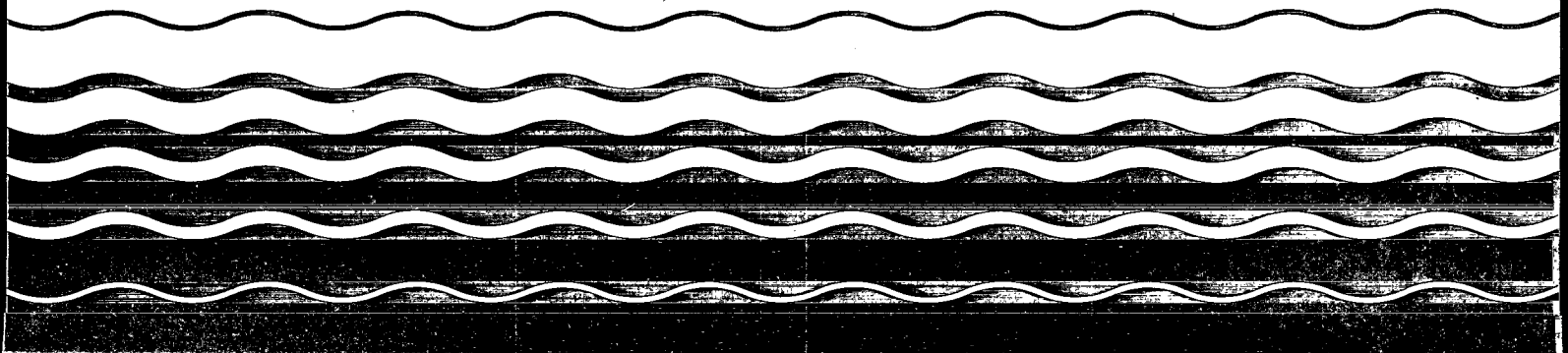
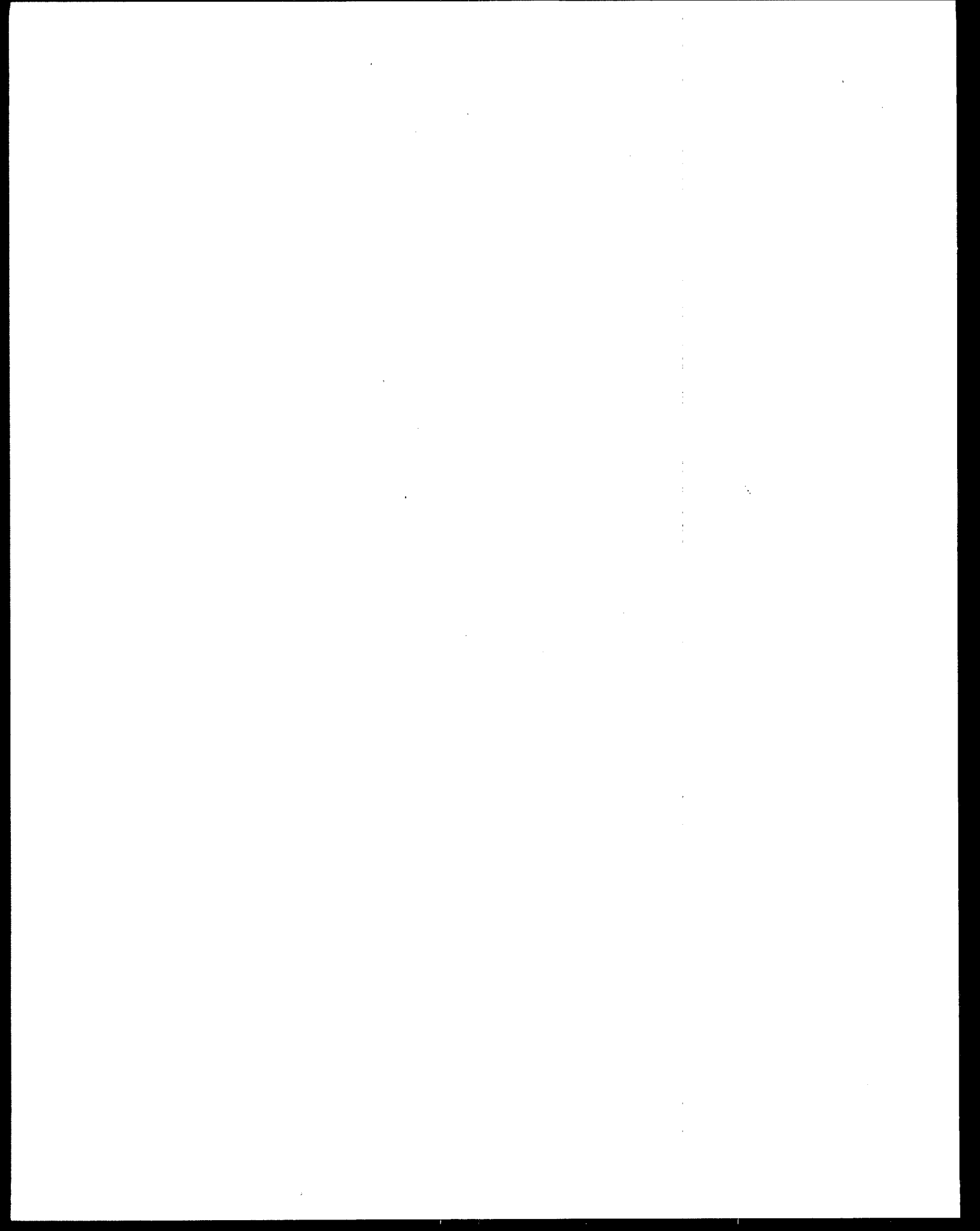




# **Development Document For Proposed Effluent Limitations Guidelines And Standards For The Centralized Waste Treatment Industry**





**DEVELOPMENT DOCUMENT  
FOR  
PROPOSED EFFLUENT LIMITATIONS  
GUIDELINES AND STANDARDS  
FOR THE  
CENTRALIZED WASTE TREATMENT INDUSTRY**

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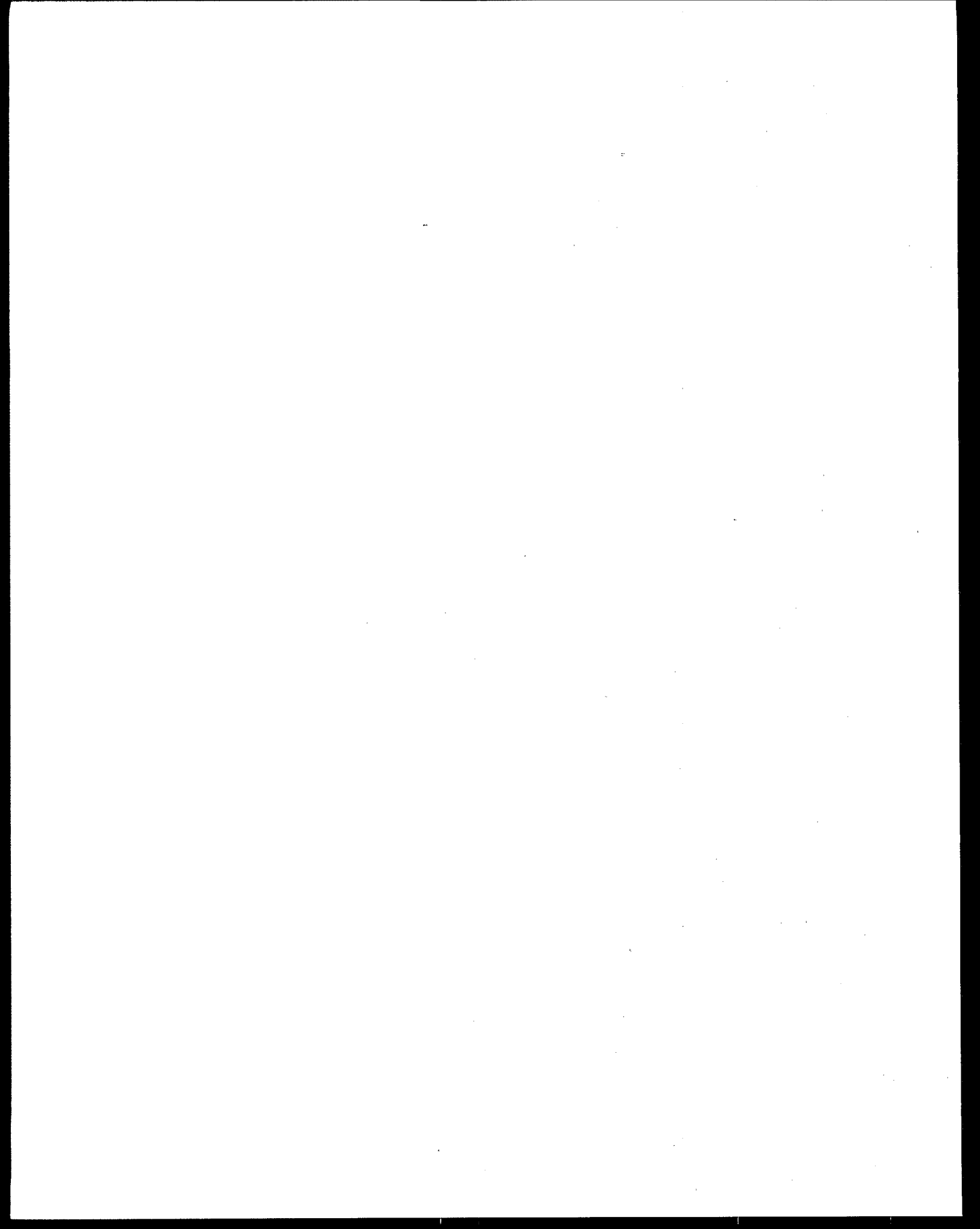
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January 1995

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Additional Support by Contract No. 68-C1-0006





