAW WASTEWATER DATA IS ONLY REPORTED
HERE FOR POLLUTANTS FOUND IN QUENCH WATER

TABLE 5-8
EPA-ITD SAMPLING PROGRAM
QUENCH WATER COMPARISON TO RAW WASTEWATER

FRACTION : METALS

PLANT NUMBER: D EPISODE NUMBER: 1179 SAMPLE POINT:	FURNACE QUENCH	RAW WASTEWATER
SAMPLE NO. SAMPLE DATE	15720 Feb 5, 1987	MEAN

PARAMETER	UNITS		
ALUMINUM	UG/L	47300	20027
ANTIMONY	UG/L	599	3481
ARSENIC	UG/L	10	54
BARIUM	UG/L	5680	1969
BERYLLIUM	UG/L	5	14
BORON	UG/L	7270	2084
CADMIUM	UG/L	734	405
CALCIUM	UG/L	173000	39155
CHROMIUM	UG/L	11700	3163
COBALT	UG/L	3520	404
COPPER	UG/L	1150	1581
IRON	UG/L	47100	106450
LEAD	UG/L	11300	14485
MAGNESIUM	UG/L	29800	12022
MANGANESE	UG/L	1500	1703
MERCURY	UG/L	.8	5
MOLYBDENUM	UG/L	789	558
NICKEL	UG/L	1210	201
SELENIUM	UG/L	25	13
SILVER	UG/L	1	2
SODIUM	UG/L	773000	5183000
THALLIUM	UG/L	50	25
TIN	UG/L	353	1459
TITANIUM	UG/L	781	475
VANADIUM	UG/L	50	34
YTTRIUM	UG/L	50	20
ZINC	UG/L	107000	24975

NOTE: MG/L = MILLIGRAMS PER LITER
UG/L = MICROGRAMS PER LITER
PPT = PARTS PER TRILLION

TABLE 5-9
EPA-ITD SAMPLING PROGRAM
QUENCH WATER COMPARISON TO RAW WASTEWATER

FRACTION : DIOXINS/FURANS

PLANT NUMBER: D EPISODE NUMBER: 1179 SAMPLE POINT:	FURNACE QUENCH	RAW WASTEWATER
SAMPLE NO. SAMPLE DATE	15720 Feb 5, 1987	MEAN

PARAMETER	UNITS		
1234678-HpCDD	PPT	14.69	
1234678-HpCDF	PPT	2.04	
123478-HxCDF	PPT	0.55	
123678-HxCDD	PPT	0.37	
123789-HxCDD	PPT	0.36	
234678-HxCDF	PPT	0.54	
2378-TCDF	PPT	0.21	
OCDD	PPT	202.72	
OCDF	PPT	10.35	
TOTAL HpCDD	PPT	26.41	
TOTAL HpCDF	PPT	6.86	
TOTAL HxCDD	PPT	3.37	
TOTAL HxCDF	PPT	2.65	
TOTAL PCDD	PPT	0.63	
TOTAL PCDF	PPT	1.01	
TOTAL TCDD	PPT	1.19	
TOTAL TCDF	PPT	7.25	

NOTE: MG/L = MILLIGRAMS PER LITER
UG/L = MICROGRAMS PER LITER
PPT = PARTS PER TRILLION
RAW WASTEWATER NOT SAMPLED FOR DIOXINS/FURANS

TABLE 5-10. DRUM RECONDITIONING WASTEWATER DATA OBTAINED THROUGH THE NABADA SURVEY

Parameter (mg/l)	Number of Observations	Mean	Range	
			Low	High
BOD	31	4,599	10	44,133
COD	24	24,549	91.5	310,909
TSS	46	2,435	77	24,000
Phenols	21	43.8	0.044	148
Oil and grease	37	10,228	19.2	248,340
Cadmium	12	0.10	0.0002	0.90
Chromium	26	12.5	0.023	244
Copper	16	2.4	0	23.0
Iron	12	114	1.6	1,041
Lead	29	45.8	0	682
Mercury	11	1.0	0	5.9
Nickel	12	0.3	0	1.0
Zinc	33	24.0	0.1	228

types (e.g., spent caustic, rinse water, and clarified effluents) and thus are indicative only of the ranges of concentrations that might be encountered. The data demonstrate that high levels of BOD, COD, TSS, and oil and grease are present in untreated drum reconditioning wastewater. For example, COD is 24,549 mg/l and oil and grease is 10,228 mg/l. Average levels greater than 10 mg/l are reported for chromium, iron, lead, and zinc.

5.3.3 EPA ORD Sampling Data

In 1981, EPA ORD reported the results of its sampling and analysis of three reconditioning plants that was conducted to define pollutant levels in various wastestreams (Touhill 1981b). The three facilities selected for testing were: (1) a large drum washing plant that recycles most of its caustic washing and rinsing solutions, (2) a large burning and washing plant that recycles caustic wash but discharges rinse water, and (3) a large washing plant that handles substantial volumes of pesticide containers. Each plant is identified as plants E, F, and G respectively. Selected samples at each facility were each analyzed for only a limited fraction of pollutant parameters. Table 5-11 lists the wastestreams sampled and pollutant fractions analyzed for the three plants. The facilities are described in more detail below.