## TABLE OF CONTENTS

EXECUTIVE SUMMARY .....	ES-1
SECTION 1 STATUTORY REQUIREMENTS .....	1-1
1.1 LEGAL AUTHORITY .....	1-1
1.1.1 Best Practicable Control Technology Currently Available (BPT) (Section 304(b)(1) of the CWA) .....	1-1
1.1.2 Best Conventional Pollutant Control Technology (BCT) (Section 304(a)(4) of the CWA) .....	1-2
1.1.3 Best Available Technology Economically Achievable (BAT) (Sections 304(b)(2)(B) of the CWA) .....	1-3
1.1.4 New Source Performance Standards (NSPS) (Section 306 of the CWA) .....	1-3
1.1.5 Pretreatment Standards for Existing Sources (PSES) (Section 307(b) of the CWA) .....	1-4
1.1.6 Pretreatment Standards for New Sources (PSNS) (Section 307(b) of the CWA) .....	1-4
1.2 SECTION 304(M) REQUIREMENTS AND LITIGATION .....	1-5
SECTION 2 DATA COLLECTION .....	2-1
2.1 CLEAN WATER ACT SECTION 308 QUESTIONNAIRES .....	2-1
2.1.1 Development of Questionnaires .....	2-1
2.1.2 Distribution of Questionnaires .....	2-4
2.2 SAMPLING PROGRAM .....	2-5
2.2.1 Pre-1989 Sampling Program .....	2-5
2.2.2 1989 - 1993 Sampling Program .....	2-6
2.2.3 1994 Sampling Program .....	2-9
SECTION 3 DESCRIPTION OF THE INDUSTRY .....	3-1
3.1 GENERAL INFORMATION .....	3-2
3.2 WASTES RECEIPTS .....	3-3
3.2.1 Waste Receipt Types .....	3-4
3.2.2 Procedures for Receipt of Wastes .....	3-6
3.3 DISCHARGE INFORMATION .....	3-8
3.4 TREATMENT RESIDUALS .....	3-9
3.5 INDUSTRY SUBCATEGORIZATION .....	3-10
3.5.1 Development of Subcategorization Scheme .....	3-11
3.5.2 Proposed Subcategories .....	3-12

## TABLE OF CONTENTS (continued)

SECTION 4	WASTEWATER USE AND WASTEWATER CHARACTERIZATION ..	4-1
4.1	WATER USE AND SOURCES OF WASTEWATER .....	4-1
4.2	WATER USE BY DISCHARGE .....	4-4
4.3	WATER USE BY SUBCATEGORY .....	4-5
4.4	WASTEWATER CHARACTERIZATION .....	4-6
4.4.1	Pollutant Parameters .....	4-7
4.4.2	Priority and Non-Conventional Pollutants .....	4-9
4.5	WASTEWATER POLLUTANT DISCHARGES .....	4-13
4.5.1	Metals Subcategory Current Performance .....	4-13
4.5.2	Oils Subcategory Current Performance .....	4-18
4.5.3	Organics Subcategory Current Performance .....	4-21
SECTION 5	POLLUTANTS AND POLLUTANT PARAMETERS	
	SELECTED FOR REGULATION .....	5-1
5.1	POLLUTANT PARAMETERS .....	5-1
5.2	PRIORITY AND NON-CONVENTIONAL POLLUTANTS .....	5-2
5.3	SELECTION OF POLLUTANTS TO BE REGULATED FOR PSES AND	
	PSNS .....	5-6
5.3.1	Pass-Through Analysis Approach .....	5-7
5.3.2	50 POTW Study Data Base .....	5-8
5.3.3	RREL Treatability Data Base .....	5-9
5.3.4	Final POTW Data Editing .....	5-9
5.3.5	Final Pass-Through Analysis Results .....	5-14
5.4	REFERENCES .....	5-19
SECTION 6	WASTEWATER TREATMENT TECHNOLOGIES .....	6-1
6.1	PHYSICAL/CHEMICAL/THERMAL WASTEWATER TREATMENT	
	TECHNOLOGIES .....	6-1
6.1.1	Chemical Precipitation .....	6-2
6.1.2	Clarification .....	6-10
6.1.3	Plate and Frame Pressure Filtration .....	6-12
6.1.4	Emulsion Breaking .....	6-14
6.1.5	Equalization .....	6-16
6.1.6	Air Stripping .....	6-17
6.1.7	Multi-media Filtration .....	6-21
6.1.8	Carbon Adsorption .....	6-24
6.1.9	Cyanide Destruction .....	6-30
6.1.10	Chromium Reduction .....	6-33
6.1.11	Electrolytic Recovery .....	6-36
6.1.12	Ion Exchange .....	6-37
6.1.13	Gravity Separation .....	6-41

## TABLE OF CONTENTS (continued)

	6.1.14 Dissolved Air Flotation .....	6-42
6.2	BIOLOGICAL WASTEWATER TREATMENT TECHNOLOGIES .....	6-45
	6.2.1 Sequencing Batch Reactors .....	6-47
	6.2.2 Biotowers .....	6-50
	6.2.3 Activated Sludge .....	6-52
6.3	ADVANCED WASTEWATER TREATMENT TECHNOLOGIES .....	6-54
	6.3.1 Ultrafiltration .....	6-54
	6.3.2 Reverse Osmosis .....	6-57
	6.3.3 Lancy Filtration .....	6-60
	6.3.4 Liquid Carbon Dioxide Extraction .....	6-62
6.4	SLUDGE TREATMENT AND DISPOSAL .....	6-63
	6.4.1 Plate and Frame Pressure Filtration .....	6-66
	6.4.2 Belt Pressure Filtration .....	6-68
	6.4.3 Vacuum Filtration .....	6-70
	6.4.4 Filter Cake Disposal .....	6-72
6.5	REFERENCES .....	6-73
SECTION 7	COST OF TREATMENT TECHNOLOGIES .....	7-1
7.1	COSTS DEVELOPMENT .....	7-1
	7.1.1 Technology Costs .....	7-1
	7.1.2 Option Costs .....	7-4
7.2	PHYSICAL/CHEMICAL/THERMAL WASTEWATER TREATMENT TECHNOLOGY COSTS .....	7-4
	7.2.1 Chemical Precipitation .....	7-4
	7.2.2 Clarification .....	7-14
	7.2.3 Plate and Frame Pressure Filtration - Liquid Stream .....	7-16
	7.2.4 Equalization .....	7-20
	7.2.5 Air Stripping .....	7-21
	7.2.6 Multi-Media Filtration .....	7-23
	7.2.7 Carbon Adsorption .....	7-24
	7.2.8 Cyanide Destruction .....	7-26
	7.2.9 Chromium Reduction .....	7-28
7.3	BIOLOGICAL WASTEWATER TREATMENT TECHNOLOGY COSTS .....	7-30
	7.3.1 Sequencing Batch Reactors .....	7-30
7.4	ADVANCED WASTEWATER TREATMENT TECHNOLOGY COSTS .....	7-31
	7.4.1 Ultrafiltration .....	7-31
	7.4.2 Reverse Osmosis .....	7-33
7.5	SLUDGE TREATMENT AND DISPOSAL COSTS .....	7-34
	7.5.1 Plate and Frame Pressure Filtration - Sludge Stream .....	7-34

## TABLE OF CONTENTS (continued)

	7.5.2 Filter Cake Disposal .....	7-36
7.6	ADDITIONAL COSTS .....	7-38
	7.6.1 Retrofit Costs .....	7-38
	7.6.2 Monitoring Costs .....	7-38
	7.6.3 RCRA Permit Modification Costs .....	7-40
	7.6.4 Land Costs .....	7-41
7.7	REFERENCES .....	7-44
SECTION 8	DEVELOPMENT OF LIMITATIONS AND STANDARDS .....	8-1
8.1	ESTABLISHMENT OF BPT .....	8-1
	8.1.1 Rationale for Metals Subcategory BPT Limitations .....	8-3
	8.1.2 Rationale for Oils Subcategory BPT Limitations .....	8-9
	8.1.3 Rationale for Organics Subcategory BPT Limitations .....	8-14
8.2	BCT .....	8-19
8.3	BAT .....	8-19
8.4	NSPS .....	8-20
8.5	PSES .....	8-21
8.6	PSNS .....	8-22
8.7	COST OF TECHNOLOGY OPTIONS .....	8-22
	8.7.1 Proposed BPT Costs .....	8-23
	8.7.2 Proposed BCT/BAT Costs .....	8-24
	8.7.3 Proposed PSES Costs .....	8-24
8.8	POLLUTANT REDUCTIONS .....	8-25
	8.8.1 Conventional Pollutant Reductions .....	8-25
	8.8.2 Priority and Nonconventional Pollutant Reductions .....	8-26
SECTION 9	NON-WATER QUALITY IMPACTS .....	9-1
9.1	AIR POLLUTION .....	9-1
9.2	SOLID AND OTHER AQUEOUS WASTE .....	9-2
	9.2.1 Filter Cake .....	9-3
	9.2.2 Reverse Osmosis Concentrate .....	9-4
	9.2.3 Ultrafiltration Concentrate .....	9-5
	9.2.4 Spent Carbon .....	9-5
	9.2.5 Air Stripper Oxidizer Catalyst .....	9-6
9.3	ENERGY REQUIREMENTS .....	9-7
9.4	LABOR REQUIREMENTS .....	9-8

## TABLE OF CONTENTS (continued)

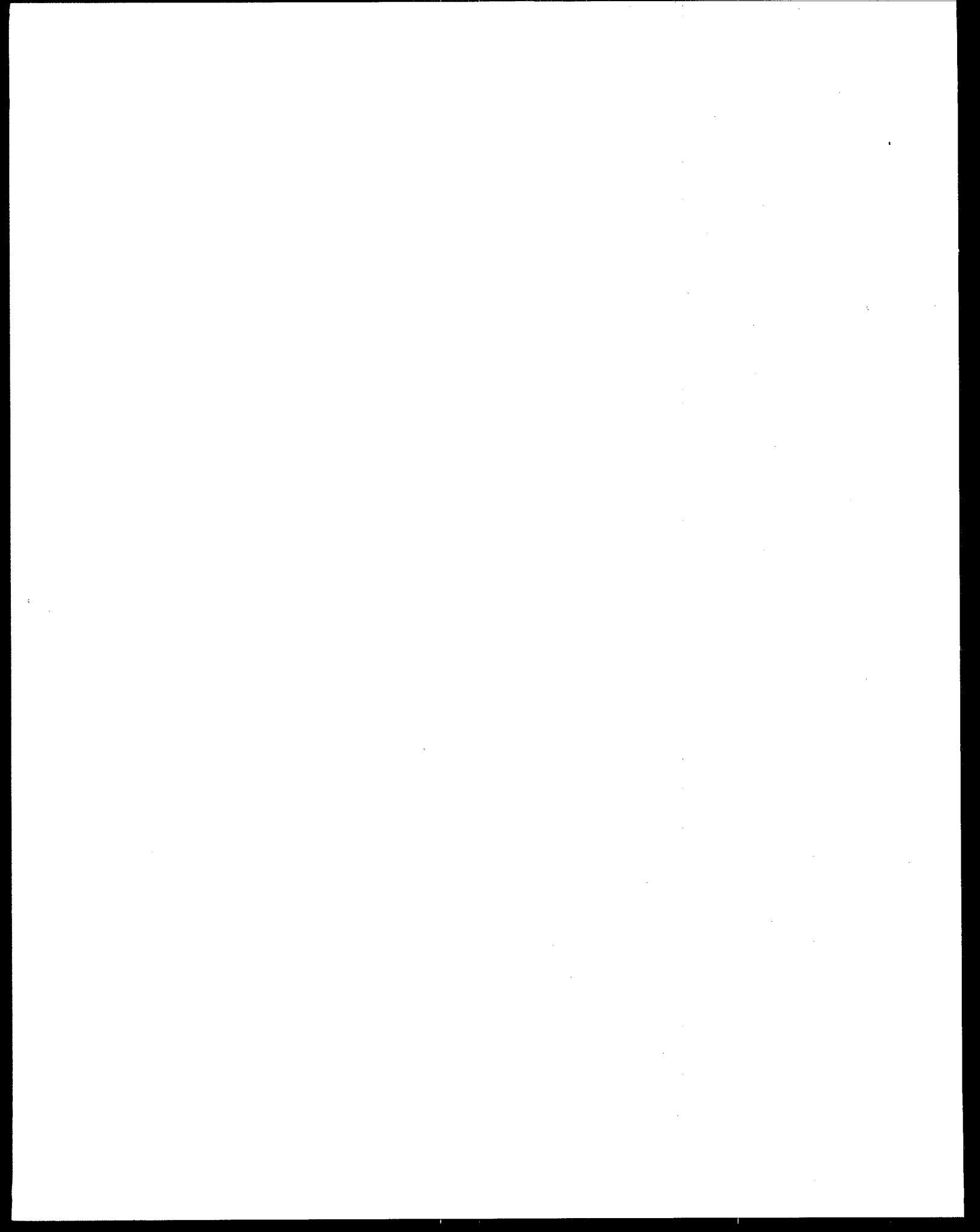
SECTION 10 IMPLEMENTATION .....	10-1
10.1 APPLICABLE WASTE STREAMS .....	10-1
10.2 DETERMINATION OF SUBCATEGORIES .....	10-2
10.3 ESTABLISHING LIMITATIONS AND STANDARDS FOR FACILITY DISCHARGES .....	10-4
10.3.1 Facilities with One Operation .....	10-4
10.3.2 Facilities with Operations Classified in Multiple Subcategories	10-5

Appendix A RCRA And Waste Form Codes Reported by Facilities in 1989

Appendix B Initial Pollutants Included in Sampling Program

Appendix C Acronyms and Definitions

Index



## LIST OF TABLES

ES-1	Technology Basis for BPT Effluent Limitations .....	ES-3
ES-2	Cost of Implementing Regulations [in millions of 1993 dollars] .....	ES-4
3-1	RCRA Codes Reported by Facilities in 1989. ....	3-4
3-2	Waste Form Codes Reported by Facilities in 1989. ....	3-5
3-3	Quantity of Waste Received for Treatment .....	3-6
3-4	Distribution of Facility Discharge .....	3-8
3-5	Quantity of Wastewater Discharged in 1989 .....	3-9
3-6	Quantity of Treatment Residuals in 1989 .....	3-10
4-1	Comparison of total facility discharge to total CWT discharge. ....	4-4
4-2	Summary of Wastewater by Subcategory .....	4-6
4-3	Influent Concentrations Ranges for Selected Pollutant Parameters .....	4-8
4-4	Range of Metal Pollutant Influent Concentrations (mg/l) .....	4-10
4-5	Range of Organic Pollutant Influent Concentrations (mg/l) .....	4-11
4-6	Metals Subcategory Current Performance .....	4-16
4-7	Oils Subcategory Current Performance .....	4-19
4-8	Organics Subcategory Current Performance .....	4-22
5-1	Pollutants Selected for Regulation .....	5-3
5-2	Pollutants Excluded from Regulation Due to the Concentration Detected ....	5-4
5-3	Pollutants Excluded from Regulation Due to Lack of Detection or Analysis at the Technology Option Facility .....	5-5
5-4	Pollutants Excluded from Regulation Due to Ineffective Treatment .....	5-6
5-5	Generic Removals for Group C: Hydrocarbons .....	5-11
5-6	Generic Removals for Group Q: Ethers .....	5-11
5-7	Final POTW Removals for CWT Pollutants .....	5-12
5-8	Volatile Override Analysis for CWT Pollutants .....	5-15
5-9	Final Pass-Through Results for Metals Subcategory Option 3 .....	5-16
5-10	Final Pass-Through Results for Oils Subcategory Options 2 and 3 .....	5-17
5-11	Final Pass-Through Results for Organics Subcategory Option 1 .....	5-18
6-1	Chemical Precipitation System Performance Data for CWT QID 059 .....	6-6
6-2	Chemical Precipitation System Performance Data for CWT QID 105 .....	6-6
6-3	Chemical Precipitation System Performance Data for CWT QID 230 .....	6-7
6-4	Selective Metals Precipitation (Solid Metals Recovery) System Performance Data for CWT QID 130 .....	6-7

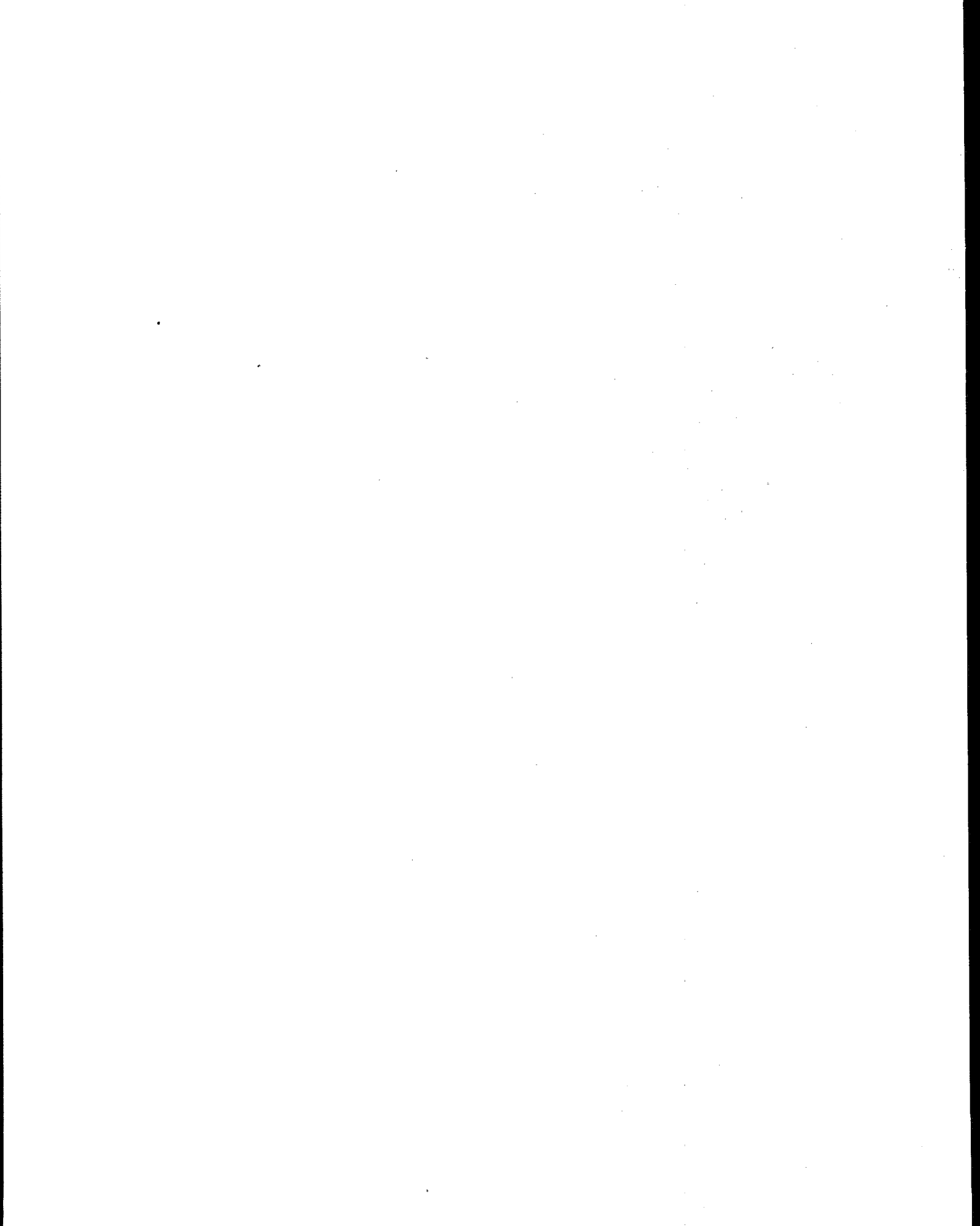
## LIST OF TABLES (continued)

6-5	Selective Metals Precipitation (Liquid Metals Recovery) System Performance Data for CWT QID 130 .....	6-8
6-6	Secondary Precipitation System Performance Data for CWT QID 130 .....	6-8
6-7	Tertiary Precipitation System Performance Data for CWT QID 130 .....	6-9
6-8	Overall Metals Precipitation System Performance Data for CWT QID 130 ...	6-9
6-9	Air Stripping System Performance Data .....	6-21
6-10	Carbon Adsorption System Performance Data for Organics Subcategory ..	6-28
6-11	Carbon Adsorption System Performance Data for Oils Subcategory .....	6-29
6-12	Sequencing Batch Reactor System Performance Data .....	6-49
6-13	Ultrafiltration System Performance Data .....	6-56
6-14	Reverse Osmosis System Performance Data .....	6-59
6-15	Lancy Filtration System Performance Data .....	6-62
6-16	Liquid CO <sub>2</sub> Extraction System Performance Data .....	6-65
7-1	Standard Capital Cost Factors .....	7-2
7-2	Standard O & M Cost Factors .....	7-3
7-3	CWT Subcategory Options .....	7-5
7-4	Monitoring Costs for the CWT Industry Cost Exercise .....	7-40
7-5	RCRA Permit Modification Costs Reported in WTI Questionnaire .....	7-41
7-6	State Land Costs for the CWT Industry Cost Exercise .....	7-43
8-1	BPT Effluent Limitations for the Metals Subcategory .....	8-6
8-2	BPT Effluent Limitations for the Oils Subcategory (mg/l) .....	8-11
8-3	BPT Effluent Limitations for the Organics Subcategory (mg/l) .....	8-16
8-4	Cost of Implementing Proposed BPT Regulations [in millions of 1993 dollars]	8-23
8-5	Cost of Implementing Proposed PSES Regulations [in millions of 1993 dollars]	8-24
8-6	Reduction in Direct Discharge of Priority and Nonconventional Pollutants After Implementation of Proposed BPT/BAT Regulations .....	8-27
8-7	Reduction in Indirect Discharge of Priority and Nonconventional Pollutants After Implementation of Proposed PSES Regulations .....	8-28
9-1	Air Pollution Reductions for the CWT Industry .....	9-2
9-2	Filter Cake Generation for the CWT Industry .....	9-4
9-3	Reverse Osmosis Concentrate Generation for the CWT Industry .....	9-4
9-4	Ultrafiltration Concentrate Generation for the CWT Industry .....	9-5
9-5	Activated Carbon Requirements for the CWT Industry .....	9-6
9-6	Air Stripper Oxidizer Catalyst Requirements for the CWT Industry .....	9-6