- Plant E is a large drum washing plant that recycles most of its caustic washing and rinsing solutions. During the sampling period, 2,400 drums were processed each 8-hour work day. Of the containers processed, 75 percent were empty oil drums, while the remainder formerly contained paint, varnish, acrylics, and various other chemicals.

- Plant F is a large drum washing and burning plant that recycles caustic washing solutions, but does not recycle rinse water. During the 4-day sampling period at the washing facility, approximately 1,200 to 1,400 drums per day were processed. About 90 percent were empty oil drums, whereas the remainder formerly contained paints, resins, and various chemicals.

- Plant G is a facility that washes pesticide containers. During the 5-day sampling period, approximately 16,000 drums were processed. On the first day of sampling, 468 pesticide drums were washed. A total of 4,000 drums of all types were processed that day. The pesticide drums contained either parathion, diazinon, or nemacur. No pesticide drums were washed during the remaining 4 days of the sampling period. However, all composite samples were analyzed for pesticides to determine concentrations remaining in the caustic washing solution.

TABLE 5-11. EPA ORD STUDY

Wastestream	Drum Washing Wastestreams Sampled and Parameters Measured			
	Plants Sampled for Conventional and Nonconventional Pollutants	Plants Sampled for Metals	Plants Sampled for Organics	Plants Sampled for Pesticides
Spent Caustic Wash	E,F,G	E		G
Clarified Caustic Wash	E,F	E	E,F	-
Caustic Sludge	-	E,G	E,F	-
Ash Quench Water	-	-	F	-
Furnace Ash	-	F	F	-

The analytical results were reported for the following aqueous wastestreams, which are discussed below: (1) spent caustic wash, (2) clarified caustic wash, and (3) quench water. Analytical results for sludge and ash samples are discussed in Section 8.

5.3.3.1 Spent Caustic Wash

Spent caustic wash is a concentrated internal wastestream with a high pH that is the result of the primary washing operations at a drum washing plant. Based on the data presented in Table 5-11 for Plants E, F, and G, an average COD level of 100,000 mg/l can be anticipated. The levels reported for several metals at Plant A are high, especially lead and zinc, which are 227 and 362 mg/l, respectively.

Plant G spent caustic wash was analyzed for three pesticide parameters, since 10 percent of the drums washed at that plant contained pesticides. Five samples were analyzed for diazinon, nemacur and parathion. The average levels measured for the respective parameters were 1.1, 1.7, and 2.4 mg/l.

5.3.3.2 Clarified Caustic Wash

Caustic wash is generally settled, or clarified after polymer addition, prior to reuse. The data in Table 5-12 show high levels of COD and organics in clarified caustic wash waters at Plants E and F. Plants E and F handled drums that previously contained petroleum oils, paints, or organic chemicals. The metals measured in the clarified caustic at Plant E are lower than the levels shown in Table 5-13 for its unclarified caustic wash. This is probably due to the removal of suspended solids by clarification.

5.3.3.3 Ash Quench Water

Water is used to quench burning residue and control potentially airborne ash on drums that have been burned. The organic pollutant data in Table 5-14 show high levels of ethylbenzene, 1,1,1-trichloroethane, and toluene for a quench water sample drawn from Plant F.

TABLE 5-12. EPA ORD STUDY DATA FOR SPENT CAUSTIC WASH PLANTS E, F, AND G

COD (mg/l)

Plant	Sample 1	Sample 2	Sample 3	Average
E	94,300	124,000	-	109,150
F	41,700	386,000	-	213,850
G (Tank #1)	59,800	66,700	83,500	70,000
G (Tank #2)	29,200	30,500	35,500	31,730

Plant E (mg/l)

	Sample 1	Sample 2
Aluminum	59.0	54.2
Antimony	32.9	11.5
Arsenic	2.56	0.596
Barium	3.09	1.79
Beryllium	<0.009	<0.001
Boron	848	535
Cadmium	0.002	0.002
Chromium	0.240	0.330
Cobalt	2.55	2.95
Copper	0.520	0.500
Iron	86.1	46.1
Lead	227	23.6
Magnesium	0.690	<0.001
Manganese	5.26	1.29
Mercury	<0.001	<0.001
Molybdenum	18.9	12.5
Nickel	5.33	7.19
Phosphorus	274	189
Selenium	0.087	0.271
Silicon (%)	13.4	7.68
Strontium	0.120	0.070
Thallium	<0.01	<0.1
Tin	39.0	12.4
Titanium	1.90	3.38
Vanadium	2.34	1.88
Zinc	362	250

TABLE 5-13. EPA ORD STUDY ANALYSIS DATA FOR CLARIFIED CAUSTIC WASH PLANTS E AND F

Concentration (mg/l)