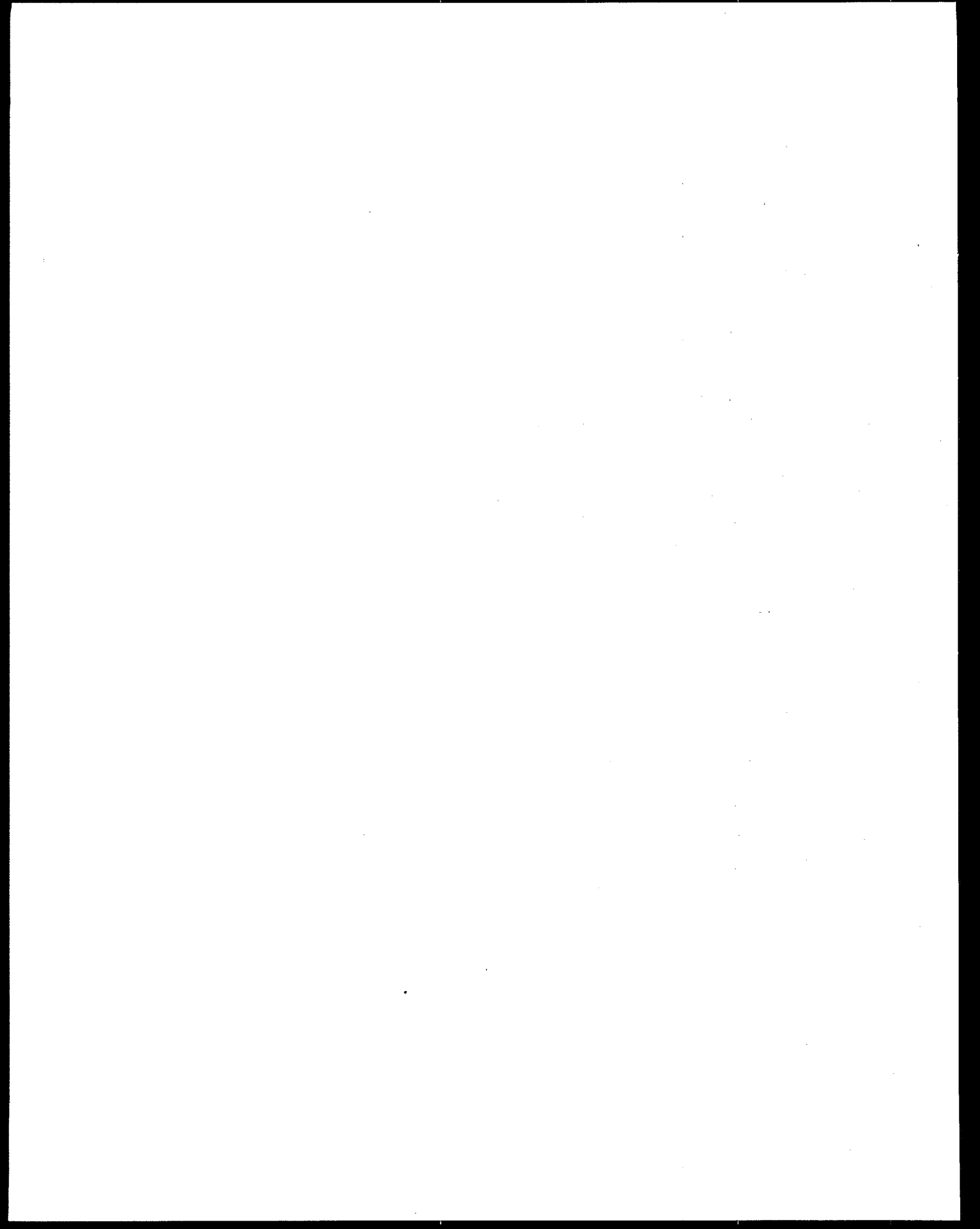
## LIST OF TABLES (continued)

9-7	Energy Requirements for the CWT Industry .....	9-7
9-8	Labor Requirements for the CWT Industry .....	9-8
10-1	Pollutant Concentrations for Determination of Subcategory .....	10-3



## LIST OF FIGURES

3-1	Distribution of Centralized Waste Treatment Facilities .....	3-2
3-2	Waste Receipt Procedures .....	3-7
4-3	Example of Non-CWT Wastewater Addition .....	4-13
6-1	Chemical Precipitation System Diagram .....	6-4
6-2	Clarification System Diagram .....	6-11
6-3	Plate and Frame Pressure Filtration System Diagram .....	6-13
6-4	Emulsion Breaking System Diagram .....	6-15
6-5	Equalization System Diagram .....	6-18
6-6	Air Stripping System Diagram .....	6-19
6-7	Multi-Media Filtration System Diagram .....	6-23
6-8	Carbon Adsorption System Diagram .....	6-25
6-9	Cyanide Destruction System Diagram .....	6-31
6-10	Chromium Reduction System Diagram .....	6-35
6-11	Electrolytic Recovery System Diagram .....	6-38
6-12	Ion Exchange System Diagram .....	6-40
6-13	Gravity Separation System Diagram .....	6-43
6-14	Dissolved Air Flotation System Diagram .....	6-44
6-15	Sequencing Batch Reactor System Diagram .....	6-48
6-16	Biotower System Diagram .....	6-51
6-17	Activated Sludge System Diagram .....	6-53
6-18	Ultrafiltration System Diagram .....	6-55
6-19	Reverse Osmosis System Diagram .....	6-58
6-20	Lancy Filtration System Diagram .....	6-61
6-21	Liquid CO <sub>2</sub> Extraction System Diagram .....	6-64
6-22	Plate and Frame Pressure Filtration System Diagram .....	6-67
6-23	Belt Pressure Filtration System Diagram .....	6-69
6-24	Vacuum Filtration System Diagram .....	6-71



## EXECUTIVE SUMMARY

EPA is proposing technology-based limits for the discharge of pollutants into navigable waters of the United States and into publicly-owned treatment works by existing and new facilities that are engaged in the treatment of industrial waste from off-site facilities - the Centralized Waste Treatment Point Source Category. This proposed regulation would establish effluent limitations guidelines for direct dischargers based on the following treatment technologies: "best practicable control technology" (BPT), "best conventional pollutant control technology" (BCT), and "best available technology economically achievable" (BAT). New source performance standards are based on "best demonstrated technology." The proposal also would establish pretreatment standards for new and existing indirect dischargers.

EPA identified 85 facilities which are included in the Centralized Waste Treatment Industry. The proposed effluent limitations guidelines and standards are intended to cover wastewater discharges resulting from treatment of, or recovery of components from, hazardous and non-hazardous industrial waste received from off-site facilities by tanker truck, trailer/roll-off bins, drums, barges, or other forms of shipment. Any discharges generated from the treatment of wastes received through an open or enclosed conduit (i.e., pipeline, channels, ditches, trenches, etc.) from the original source of waste generation are not included in the regulation. EPA has estimated that the proposed regulation will apply to 72 facilities which discharge wastewater. Sixteen facilities discharge wastewater directly; and 56 discharge indirectly to publicly-owned treatment works (POTW). Facilities in the Centralized Waste Treatment Industry accept many types of wastes for treatment or recovery. The proposed regulation applies to the following activities:

- Subcategory A: Discharges from operations which treat, or treat and recover metals from, metal-bearing waste received from off-site,

- Subcategory B: Discharges from operations which treat, or treat and recover oil from, oily waste received from off-site, and
- Subcategory C: Discharges from operations which treat, or treat and recover organics from, other organic-bearing waste received from off-site.

Such operations would include facilities whose exclusive operation is the treatment of off-site generated industrial waste as well as industrial or manufacturing facilities that also accept waste from off-site for centralized treatment.

The EPA evaluated various treatment technologies in developing the effluent limitations and standards. Table ES-1 lists the treatment technologies that are proposed for BPT limitations. Two options are being proposed for the Oils Subcategory because limitations for the less expensive proposed option are significantly less stringent than limitations for other industries. However, the more stringent treatment option has a greater cost. The treatment technologies proposed for BPT are the same treatment technologies proposed for BCT, BAT, NSPS, PSES, and PSNS.

After identifying treatment technologies, the EPA developed a model for calculating facility costs to upgrade present facility operations to the technology options proposed. Table ES-2 presents the capital and annual operating and maintenance costs associated with the proposed technology options. In addition to the costs for upgrading facility operations, costs were also calculated for modifying RCRA permits for facilities which accept hazardous waste for treatment and for the additional monitoring requirements for the proposed regulation. Overall, the proposed technology options are estimated to have an annualized cost of \$49 million for the less stringent Regulatory Option 1 and \$74 million for the more stringent Regulatory Option 2.

**Table ES-1.** Technology Basis for BPT Effluent Limitations

Proposed Subpart	Name of Subcategory	Technology Basis
A	Metal-Bearing Waste Treatment and Recovery	Selective Metals Precipitation, Pressure Filtration, Secondary Precipitation, Solid-Liquid Separation, and Tertiary Precipitation  For Metal-Bearing Waste which includes concentrated Cyanide streams:  Pretreatment by Alkaline Chlorination at specific operating conditions
B	Oily Waste Treatment and Recovery	Regulatory Option 1: Ultrafiltration  Regulatory Option 2: Ultrafiltration, Carbon Adsorption, and Reverse Osmosis
C	Organic Waste Treatment and Recovery	Equalization, Air Stripping, Biological Treatment, and Multimedia Filtration

**Table ES-2.** Cost of Implementing Regulations [in millions of 1993 dollars]

Subcategory	Number of Facilities <sup>a</sup>	Capital Costs	Annual O&M Costs
Metals Treatment and Recovery	44	43.9	33.5
Oils Treatment and Recovery - Regulatory Option 1	35	5.23	3.15
Oils Treatment and Recovery - Regulatory Option 2	35	16.8	29.7
Organics Treatment and Recovery	22	12.4	4.5
Regulatory Option 1	72	61.5	41.2
Regulatory Option 2	72	73.1	67.7

<sup>a</sup>The total number of facilities is less than the sum of the number of facilities in each subcategory, because many facilities may operate in more than one subcategory.

EPA estimated the amount of pollutant reductions that would result for each of the proposed technology options. Currently, 262.1 million pounds of pollutants are estimated to be discharge directly and indirectly to POTWs. The proposed regulation would decrease the amount of pollutants currently discharge by 129 millions pounds of pollutants for Regulatory Option 1 and 146 million pounds for Regulatory Option 2.



## **SECTION 1**

### **STATUTORY REQUIREMENTS**

Effluent limitations guidelines and standards for the Centralized Waste Treatment Industry are being proposed under the authority of Sections 301, 304, 306, 307, and 501 of the Clean Water Act (the Federal Water Pollution Control Act Amendments of 1972, 33 U.S.C. 1251 et seq., as amended by the Clean Water Act of 1977, Pub. L. 95-217, and the Water Quality Act of 1987, Pub. L. 100-4), also referred to as "the Act."

#### **1.1    *LEGAL AUTHORITY***

The Federal Water Pollution Control Act Amendments of 1972 established a comprehensive program to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters." (Section 101(a)). To implement the Act, EPA is to issue effluent limitations guidelines and standards for industrial discharges. These guidelines and standards are summarized briefly in the following sections.

##### **1.1.1    *Best Practicable Control Technology Currently Available (BPT)*** ***(Section 304(b)(1) of the CWA)***

In the guidelines, EPA defines BPT effluent limits for conventional, priority, and non-conventional pollutants. In specifying BPT, EPA looks at a number of factors. EPA first considers the cost of achieving effluent reductions in relation to the effluent reduction benefits. The Agency next considers: 1) the age of the equipment and facilities, the processes employed and any required process changes, engineering aspects of the control technologies, non-water quality environmental impacts (including energy requirements), and such other factors as the Agency deems appropriate (CWA §304(b)(1)(B)). Traditionally, EPA establishes BPT effluent limitations based on the

average of the best performances of facilities within the industry of various ages, sizes, processes or other common characteristics. Where, however, existing performance within a category or subcategory is uniformly inadequate, EPA may require higher levels of control than currently in place in an industrial category (or subcategory) if the Agency determines that the technology can be practically applied. BPT may be transferred from a different subcategory or category.

In the initial stages of EPA CWA regulation, EPA efforts emphasized the achievement of BPT limitations for control of the "classical" pollutants (e.g., TSS, pH, BOD<sub>5</sub>). However, nothing on the face of the statute explicitly restricted BPT limitation to such pollutants. Following passage of the Clean Water Act of 1977 with its requirement for point sources to achieve best available technology limitations to control discharges of toxic pollutants, EPA shifted its focus to address the listed priority pollutants under the guidelines program. BPT guidelines continue to include limitations to address all pollutants.

#### **1.1.2 Best Conventional Pollutant Control Technology (BCT)** **(Section 304(a)(4) of the CWA)**

The 1977 Amendments added Section 301(b)(2)(E) to the Act establishing BCT for discharges of conventional pollutants from existing industrial point sources. Section 304(a)(4) designated the following as conventional pollutants: Biochemical oxygen demanding pollutants (BOD), total suspended solids (TSS), fecal coliform, pH, and any additional pollutants defined by the Administrator as conventional. The Administrator designated oil and grease as an additional conventional pollutant on July 30, 1979 (44 FR 44501). BCT is not an additional limitation, but replaces BAT for the control of conventional pollutants. In addition to other factors specified in Section 304(b)(4)(B), the Act requires that BCT limitations be established in light of a two-part "cost-effectiveness" test [*American Paper Institute v. EPA*, 660 F.2d 954 (4th Cir. 1981)]. EPA's current

methodology for the general development of BCT limitations was issued in 1986 (51 FR 24974; July 9, 1986).

### **1.1.3 *Best Available Technology Economically Achievable (BAT)*** ***(Sections 304(b)(2)(B) of the CWA)***

In general, BAT effluent limitations guidelines represent the best economically achievable performance of plants in the industrial subcategory or category. The CWA establishes BAT as a principle means of controlling the direct discharge of priority and non-conventional pollutants to waters of the United States. The factors considered in assessing BAT include the cost of achieving BAT effluent reductions, the age of equipment and facilities involved, the process employed, potential process changes, and non-water quality environmental impacts, including energy requirements. The Agency retains considerable discretion in assigning the weight to be accorded these factors. Unlike BPT limitations, BAT limitations may be based on effluent reductions attainable through changes in a facility's processes and operations. As with BPT, where existing performance is uniformly inadequate, BAT may require a higher level of performance than is currently being achieved based on technology transferred from a different subcategory or category. BAT may be based upon process changes or internal controls, even when these technologies are not common industry practice.

### **1.1.4 *New Source Performance Standards (NSPS) (Section 306 of the CWA)***

NSPS reflect effluent reductions that are achievable based on the best available demonstrated treatment technology. New plants have the opportunity to install the best and most efficient production processes and wastewater treatment technologies. As a result, NSPS should represent the most stringent controls attainable through the application of the best available control technology for all pollutants (i.e., conventional, nonconventional, and toxic pollutants). In establishing NSPS, EPA is directed to take into

consideration the cost of achieving the effluent reduction and any non-water quality environmental impacts and energy requirements.

#### **1.1.5 *Pretreatment Standards for Existing Sources (PSES)* (Section 307(b) of the CWA)**

PSES are designed to prevent the discharge of pollutants that pass-through, interfere-with, or are otherwise incompatible with the operation of publicly-owned treatment works (POTW). The CWA authorizes EPA to establish pretreatment standards for pollutants that pass-through POTWs or interfere with treatment processes or sludge disposal methods at POTWs. Pretreatment standards are technology-based and analogous to BAT effluent limitations guidelines.

The General Pretreatment Regulations, which set forth the framework for the implementation of categorical pretreatment standards, are found in 40 CFR Part 403. Those regulations contain a definition of pass-through that addresses localized rather than national instances of pass-through and establishes pretreatment standards that apply to all non-domestic dischargers (52 FR 1586).

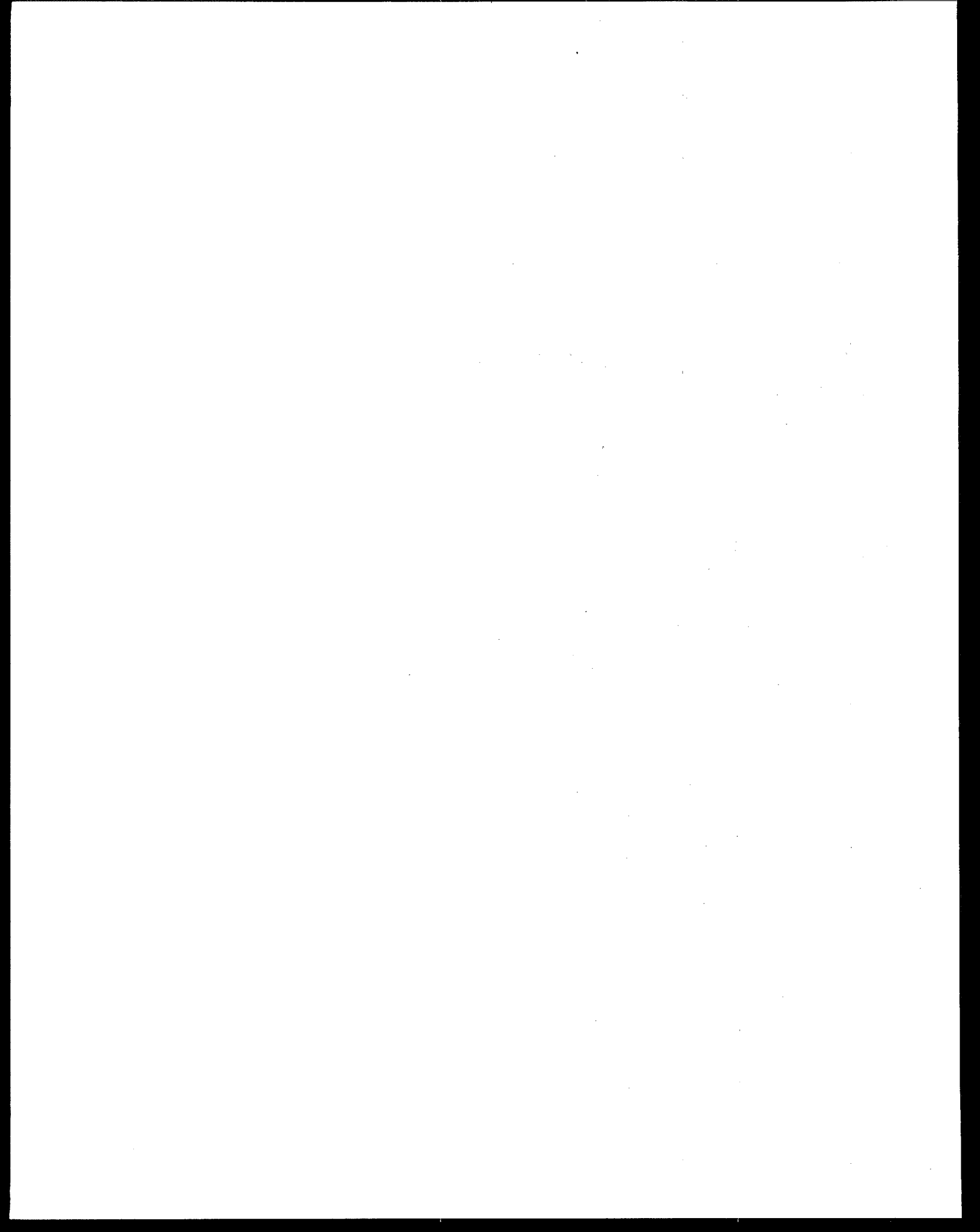
#### **1.1.6 *Pretreatment Standards for New Sources (PSNS)* (Section 307(b) of the CWA)**

Like PSES, PSNS are designed to prevent the discharges of pollutants that pass-through, interfere-with, or are otherwise incompatible with the operation of POTWs. PSNS are to be issued at the same time as NSPS. New indirect dischargers have the opportunity to incorporate into their plants the best available demonstrated technologies. The Agency considers the same factors in promulgating PSNS as it considers in promulgating NSPS.

## **1.2 SECTION 304(M) REQUIREMENTS AND LITIGATION**

Section 304(m) of the Clean Water Act (33 U.S.C. 1314(m)), added by the Water Quality Act of 1987, requires EPA to establish schedules for (i) reviewing and revising existing effluent limitations guidelines and standards ("effluent guidelines"), and (ii) promulgating new effluent guidelines. On January 2, 1990, EPA established an Effluent Guidelines Plan (55 FR 80), in which schedules were established for developing new and revised effluent guidelines for several industrial categories. One of the industries for which the Agency established a schedule was the Waste Treatment Industry Phase I - Centralized Waste Treatment.

Natural Resources Defense Council, Inc. (NRDC) and Public Citizen, Inc. challenged the Effluent Guidelines Plan in a suit filed in U.S. District Court for the District of Columbia (*NRDC et al v. Reilly*, Civ. No. 89-2980). The plaintiffs charged that EPA's plan did not meet the requirements of Section 304(m). A Consent Decree in this litigation was entered by the Court on January 31, 1992. The Decree requires, among other things, that EPA propose effluent guidelines for the subcategories of the Centralized Waste Treatment Industry by April 1994, and take final action by January 1996. In March 1994, due to project delays, an unopposed motion was filed to the court to extend the proposal until December 1994 and promulgation until September 1996.