	Plant E		Plant F	
	Sample 1	Sample 2	Sample 1	Sample 2
COD	20,700	22,100	514,000	511,000
Acenaphthene	-	-	<50	100
Anthracene	0.2	0.03	-	-
Aliphatics, C7-18	-	-	150,000	250,000
Phenanthrene Benzene	<0.01	<0.01	-	-
Benzenes, C3-C4	-	-	50,000	74,000
Chlorobenzene	<0.01	<0.01	-	-
2-Chlorophenol	<0.025	<0.025	-	-
Bis-(2-ethylhexyl)-Chrysene	-	-	<50	<320
1,2-Dichlorobenzene	0.02	<0.01	-	-
2,4-Dimethylphenol	1.25	0.29	-	-
Ethylbenzene	0.05	0.08	-	-
Fluoranthene	-	-	70	500
Methylene Chloride	0.02	0.01	-	-
Naphthalene	0.2	0.03	1,500	70,000
n-Nitrosodiphenylamine	1.07	-	-	-
p-chloro-m-cresol	1.52	-	-	-
Phenol	2.62	0.8	-	-
Phenols, total	18.8	14.2	340	330
Pyrene	-	-	100	20
Tetrachloroethylene	<0.01	<0.01	-	-
Silicones	-	-	200	300
Toluene	0.3	0.35	-	-
1,2,4-Trichlorobenzene	-	<0.01	-	-
1,1,1-Trichloroethane	<0.01	<0.01	-	-
Aluminum	54.1	<0.012	-	-
Antimony	10.5	4.48	-	-
Arsenic	0.630	0.494	-	-
Barium	0.970	0.015	-	-
Beryllium	<0.001	<0.001	-	-
Boron	437	55.3	-	-
Cadmium	0.220	<0.002	-	-
Calcium	4.03	14.0	-	-
Chromium	0.510	<0.004	-	-
Cobalt	1.92	0.655	-	-
Copper	0.480	0.525	-	-
Cyanides	4.70	<0.002	2.59	0.915
Iron	40.4	32.6	-	-
Lead	45.4	23.0	-	-
Magnesium	0.010	1.27	-	-
Manganese	0.690	<0.001	-	-
Mercury	<0.001	<0.001	-	-

TABLE 5-13. EPA-ORD STUDY ANALYSIS DATA FOR CLARIFIED CAUSTIC WASH PLANTS E AND F (Continued)

Concentration (mg/l)

	Plant E		Plant F	
	Sample 1	Sample 2	Sample 1	Sample 2
Molybdenum	9.67	8.81	-	-
Nickel	7.29	<0.036	-	-
Phosphorus	179	158	-	-
Selenium	0.146	0.037	-	-
Silicon (%)	0.394	376	-	-
Silver	0.320	<0.005	-	-
Sodium (%)	6.79	7.96	-	-
Strontium	0.020	<0.001	-	-
Thallium	<0.1	<0.1	-	-
Tin	10.8	4.62	-	-
Titanium	0.810	0.335	-	-
Vanadium	1.41	0.360	-	-
Zinc	204	2.07	-	-

TABLE 5-14. EPA ORD STUDY
ANALYTICAL DATA FOR ASH QUENCH WATER
PLANT F

Parameter	Concentration (mg/l)
Benzene	0.04
Ethylbenzene	0.43
Chloroform	<0.01
Chloroethane	0.01
1,1-Dichloroethane	0.03
1,2-Dichloroethane	<0.01
1,1,1-Trichloroethane	0.47
1,1-Dichloroethylene	0.12
Trichloroethylene	0.01
Tetrachloroethylene	0.01
Toluene	6.39
Methylene Chloride	0.11
Trichlorofluoromethane	<0.01

5.3.4 Compliance Monitoring Data

EPA ITD, as part of its current study, visited drum reconditioners to identify suitable candidates for wastewater sampling. During its visits, compliance sampling data were collected for eight facilities. Each of the eight facilities is required to monitor periodically pollutants specified in their publicly owned treatment works (POTW) pretreatment permit. Therefore, all data reported here represent actual facility discharges to POTWs. Table 5-15 lists the eight facilities that supplied compliance monitoring data. Plant characteristics also are listed. The eight facilities reflect the broad range of drum types processed and include both large and small plants. However, more data are reported for washing processes than for burning processes. Half of the facilities recycle caustic wash water and five of the eight treat their wastewater prior to discharge.

Effluent monitoring data are summarized in Table 5-16. The ranges reported for most parameters are wide; however, the means and medians for BOD and COD compare closely. BOD and COD both average over 2,000 mg/l in the discharges. Values over 1,000 mg/l for TSS and for oil and grease are common. The metals chromium, iron, lead, mercury, and zinc typically are measured at concentrations greater than 1.0 mg/l.

5.3.5 Comparison of Data Sources

EPA ITD data are the most comprehensive and representative available for characterizing industry raw wastewater. Data reported from other sources confirm the high levels of conventional and nonconventional pollutants measured by EPA ITD, as shown in the summary data below for BOD_5, COD, TSS, oil and grease, and phenol.