## **SECTION 2**

### **DATA COLLECTION**

EPA has gathered and evaluated technical and economic data from various sources in the course of developing the effluent limitations guidelines and standards for the Centralized Waste Treatment Industry. These data sources include:

- Responses to EPA's "1991 Waste Treatment Industry Questionnaire,"
- Responses to EPA's "Detailed Monitoring Questionnaire,"
- EPA's 1990 - 1994 sampling of selected Centralized Waste Treatment facilities,
- Literature data, and
- Other EPA studies of Treatment, Storage, Disposal, and Recycling facilities.

EPA has used data from these sources to profile the industry with respect to: wastes received for treatment or recovery, treatment/recovery processes, geographical distribution, and wastewater and solid waste disposal practices. EPA then characterized the wastewater generated by treatment/recovery operations through an evaluation of water usage, type of discharge or disposal, and the occurrence of conventional, non-conventional, and priority pollutants.

#### **2.1 CLEAN WATER ACT SECTION 308 QUESTIONNAIRES**

##### **2.1.1 Development of Questionnaires**

A major source of information and data used in developing effluent limitations guidelines and standards is industry responses to questionnaires distributed by EPA under the Authority of Section 308 of the Clean Water Act. These questionnaires typically

request information concerning treatment processes, wastes received for treatment, and disposal practices as well as wastewater treatment system performance data. Questionnaires also request financial and economic data for use in assessing economic impacts and the economic achievability of technology options.

EPA used its experience with previous questionnaires to develop two questionnaires (the 1991 Waste Treatment Industry Questionnaire and the Detailed Monitoring Questionnaire) for this study. The 1991 Waste Treatment Industry Questionnaire was designed to request 1989 technical, economic, and financial data to describe industrial operations adequately from a census of the industry. The Detailed Monitoring Questionnaire was designed to elicit daily analytical data from a limited number of facilities which would be chosen after receipt and review of the 1991 Waste Treatment Industry Questionnaire responses.

For the 1991 Waste Treatment Industry Questionnaire, EPA wanted to minimize the burden to Centralized Waste Treatment facilities because these facilities are also required to complete extensive paperwork under the Resource Conservation and Recovery Act. A questionnaire was developed for which recipients could use information reported in their 1989 Hazardous Waste Biennial Report to complete specific tables as well as any other readily accessible data. The questionnaire specifically requested information on:

- treatment/recovery processes,
- types of waste received for treatment,
- wastewater and solid waste disposal practices,
- ancillary waste management operations,
- summary analytical monitoring data,
- the degree of co-treatment (treatment of waste received from off-site with other on-site industrial waste),
- cost of waste treatment/recovery processes, and
- the extent of wastewater recycling or reuse at facilities.



In the 1991 Waste Treatment Industry Questionnaire, EPA requested summary monitoring data from all recipients, but summary information is not sufficient for determining limitations and industry variability. Therefore, the Detailed Monitoring Questionnaire was designed to collect daily analytical data from a limited number of facilities. Facilities would be chosen to complete the Detailed Monitoring Questionnaire based on technical information submitted in the 1991 Waste Treatment Industry Questionnaire, such as on-site treatment technologies, types of waste accepted for treatment, and present permit limitations. The burden was also minimized in the Detailed Monitoring Questionnaire by tailoring the questionnaire to the facility operations.

Due to the lack of monitoring data on the wastewater treatment system influent, waste receipt data for a six-week period was also requested in the Detailed Monitoring Questionnaire. Waste receipt data are forms containing information on specific shipments of waste. A limit of six weeks was placed on this request to minimize the burden to facilities responding as well as to request a manageable set of data.

EPA sent draft questionnaires to industry trade associations, treatment facilities who had expressed interest, and environmental groups for review and comment. A pre-test of the 1991 Waste Treatment Industry Questionnaire was also conducted at nine Centralized Waste Treatment facilities to determine if the type of information necessary would be received from the questions posed as well as to determine if questions were designed to minimize the burden to facilities. A pre-test of the Detailed Monitoring Questionnaire was not possible due to project schedule limitations.

Based on comments from the reviewers, EPA determined the draft questionnaire required minor adjustments in the technical section, but extensive revisions were required for the economic and financial section. These revisions were required because this data collection effort was the first attempt at requesting information from a service industry as opposed to a manufacturing-based industry.

As required by the Paperwork Reduction Act, 44 U.S.C. 3501 *et seq.*, EPA submitted the questionnaire package (including the revised 1991 Waste Treatment Industry Questionnaire and the Detailed Monitoring Questionnaire) to the Office of

Management and Budget (OMB) for review, and published a notice in the *Federal Register* to announce the questionnaire was available for review and comment (55 FR 45161). EPA also redistributed the questionnaire package to industry trade associations, Centralized Waste Treatment Industry facilities, and environmental groups that had provided comments on the previous draft and to any others who requested a copy of the questionnaire package.

No additional comments were received. In fact, one industry trade association submitted comments to OMB in favor of the questionnaire and requested OMB's immediate clearance. OMB cleared the entire questionnaire package for distribution on April 10, 1991.

### **2.1.2 *Distribution of Questionnaires***

EPA identified 455 facilities as possible Centralized Waste Treatment facilities from various sources, such as the respondent list to the Survey of Treatment, Storage, Disposal, and Recycling Facilities, companies listed in the Environmental Information (EI) Directory, companies listed in major city telephone directories under environmental services, and facilities listed in the Toxic Release Inventory (TRI) data which receive waste from off-site.

Under the authority of Section 308 of the Act, EPA distributed the 1991 Waste Treatment Industry Questionnaire to all 455 facilities in the EPA facility database. EPA received responses from 413 facilities (a 91% response rate). In general, after review of the responses, EPA concluded that 326 facilities were not in the scope of the proposed regulation either because they were closed or the facility did not meet the profile of a CWT facility. The responses indicated that 89 respondents received waste from off-site for treatment or recovery. Four of the 89 received waste via a conduit (e.g., pipeline, trenches, or ditches) from the original source of waste generation and are not covered under the proposed regulation. Therefore, 85 facilities were identified as being in the Centralized Waste Treatment Industry.

In addition to information obtained through the 1991 Waste Treatment Industry Questionnaire, information was also obtained through follow-up phone calls and written requests for clarification of questionnaire responses.

After receipt of 1991 Waste Treatment Industry Questionnaire responses, information was reviewed and nineteen facilities were chosen to complete the Detailed Monitoring Questionnaire based on: types and quantities of wastes received for treatment; quantity of on-site generated wastewater not resulting from treatment or recovery of off-site generated waste; treatment/recovery technologies operated; wastewater discharge options; and present wastewater permit limitations.

## **2.2 SAMPLING PROGRAM**

### **2.2.1 *Pre-1989 Sampling Program***

From 1986 to 1987, twelve facilities were sampled to characterize the waste streams and on-site treatment technology performance at hazardous waste incinerators, Subtitle C and D landfills, and facilities which receive waste from off-site for treatment as a part of the Hazardous Waste Treatment Industry Study. All of the facilities in this sampling program had multiple operations, such as incineration and commercial wastewater treatment. The sampling program did not focus on characterizing the individual waste streams from different operations. Therefore, the data collected cannot be used for the characterization of Centralized Waste Treatment wastewater, assessment of treatment performance, or the development of limitations and standards. Information collected in the study is presented in the Preliminary Data Summary for the Hazardous Waste Treatment Industry (EPA 440/1-89/100).

## **2.2.2        1989 - 1993 Sampling Program**

### **2.2.2.1      Facility Selection**

Between 1989 and 1993, EPA visited 26 of the 85 centralized waste treatment facilities. During each visit, EPA gathered the following information:

- the process for accepting waste for treatment or recovery,
- the types of waste accepted for treatment,
- design and operating procedures for treatment technologies,
- general facility management practices,
- wastewater discharge options,
- solid waste disposal practices, and
- other facility operations.

After reviewing the information received during facility site visits, the EPA chose the facilities to be sampled by assessing whether the wastewater treatment system (1) was effective in removing pollutants; (2) treated wastes received from a variety of sources, (3) employed either novel treatment technologies or applied traditional treatment technologies in a novel manner, and (4) applied waste management practices that increased the effectiveness of the treatment unit.

The EPA also needed to determine if the CWT portion of the facility flow was adequate to assess the treatment system performance for CWT waste streams. For many facilities, the CWT operations were minor portions of the overall site operation. In such cases, when the CWT waste stream is commingled prior to treatment, characterizing the CWT waste stream and assessing the treatment performance in respect to a CWT waste stream would be difficult and therefore could not be used to establish effluent limitations guidelines and standards for the Centralized Waste Treatment Industry.

Another important aspect, when selecting facilities for the sampling program was the quantity of non-CWT wastewater treatment with CWT wastewater. For example, many facilities treated metal-bearing and oily waste in the same treatment system. The EPA needed to assess if these pollutants were being removed when these waste streams were treated in the same treatment system or if dilution was occurring.

Based on information received during the visits and responses to the 1991 Waste Treatment Industry Questionnaire, EPA selected eight of the 26 facilities to be included in the wastewater sampling program for establishing limitations and standards. An additional facility was sampled to characterize the wastes received and treatment processes of a facility that treated only non-hazardous waste. The other 17 facilities visited were not sampled, because they did not meet the criteria listed above.

Based on information received, EPA chose six facilities to be sampled to assess the performance at facilities which treated metal-bearing waste. All of the facilities visited used metals precipitation as a means for treatment, but each of the systems was unique due to the chemicals used and actual treatment set-up. Most facilities precipitated metals in batches. Similar waste receipts were mixed and the metals were precipitated in a one step process. One facility separated each waste shipment into separate treatment tanks to facilitate the precipitation of specific metals and then transferred the batch to another tank to precipitate additional metals. Another facility had a continuous system for precipitation: whereas, the wastewater flowed from one treatment chamber to another and in each chamber different chemicals were used.

For oily wastes, three facilities were sampled to characterize the waste streams and assess the treatment performance. All three facilities used chemical emulsion-breaking processes to initially separate oil-water mixtures. For two of the three facilities, the wastewater from emulsion-breaking was commingled with metal-bearing CWT wastewater prior to further treatment. One facility treated the wastewater from emulsion-breaking in a system specifically designed to treat oily wastes and the oily wastewater was not commingled with other waste streams. No other facilities were identified for sampling because most of the facilities accepted other types of waste for treatment and did not

operate treatment systems specifically designed for treatment of oily wastes as in the case with two of the facilities sampled.

Two organic waste treatment facilities were sampled to characterize the waste streams and assess treatment performance. One facility treated the organic waste stream by the following sequence of treatment technologies; two air-strippers in series equipped with air pollution control devices, biological treatment in a Sequential Batch Reactor, multimedia filtration, and final polishing by carbon adsorption units. The other facility utilized a patented CO<sub>2</sub> extraction process to recover organic compounds for use as fuel and treated the resulting wastewater via carbon adsorption. No further facilities were identified for sampling because most of the facilities treating organic waste have other industrial operations and the portion of CWT waste was minor in comparison to the overall facility flow.

#### **2.2.2.2      *Sampling Episodes***

After a facility was chosen to participate in the sampling program, a draft sampling plan was prepared which described the location of sample points and analysis to be performed at specific sample points as well as the procedures to be followed during the sampling episode. Prior to sampling, a copy of the draft sampling plan was provided to the facility for review and comment to ensure the EPA properly described and understood facility operations. All comments were incorporated into the final sampling plan. During the sampling episode, teams of EPA employees and contractors collected and preserved samples. Samples were sent to EPA approved laboratories for analysis. Samples were collected at influent, intermediate, and effluent points. Facilities were given the option to split samples with the EPA, but most facilities declined. Following the sampling episode, a draft sampling report was prepared that included descriptions of the treatment/recovery processes, sampling procedures, and analytical results. After all information was gathered, the reports were provided to facilities for review and comment. Corrections were

incorporated into the final report. The facilities also identified any information in the draft sampling report that were to be considered Confidential Business Information.

At the initial two sampling episodes, the entire spectrum of chemical compounds for which there are EPA-approved analytical methods were analyzed (more than 480 compounds). All compounds were analyzed because no data was received from facilities to narrow the list of analytes. After a review of initial analytical data, the number of constituents analyzed was decreased to 320 by omitting analysis for dioxins/furans, pesticides/herbicides, methanol, ethanol, and formaldehyde. Pesticides/herbicides were analyzed on a limited basis depending on the treatment chemicals used at facilities. Dioxin/furan analysis was performed on a limited basis for solid/filter cake samples to assess possible environmental impacts.

Data was collected for a variety of treatment systems handling a variety of wastes. Information on the waste stream characteristics is included in Section 4 and treatment system performance is included in Section 6.

### **2.2.3 1994 Sampling Program**

In 1994, an additional four facilities were visited to identify the types of waste presently being accepted at oily waste treatment facilities. These facilities were not in operation at the time the questionnaire was mailed, and they specialize in the treatment of bilge waters and unstable oil-water mixtures. In the 1989 - 1993 sampling program, oily waste treatment facilities were characterized as treating concentrated, stable oil-water emulsions. According to information received from permit writers, the industry trend has been in the area of bilge water treatment. From these site visits, one facility was chosen to be sampled based on the on-site treatment and type of oily waste accepted for treatment. At the time of proposal, the analytical data could not be reviewed, but are included in the regulatory record. The information collected will be used for re-evaluating EPA's characterization of the oily wastes accepted for treatment. EPA will re-assess the

pollutant concentrations detected at oily waste treatment facilities as well as evaluate additional treatment technologies.



## **SECTION 3**

### **DESCRIPTION OF THE INDUSTRY**

Development of a Centralized Waste Treatment Industry is a probable outgrowth of the increased pollution control measures required by CWA and RCRA requirements. In order to comply with CWA discharge limits, industries covered by categorical regulations installed new (or upgraded existing) wastewater treatment facilities in order to treat their process wastewater. But the wastewater treatment produced a residual sludge which required further treatment before disposal under RCRA requirements. Furthermore, many industrial process by-products were now, for regulatory purposes, classified as either RCRA listed or characteristic hazardous wastes which required special handling or treatment before disposal. Therefore, a market for waste management was developed due to the demand of waste management services.

In the early 1990's, this industry experienced a slow down because many existing facilities were designed to handle larger quantities of wastes than the market produced. Generally, reduced economic activity, in combination with pollution prevention measures, resulted in a decrease in the amount of waste sent off-site for treatment. Also, the available capacity in the industry reflected industry anticipation that upcoming environmental regulations would be increasingly stringent and thereby increase the demand for waste management services. As a result, when demand failed to materialize as expected, competition among facilities increased. This resulted in facilities operating below capacity and experiencing economic and financial difficulties. This trend may be changing at the present. Recently, participants in the March 1994 public meeting for this proposal stated that the industry is experiencing new growth due to increasing environmental regulations.

### 3.1 GENERAL INFORMATION

In 1989, EPA identified 85 facilities that accept by any form of shipment hazardous or non-hazardous industrial waste from off-site for treatment or recovery. The distribution of the 85 Centralized Waste Treatment facilities in the United States is presented in Figure 3-1. Most facilities are located in the eastern half of the United States with the highest concentration in the Mid-West. Many facilities are located close to large industrial areas to facilitate the transfer of waste from manufacturing facilities.

Most facilities receive waste via tanker truck. However, other forms of shipment are used for transporting wastes, such as trailers/roll-off boxes, drums, and barges. In the data collection, EPA identified four facilities which were receiving all of the waste from off-site via a pipeline. In evaluating the operations and waste accepted at such facilities, EPA determined that their operation was not similar to a facility which received waste by other



**Figure 3-1. Distribution of Centralized Waste Treatment Facilities**

forms of shipment and therefore would not be included in the scope of the proposed effluent limitations guidelines and standards.

The wastes sent by way of a conduit (i.e., pipeline, trenches, ditches, etc.) for treatment were characterized as process wastewater from existing categorical industries, not concentrated, difficult-to-treat wastes. Therefore, Best Professional Judgment (BPJ) discharge permits for facilities accepting waste via a conduit should be developed using the categorical standards from the industries which are sending the waste.

Many facilities have other industrial operations on-site in addition to a Centralized Waste Treatment facility. These industrial processes include other waste management operations (i.e., landfills, incinerators, solidification or fuel blending processes, etc.) or manufacturing operations. Approximately, 14 facilities are manufacturers of products. The most common manufacturing industries represented are organic chemicals and inorganic chemicals. The effect of the addition of other industrial wastewater is only discussed if the other industrial wastewater is co-treated with Centralized Waste Treatment wastewater. For these types of facilities, in general, CWT wastewater accounts for only 7% of the overall facility flow.

Some information normally used to describe an industry was not available for this study. For example, U.S. Department of Commerce, Bureau of the Census Standard Industrial Classification (SIC) codes are typically used by industries to describe a facility operation. No SIC codes exist for the Centralized Waste Treatment Industry. Some facilities have chosen 4959 as the SIC code, Sanitary Services, Not Elsewhere Classified. This classification, however, actually pertains to services such as beach maintenance, oil spill clean-up, snowplowing, etc.

### **3.2 WASTES RECEIPTS**

As previously explained, EPA also collected various information was collected pertaining to the types of waste accepted for treatment. Seventy-two out of the 85 Centralized Waste Treatment facilities are RCRA-permitted treatment, storage, and

disposal facilities (TSDFs). Therefore, a majority of facilities was able to use information reported in the 1989 Biennial Hazardous Waste Report to classify the wastes accepted for treatment by the appropriate RCRA and Waste Form Codes.

Most of the waste treated at Centralized Waste Treatment facilities is characterized as highly-concentrated and consequently difficult-to-treat. The concentration of pollutants detected in the raw wastewater was the highest detected in existing categorical regulations.

### 3.2.1 Waste Receipt Types

Facilities received a wide variety of hazardous and non-hazardous industrial waste for treatment in the Centralized Waste Treatment Industry. For hazardous wastes, RCRA Codes are often used to categorize wastes. The RCRA codes reported in the 1991 Waste Treatment Industry Questionnaire are listed in Table 3-1. Most of the RCRA codes do not contain information regarding the waste characteristics such as chemical constituent or concentration of chemical constituents.

**Table 3-1.** RCRA Codes Reported by Facilities in 1989.

RCRA Codes										
D001	D012	F009	K016	K063	P020	P069	U002	U052	U118	U161
D002	D017	F010	K031	K064	P022	P071	U003	U054	U122	U162
D003	D035	F011	K035	K086	P028	P074	U008	U057	U125	U188
D004	F001	F012	K044	K093	P029	P078	U009	U069	U134	U190
D005	F002	F019	K045	K094	P030	P087	U012	U080	U135	U205
D006	F003	F039	K048	K098	P040	P089	U013	U092	U139	U210
D007	F004	K001	K049	K103	P044	P098	U019	U098	U140	U213
D008	F005	K011	K050	K104	P048	P104	U020	U105	U150	U220
D009	F006	K013	K051	P011	P050	P106	U031	U106	U151	U226
D010	F007	K014	K052	P012	P063	P121	U044	U107	U154	U228
D011	F008	K015	K061	P013	P064	P123	U045	U113	U159	U239

In the Hazardous Waste Biennial Report, Waste Form Codes are used to further characterize the wastes received for treatment. The Waste Form Codes reported by Centralized Waste Treatment facilities are listed in Table 3-2. Definitions of the RCRA Codes and Waste Form Codes are listed in Appendix A. Some facilities, especially those that treat non-hazardous waste, did not report the Waste Form Code information due to the variety and complexity of their operations.

**Table 3-2. Waste Form Codes Reported by Facilities in 1989.**

Waste Form Codes										
B001	B106	B112	B119	B206	B219	B310	B501	B508	B519	B608
B101	B107	B113	B201	B207	B305	B312	B502	B510	B601	B609
B102	B108	B114	B202	B208	B306	B313	B504	B511	B603	
B103	B109	B115	B203	B209	B307	B315	B505	B513	B604	
B104	B110	B116	B204	B210	B308	B316	B506	B515	B605	
B105	B111	B117	B205	B211	B309	B319	B507	B518	B607	

In Table 3-3, information on the quantity of hazardous and non-hazardous industrial waste received for treatment or recovery is compiled. Many facilities which are permitted to accept hazardous wastes also treat or recover a large quantity of non-hazardous wastes. For purposes of the proposed effluent limitations guidelines and standards, "hazardous wastes" are those defined by RCRA as hazardous. State-defined hazardous wastes, such as waste oils, are classified as non-hazardous for the purposes of this study.