	Concentration (mg/l)		
	EPA ITD	NABADA	Compliance Monitoring
BOD_5	3,714	4,599	2,874
COD	17,423	24,549	5,599
TSS	4,709	2,435	1,807
Oil and Grease	13,228	10,228	3,688
Phenol	35	43	55

TABLE 5-15. COMPLIANCE MONITORING DATA FACILITY CHARACTERISTICS

Plant	Drum Types Processed	Process Type	Process Throughput (Drums/day)	Is Caustic Wash Recycled (Yes/No)	Wastewater Treatment
A	60% Petroleum 30% Solvents 10% Other	Washing	900	No	Oil/Water Separation and Sedimentation
D	80% Paint (Open-Head) 10% Adhesives (Open-Head) 10% Other (Open-Head) 30% Petroleum (Tight-Head) 30% Chemicals (Tight-Head) 20% Resins 10% Paint (Tight-Head) 10% Other (Tight-Head)	o Burning o Washing	3,000 3,000	Yes	Sedimentation and Air Flotation
H	70% Food (Open-Head) 15% Paint (Open-Head) 15% Petroleum (Tight-Head)	o Burning o Washing	o 1,200 o 200	Yes	Sedimentation
I	60% Petroleum 20% Plating 10% Food 10% Soaps, disinfectants	Washing	350	No	None
J	60% Petroleum 25% Food 15% Other	Washing	300	No	None
K	65% Food, paint, adhesives and and asphalt (Open-Head) 35% Petroleum, chemicals, and paint (Tight-Head)	o Burning o Washing	1,000 425	Yes	Oil/Water Separation and Sedimentation
L	95% Petroleum 5% Other	Washing	2,000	Yes	Oil/Water Separation and Sedimentation

TABLE 5-15. COMPLIANCE MONITORING DATA FACILITY CHARACTERISTICS (Continued)

Plant	Drum Types Processed	Process Type	Process Throughput (Drums/day)	Is Caustic Wash Recycled (Yes/No)	Wastewater Treatment
M	60% Petroleum 30% Paint, resins 10% Other	Washing	2,000	No	None

TABLE 5-16. PRETREATMENT COMPLIANCE MONITORING DATA FOR EIGHT DRUM RECONDITIONERS

Parameter (mg/l)	Number of Observations	Mean	Median	Range Low	Range High
BOD_5	63	2874	2400	7	21,000
COD	6	5599	2510.5	45	18,697
TSS	75	1807	630	10	25,750
Oil and Grease	71	3688	964	11	57,744
Phenol	33	55.4	9.450	0.051	375
Phosphorus	64	39.2	17.15	<.02	323
Cyanide	32	0.381	0.1	0.005	4.81
Arsenic	6	0.005	0.006	0.003	.007
Cadmium	62	0.04	0.02	0.00	.62
Chromium (hexavalent)	6	0.088	0.12	<.025	<.12
Chromium	61	2.03	0.69	<.02	12.8
Copper	61	0.869	0.34	0.02	6.98
Iron	14	64.8	9.	1	434
Lead	63	6.21	1.38	<.02	33
Manganese	2	0.075	0.08	0.06	.09
Mercury	47	2.123	0.400	0.0	49.8
Nickel	58	0.806	0.145	0.0	22.5
Silver	9	0.012	0.01	0.01	.02
Zinc	63	11.2	2.53	0.05	108.5

High levels also are observed for metals across the data sources, as shown below for selected parameters.

	Concentration (mg/l)		
	EPA ITD	NABADA	Compliance Monitoring
Chromium	3	12	2
Iron	106	114	64
Lead	14	45	6
Zinc	25	24	11

Extractable and volatile organic data are only available for quench water and an internal wastestream for the purpose of comparison to EPA ITD data. The data in Table 5-12 show that at least 12 organics were observed in caustic wash samples from 2 plants. A sample of quench water shows that 10 priority pollutants were measured, as shown in Table 5-13. EPA ITD detected 42 extractable and volatile compounds and wide ranges of concentrations were measured. No dioxin/furan data are available for comparing quench water data sources. The three pesticides observed at Plant F reflect the large number of pesticide drums reconditioned there. No pesticides were found at 3 of the 4 plants sampled by EPA-ITD, however, 11 compounds were detected at Plant D. The presence of pesticide and herbicides is probably a site specific phenomenon.

5.4 POLLUTANT ANALYSIS, RECOVERY, AND QUANTIFICATION

In order to fully interpret analytical data, QA/QC information must first be evaluated. This is especially true for the analysis of organic pollutants. Of particular concern in organics analysis is percent recovery. For example, if 100 µg/l of a compound is reported but the percent recovery is 50 percent, the real concentration could be anywhere from 100 to 200 µg/l. Conversely, if the recovery is 1,000 percent, the real concentration could be 10 µg/l. Expected recoveries for organic compounds using CLP protocols are 60 to 150 percent and for pesticides the recovery is 60 to 200 percent. The percent recovery for a compound becomes increasingly important when concentrations are low (i.e., near their detection limits).

The detection limits for the variouis organics in the HWT industry sampling effort ranged from 10 to 5,000 µg/l depending on the compound and the sample. Several potential reasons are:

- o A sample extract containing a large amount of organics can overload the GC/MS. Consequently, the full strength extract cannot be run, making dilutions necessary and resulting in high detection limits.
- o Some detection limits are high, even in "clean water." For example, the detection limit for some organics in reagent water is 10 µg/l while it is 250 µg/l for others.
- o High concentrations of a few compounds can swamp everything else. In this case, it may be necessary to use large dilutions to quantify the compounds present in high concentrations, thereby diluting those found in low concentrations. When the full strength extract is rerun to detect and quantify the low concentration compounds, the high concentration compounds mask their presence.
- o Some polar compounds (such as organic acids) are readily soluble in water, and are hard to separate and analyze with a GC. Furthermore, some polar compounds do not extract well during the extraction procedure.

Such analytical problems were experienced by the laboratories used during the 1986-87 sampling programs. This resulted in pollutants not being found in samples, when high concentrations of these pollutants had been found in similar wastewaters in other samples. Future Industrial Technology Division sampling analysis efforts will be designed to correct these problems.

5.5 SUMMARY

- o The average drum reconditioner handles 427 drums daily and discharges 6.9 gallons of wastewater per reconditioned drum, or 2,950 gallons per day. Raw wastewater results from the washing and rinsing of tight head drums or the quenching of burning residue on open head drum surfaces.
- o Industry raw wastewater is characterized by very high concentrations of conventional, nonconventional, metal, and organic pollutants. The data shown below for selected parameters is representative of a typical raw wastewater:

Parameter	Concentration (mg/l)
BOD^5	3,714
TSS	4,709
COD	17,423

Parameter	Concentration (mg/l)
Oil and Grease	13,228
TOC	2,991
Iron	106
Lead	14
Zinc	25
2-Butanone	744
Acetone	858

- Forty-two extractable and volatile organics are detected in industry raw wastewaters and one-third have concentrations greater than 10 mg/l.

- The following pesticide/herbicide compounds are found in industry raw wastewaters at levels greater than 1 μg/l: azinphos ethyl, azinphos methyl, fensolfothion, diazinon, dimethoate, leptophos, nemacur, parathion and TEPP.

6. CONTROL AND TREATMENT TECHNOLOGY

This section describes the types of control and treatment technologies used in the drum reconditioning industry. The pollutant removal effectiveness of these technologies also is discussed. In addition, the control technology that allows some reconditioners to achieve zero process wastewater is discussed.

6.1 INTRODUCTION

Drum reconditioning wastewater disposal practices are related to the types of treatment provided to internal and end-of-pipe wastestreams. Results of the National Barrel and Drum Association (NABADA) survey show that 75 percent of drum reconditioners recycle caustic wash to some degree (Touhill 1981a). Approximately 20 percent of the washing plants do not reuse caustic and discharge it to publicly owned treatment works (POTWs). Another 20 percent reuse a portion and discharge the excess. About half of the plants do not discharge caustic to the sewer, since all of the caustic is reused. Rinse waters are discharged to POTWs by half of the washing plants and about 35 percent treat and reuse rinse water. NABADA survey results from 49 facilities show that none of the plants discharge caustic to surface waters and that 3 percent discharge rinsewaters to surface waters. All reconditioners that reuse wastewater must treat it. Typical caustic wash water treatment consists of screening and/or sedimentation. Oil/water separation and air flotation also are used to treat wastewater for resue, but these treatments are more commonly used as end-of-pipe technologies. Sixty-one percent of the NABADA survey respondees reported the use of oil/water separators. Thirty-four percent use sedimentation, and 17 percent use air flotation. Fifty-six percent use screens to remove large solids and to reduce pump failure.

6.2 IN-PLANT CONTROL MEASURES

In-plant wastewater control measures provide methods for reducing the amounts of pollutants discharged by drum reconditioning facilities. The amount of drum residue brought onto facility property can be reduced if strict management procedures are enforced in the plant receiving area. Storm water contamination can be minimized if storage areas are well-maintained. The pollutant load to the wastewater treatment system can be reduced significantly

if drums are drained prior to reconditioning. Water conservation measures can reduce pollutant levels and minimize the use of chemicals used in the reconditioning processes. Wastestream segregation is probably the most effective in-plant control measure practiced by reconditioners. Each of these control measures is discussed below.

6.2.1 Receiving

Drums arrive at reconditioning plants in three different ways: (1) drums can be delivered to the plant by users (usually for laundering as a service), (2) drums can be delivered by brokers who buy the drums from various users, or (3) the reconditioner can pick up the drums at the user's plant. In the first two cases, drums are inspected by trained personnel as they are unloaded from trucks. The following types of drums are refused for reconditioning and are returned to the user or broker:

- Damaged drums.
- Drums that contain more than 1 inch of residue, unless special provision is made to deal with those materials.
- Drums that contain unacceptable materials, i.e., those containing hazardous materials and/or materials that the reconditioners customarily refuse (e.g., pesticides, resins, inks, adhesives, etc.).
- Drums without bungs, rings, and lids in place. (Such drums could be accepted, but reconditioners might charge a fee for placing bungs, rings, and lids on the drum.)

When drums are picked up by the reconditioners, drivers inspect the loading of each drum and refuse to load unacceptable drums. When drums are received at burning plants, either from trucks or storage, those known to create possible smoking problems, e.g., heavy grease, undercoat, or silicone, are segregated within a separate area. This permits mixing these drums into normal processing in order to minimize the potential for visible emissions. Such spacing is common at many burning plants.

6.2.2 Storage

All drums going into yard storage should have bungs in place, and rings and lids should be on the drums. This greatly reduces the potential for

pollution of stormwater runoff. Furthermore, in some cases it may be appropriate for drums having ink or other water-soluble materials spilled on the outside of the drums to be wiped with an appropriate solvent before being sent into storage. This prevents contamination of stormwater runoff.

The storage area should be constructed to minimize the amount of stormwater coming into contact with the drums. Berms and dikes could be used for this purpose. In addition, storage areas could be paved where pollutants could threaten surface or groundwater.

Because deteriorating drums can be a source of pollution, use of "first-in, first-out" (FIFO) yard inventory methods is suggested. Categorization of drums in storage yards helps in drum recovery, leads to better housekeeping, and aids in minimizing stormwater contamination.

6.2.3 Draining

Because Resource Conservation and Recovery Act (RCRA) regulations encourage better emptying of drums at the source, the need to drain drums before processing is lessened. However, draining of empty oil drums is recommended, since partially full drums continue to be received by drum reconditioners, based on recent EPA site visits.

Draining is desirable because any residue removed reduces the load on the caustic washing solution and the sludge volumes generated in the caustic. In addition, such drainage has a higher heat value than caustic sludge. This is an important consideration if incinerator disposal is contemplated. If an oil recovery pit is used, it should be kept clean so that oil can be offered for sale to refiners, or burned as fuel in the furnace of the reconditioner.

6.2.4 Water Conservation

In 1979, about 17.5 gallons of water were used to process a drum (Touhill, 1981a). The current figure for the industry is estimated to be 6.9 gallons/drum for an average facility. By instituting water conservation measures, the volume of liquid waste streams requiring treatment will be reduced. Methods for conserving water include:

- Cascading water use (using water for successive lower quality needs)
- Maintaining minimum flows for rinsing, leak testing, cleanup, boilers, and compressor cooling
- Mopping up spills rather than flushing to floor drains.

Some reconditioners have stated that water conservation methods should be applied thoughtfully because concentrating some wastes could make their treatment more difficult.

6.2.5 Wastestream Segregation

Wastestream segregation is probably the most effective in-plant control measure practiced by drum reconditioners. It is essential to segregate caustic solutions and rinse waters, so that subsequent efforts to treat and reuse the various liquid wastestreams will be possible. Data are available from two sources that can be used to evaluate the effectiveness of wastestream segregation: (1) data from the U.S. Environmental Protection Agency, Office of Research and Development (EPA ORD) and (2) data from the EPA Industrial Technology Division (ITD).

EPA ORD collected and analyzed samples of caustic wash and clarified caustic wash at a reconditioning facility identified in Section 6 as Plant E. These data are shown along with the pollutant removals in Table 6-1. Caustic wash segregation and treatment resulted in an 80-percent reduction in COD and a 50-percent reduction for most metals.

EPA ITD collected a sample of caustic wash from Plant B to compare pollutant levels observed to those levels found in rinse water. Analytical results for a recycled caustic wash sample and a raw rinse wastewater sample are compared in Tables 6-2 through 6-4. Conventional and nonconventional pollutants and metals observed in the caustic wash are one order of magnitude greater than the levels observed in rinsewater. A similar conclusion can not be drawn for the extractable and volatile organics from the data shown in Table 6-4.

TABLE 6-1. COMPARISON OF CAUSTIC WASH TO CLARIFIED CAUSTIC WASH PLANT E

Parameter (mg/l)	Spent Caustic Wash Average Concentration[1]	Clarified Caustic Wash Average Concentration[1]	Percent Removal
COD	109,150	21,400	80
Aluminum	56.6	27.1	52
Antimony	44.4	7.5	83
Arsenic	1.58	0.56	65
Barium	2.44	0.49	80
Boron	692	246	64
Cadmium	0.101	0.111	0
Calcium	2.95	9.0	0
Chromium	0.29	0.257	11
Cobalt	2.75	1.29	53
Copper	0.51	0.503	1
Iron	66.1	2.35	96
Lead	125.3	34.2	73
Magnesium	0.346	0.64	0
Manganese	3.28	0.34	90
Molybdenum	15.7	9.2	41
Nickel	6.26	3.66	42
Phosphorus	232	169	27
Selenium	0.179	0.092	49
Silver	0.005	0.163	0
Strontium	0.095	0.011	88
Tin	25.7	7.71	70
Titanium	2.64	0.573	78
Vanadium	2.11	0.885	58
Zinc	306	103	66

[1]Data listed are the average result of 2 samples.

TABLE 6-2
EPA-ITD SAMPLING PROGRAM
COMPARISON OF CAUSTIC FLUSH TO RINSE WATER

FRACTION : CONVENTIONALS AND NONCONVENTIONALS

PARAMETER	UNITS		
PLANT NUMBER:		B	B
EPISODE NUMBER:		1130	1130
SAMPLE POINT		CAUSTIC FLUSH	RAW WASTEWATER
SAMPLE NO.		15346	15348
SAMPLE DATE		Aug 6, 1986	Aug 7, 1986
AMMONIA	MG/L	175	9.0
BOD-5, TOTAL	MG/L	7200	418
BOD5, DISSOLVED	MG/L	9000	2160
CHLORIDE	MG/L	6800	1400
COD, DISSOLVED	MG/L	101000	4400
COD, TOTAL	MG/L	100000	5400
DISSOLVED SOLIDS	MG/L	279000	8940
FLUORIDE	MG/L	500	15
OIL & GREASE	MG/L	2380	2940
PHENOL	MG/L	1.83	92
SULFIDE	MG/L	.1	.1
SUSPENDED SOLIDS	MG/L	26600	780
SUSPENDED VOL SOLIDS	MG/L	633	50
TKN	MG/L	630	46
TOTAL CYANIDE	MG/L	.29	.66
TOTAL ORGANIC CARBON	MG/L	3300	210
TOTAL VOL SOLIDS	MG/L	55300	1175
pH	MG/L	13	12.7

NOTE: BLANK = NO VALUE REPORTED
MG/L = MILLIGRAMS PER LITER
UG/L = MICROGRAMS PER LITER
PPT = PARTS PER TRILLION

TABLE 6-3
EPA-ITD SAMPLING PROGRAM
COMPARISON OF CAUSTIC FLUSH TO RINSE WATER

FRACTION : EXTRACTABLE AND VOLATILE ORGANICS

PARAMETER	UNITS		
PLANT NUMBER:		B	B
EPISODE NUMBER:		1130	1130
SAMPLE POINT		CAUSTIC FLUSH	RAW WASTEWATER
SAMPLE NO.		15346	15348
SAMPLE DATE		Aug 6, 1986	Aug 7, 1986
O-CRESOL	UG/L		37
1,1,2,2-TETRACHLOROETHANE	UG/L	35165	
2-BUTANONE (MEK)	UG/L	661070	1361630
2-CHLORONAPHTHALENE	UG/L	4392	46
2-METHYLNAPHTHALENE	UG/L		24
ALPHA-TERPINEOL	UG/L	2433	
BENZOIC ACID	UG/L		94999
BENZYL ALCOHOL	UG/L		59
ETHYLBENZENE	UG/L	16294	
HEXANOIC ACID	UG/L	42	
ISOBUTYL ALCOHOL	UG/L	12939	
NAPHTHALENE	UG/L	2727	
P-CYMENE	UG/L		49
STYRENE	UG/L		98
TOLUENE	UG/L	369160	262

NOTE: BLANK = NO VALUE REPORTED
MG/L = MILLIGRAMS PER LITER
UG/L = MICROGRAMS PER LITER
PPT = PARTS PER TRILLION

TABLE 6-4
EPA-ITD SAMPLING PROGRAM
COMPARISON OF CAUSTIC FLUSH TO RINSE WATER

FRACTION : METALS

PARAMETER	UNITS		
PLANT NUMBER:		B	B
EPISODE NUMBER:		1130	1130
SAMPLE POINT		CAUSTIC FLUSH	RAW WASTEWATER
SAMPLE NO.		15346	15348
SAMPLE DATE		Aug 6, 1986	Aug 7, 1986
ALUMINUM	UG/L	270000	9400
ANTIMONY	UG/L	326	15
ARSENIC	UG/L	467	23
BARIUM	UG/L	38000	1500
BERYLLIUM	UG/L	10	1
BORON	UG/L	1600	13
CADMIUM	UG/L	86	6
CALCIUM	UG/L	440000	21000
CHROMIUM	UG/L	16000	830
COBALT	UG/L	2900	120
COPPER	UG/L	8000	390
IRON	UG/L	760000	40000
LEAD	UG/L	90000	2400
MAGNESIUM	UG/L	120000	6100
MANGANESE	UG/L	41000	1800
MERCURY	UG/L	4.0	1.1
MOLYBDENUM	UG/L	3000	110
NICKEL	UG/L	800	36
SELENIUM	UG/L	325	25
SILVER	UG/L	13	1
SODIUM	UG/L	58000000	1800000
THALLIUM	UG/L	130	10
TIN	UG/L	3000	150
TITANIUM	UG/L	13000	580
VANADIUM	UG/L	1600	59
YTTRIUM	UG/L	110	10
ZINC	UG/L	650000	18000

NOTE: BLANK = NO VALUE REPORTED
MG/L = MILLIGRAMS PER LITER
UG/L = MICROGRAMS PER LITER
PPT = PARTS PER TRILLION

6.3 WASTEWATER TREATMENT

The three predominant wastewater treatment technologies used in the drum reconditioning industry are sedimentation, oil/water separation, and air flotation. Effluent from these treatment systems are either discharged to the sewer or reused in the facility as either caustic wash make up or as quench water.

EPA ITD, as part of its current study, collected influent and effluent samples from sedimentation, oil/water separation, and air flotation treatment systems at four drum reconditioning facilities. This sampling effort characterized wastewater that is discharged to the sewer and to determined treatment systems removal efficiencies. The four facilities, Plants A, B, C, and D, were described in Section 5. The treatment systems in operation at these facilities are described in the discussions below on sedimentation, oil/water separation, and air flotation. Data are also available to characterize treatment system effluents and to determine pollutant removal efficiencies.

6.3.1 Sedimentation

Sedimentation treatment systems generally consist of a tank that provides several hours detention time for a wastestream. During detention, solids settle and the clarified effluent overflows from the tank. Solids are scraped or pumped from the tank and contract hauled.

Plant C uses a batch sedimentation treatment system that incorporates chemical addition. At Plant C, drums are first flushed with kerosene to remove petroleum residue. Drums are later washed with a caustic solution and then rinsed. The process wastewater is composed of 50 percent wash water and 50 percent rinse water. The process wastewater, which has a high pH, is neutralized in a mixing tank with sulphuric acid, and then a coagulant and a flocculent are added. Separation occurs in another tank where solids settle and oils rise to the top of the tank. Oil is skimmed, solids are drawn off the bottom, and the aqueous middle layer is discharged on a batch basis.

Since wastewater is batch-treated weekly, it was impossible to obtain a matched pair of raw wastewater and treated effluent. However, the effluent data reported in Tables 6-5 through 6-7 reflect a typical discharge. The

pollutant levels observed in the Plant C discharge are much lower than those presented later in this section for Plants A, B, and D. For example, no organic is present at levels greater than 1 mg/l and the metals aluminum, lead, and zinc are present at levels less than 0.5 mg/l. These lower levels are probably due to the fact that Plant C flushes its drums with a kerosene solvent before the drums are washed. Plant C only handles petroleum drums, and the metal bearing solids usually found in paint residue are not present. Also, Plant C does not handle the wide range of chemical drums that are handled at the other plants.

6.3.2 Oil/Water Separation

Oil/water separators are designed to treat oily wastestreams without addition of chemicals. Several hours of detention are provided in a tank and floating oils and emulsions are skimmed. Solids that accumulate on the tank bottom are removed periodically.

Plant A uses an oil/water separator to treat its wastewater. Drums are drained before being flushed with caustic, and then are washed and rinsed. The process wastestream consists of caustic flush, caustic wash water, and rinse water. Oil/water separation is provided in a three-chamber tank from which oil is removed weekly. The tank provides an average detention time of 2.4 hours over an 8-hour operating shift. Since the total treatment system volume is flushed more than three times during an 8-hour shift, a matched pair of raw wastewater and treated effluent was obtained.

Paired data for conventional and nonconventional pollutants, metals, and organics are shown in Tables 6-8 through 6-10. Solids and oil and grease are removed by the oil/water separator, but other conventional and nonconventional pollutants are not removed by the separator. The oil and grease removal is 76 percent and the various solids fraction removals range from 22 to 62 percent. The system provides no appreciable removals for metals or extractable and volatile organics.

TABLE 6-5
EPA-ITD SAMPLING PROGRAM
SEDIMENTATION EFFLUENT

FRACTION : CONVENTIONALS AND NONCONVENTIONALS

PLANT NUMBER: C
EPISODE NUMBER: 1133
SAMPLE POINT: TREATED EFFLUENT

SAMPLE NO.	15358
SAMPLE DATE	Sep 18, 1986

PARAMETER	UNITS	
AMMONIA	MG/L	.10
BOD-5, TOTAL	MG/L	390
BOD5, DISSOLVED	MG/L	300
CHLORIDE	MG/L	670
COD, DISSOLVED	MG/L	970
COD, TOTAL	MG/L	1060
DISSOLVED SOLIDS	MG/L	14000
OIL & GREASE	MG/L	9
PHENOL	MG/L	.05
SUSPENDED SOLIDS	MG/L	50
SUSPENDED VOL SOLIDS	MG/L	36
TKN	MG/L	10.2
TOTAL CYANIDE	MG/L	.08
TOTAL ORGANIC CARBON	MG/L	303
TOTAL VOL SOLIDS	MG/L	20000

NOTE: MG/L = MILLIGRAMS PER LITER
UG/L = MICROGRAMS PER LITER
PPT = PARTS PER TRILLION

TABLE 6-6
EPA-ITD SAMPLING PROGRAM
SEDIMENTATION EFFLUENT

FRACTION : EXTRACTABLE AND VOLATILE ORGANICS

PLANT NUMBER: C
EPISODE NUMBER: 1133
SAMPLE POINT: TREATED EFF

PARAMETER	UNITS	SAMPLE NO. 15358	SAMPLE DATE Sep 18, 1986
4-CHLORO-3-METHYLPHENOL	UG/L	28	
ACETONE	UG/L	880	
BENZOIC ACID	UG/L	360	
HEXANOIC ACID	UG/L	24	
NAPHTHALENE	UG/L	30	

NOTE: MG/L = MILLIGRAMS PER LITER
UG/L = MICROGRAMS PER LITER
PPT = PARTS PER TRILLION