**Table 3-3. Quantity of Waste Received for Treatment**

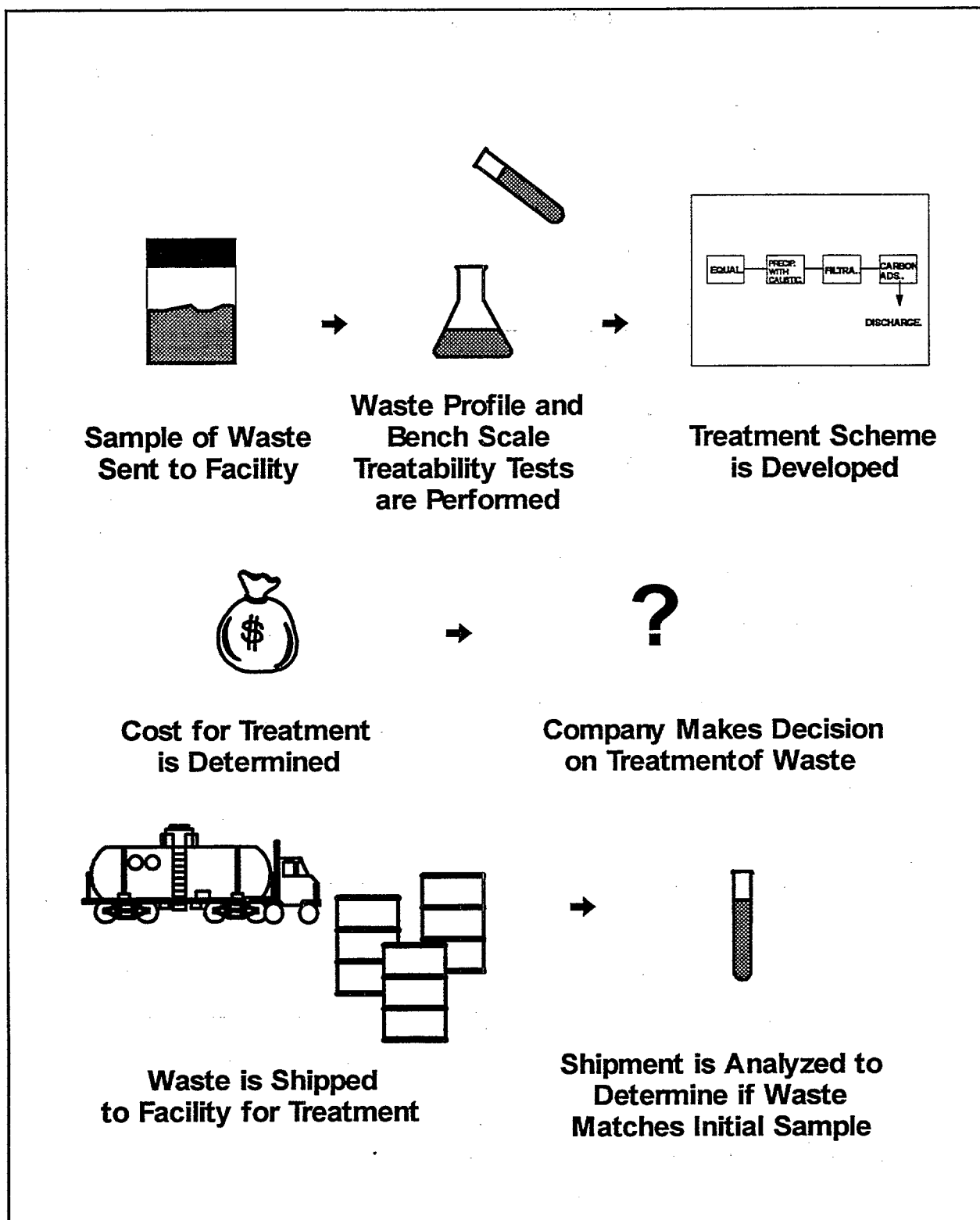
Type of Waste	Quantity of Waste (gal/yr)			
	Total	Average	Minimum	Maximum
Hazardous	506,415,098	8,052,183	1,200	85,200,000
Non-Hazardous	384,316,949	12,974,482	5,825	232,599,789

An additional potential source of information on the characterization of the wastes treated at a CWT operation is descriptive data from the generator of a waste. However, most CWT facilities did not collect information on the process for which the waste was generated. In general, based on information collected for these guidelines and standards, the most common forms of waste receipts were sludges from tank bottoms or treatment processes, rinse water from cleaning operations, and soil and wastewater from remediation activities.

### **3.2.2 Procedures for Receipt of Wastes**

In the process of gathering information, the procedures for accepting a waste for treatment or recovery were studied. The same general procedure is used for most facilities. The process is outlined in Figure 3-2.

In general, facilities require the waste generator to provide extensive paper work on the waste, such as analytical data, descriptive characteristics and chain of custody reports. Generators must also supply a sample of the waste stream to be treated with corresponding laboratory analysis. Then, the Centralized Waste Treatment facility performs further analysis and bench-scale treatability studies to determine if the waste can be handled in their treatment/recovery system. If the facility determines it can handle the waste, a price for the treatment of the given sample is established. After a price for treatment is established, the generator may then begin to transport the approved waste stream to the treatment facility.



**Figure 3-2. Waste Receipt Procedures**

Upon receipt of the waste shipment, a sample is taken for analysis. The analysis is compared to the original sample. If the analysis matches, the shipment is approved for treatment. If the analysis does not match, a new price for treatment may be determined or the shipment may be refused for treatment.

### **3.3 DISCHARGE INFORMATION**

In general, three basic options are available for disposal of wastewater treatment effluent: direct, indirect, and zero( or alternative) discharge. Direct dischargers are facilities that discharge effluent directly into a surface water. Indirect dischargers are facilities which discharge effluent to a publicly-owned treatment works (POTW). Zero or alternative dischargers do not generate a wastewater nor do they discharge to a surface water or POTW. The types of zero or alternative discharge identified as employed in the Centralized Waste Treatment Industry are underground injection control (UIC), off-site transfer for further treatment, and evaporation. Table 3-4 lists the number of dischargers for each discharge option.

**Table 3-4. Distribution of Facility Discharge**

<b>Discharge Option</b>	<b>No. of Facilities</b>
Direct	15
Indirect	56
Direct and UIC	1
UIC	4
Off-Site	6
Evaporate	2
No Wastewater Generated	1



In 1989, more than 3.0 billion gallons of wastewater were generated for disposal. Average facility information is presented in Table 3-5 for each discharge option. The proposed effluent limitations guidelines and standards for the Centralized Waste Treatment Industry do not apply to facilities with a zero or alternative discharge.

**Table 3-5.** Quantity of Wastewater Discharged in 1989

Discharge Option	Quantity Discharged in 1989 (gal)			
	Total	Average	Minimum	Maximum
Direct	2,314,110,276	144,631,892	20,605	1,169,975,506
Indirect	702,286,054	12,540,822	2,718	155,655,000
UIC	119,737,220	24,912,424	4,736,000	51,529,663
Off-Site	2,498,944	416,491	9,112	1,408,810
Evaporate	1,728,213	864,106	730,000	998,213

### 3.4 TREATMENT RESIDUALS

Various types of residuals were generated from the treatment or recovery processes. In 1989, more than 1.1 billion pounds of treatment residuals were generated. Information on the quantity of treatment residuals and disposal practices by facilities is presented in Table 3-6. The disposal practice used depends on the residual content. Metal-bearing residuals are most predominately disposed in Subtitle C or D landfills. The regulatory classification of the landfill used is dependent on the quantity of metals present in the residual and their ability to leach from the residual. Oily treatment residuals are typically reused for fuel in on-site or off-site operations. Organic residuals are usually sent to incinerators for disposal.

**Table 3-6. Quantity of Treatment Residuals in 1989**

Disposal Practice	Quantity of Treatment Residual in 1989 (lbs)			
	Total	Average	Minimum	Maximum
Subtitle C Landfill (33)	2,582,347,377	7,646,890	75	80,053,988
Subtitle D Landfill (31)	684,071,793	22,147,611	9	135,142,804
Land Application (2)	15,800	7,900	5,780	10,020
Hauled Off-Site (16)	163,014,881	10,188,430	5,984	103,025,422
Recycled Off-Site (17)	816,971,414	48,057,142	300	791,096,475
Incineration (10)	5,754,400	575,440	548	3,532,314
Sold as Product (4)	59,796,396	14,949,099	332,000	49,668,281

Note: The number of facilities using each disposal practice is listed in parentheses.

### **3.5 INDUSTRY SUBCATEGORIZATION**

Division of a point source category into groupings entitled "subcategories" provides a mechanism for addressing variations between products, raw materials, processes, and other parameters which result in distinctly different effluent characteristics. Regulation of a category by subcategory provides that each has a uniform set of effluent limitations which take into account technology achievability and economic impacts unique to that subcategory.

The factors considered in the subcategorization of the Centralized Waste Treatment Point Source Category include:

- Type of waste received for treatment,
- Treatment process,
- Nature of wastewater generated,
- Facility size,
- Facility age,
- Facility location,
- Non-water quality impact characteristics, and
- Treatment technologies and costs.

EPA evaluated these factors and determined that subcategorization is appropriate for this industry. These evaluations are discussed in detail in the following section.

### **3.5.1 *Development of Subcategorization Scheme***

In establishing the subcategories set forth in this rulemaking, EPA took into account all information it was able to collect and develop with respect to the following factors: waste type received; treatment process; nature of wastewater generated; dominant waste streams; facility size, age, and location; non-water quality impact characteristics; and treatment technologies and costs.

In this industry, a wide variety of wastes are treated at a typical facility. Facilities employ different waste treatment technologies tailored to the specific type of waste being treated in a given day. The operation of a facility changes daily depending on the type of waste accepted for treatment. Due to changing markets facilities may change the facility operation frequently. Therefore, many of the traditional subcategorization bases for facilities manufacturing products on a consistent basis are not applicable to this industry.

EPA concluded a number of factors did not provide an appropriate basis for subcategorization, because the industry must change to meet the market and regulatory demands. The Agency concluded that the age of a facility should not be a basis for subcategorization because many older facilities have unilaterally improved or modified

their treatment process over time. Facility size is also not a useful basis for subcategorization for the Centralized Waste Treatment Industry because there is only limited scale economics associated with waste treatment. Wastes can be treated to the same level regardless of the facility size. Likewise, facility location is not a good basis for subcategorization; no consistent differences in wastewater treatment performance or costs exist because of geographical location. Although non-water quality characteristics (solid waste and air emission effects) are of concern to EPA, these characteristics did not constitute a basis for subcategorization. Environmental impacts from solid waste disposal and from the transport of potentially hazardous wastewater are a result of individual facility practices and EPA could not identify practices that apply uniformly across different segments of the industry. Treatment costs do not appear to be a basis for subcategorization because costs will vary and are dependent on the waste stream variables such as flow rates, wastewater quality, and pollutant loadings. Therefore, treatment costs were not used as a factor in determining subcategories.

EPA identified only one factor with primary significance for subcategorizing the Centralized Waste Treatment Industry: type of waste received for treatment or recovery. This factor encompasses many of the other subcategorization factors. The type of treatment processes used, nature of wastewater generated, solids generated, and air emissions directly correlate to the type of waste received for treatment or recovery. Therefore, the type of waste received for treatment or recovery was determined to be the appropriate basis for subcategorization of this industry.

### **3.5.2 *Proposed Subcategories***

Based on the type of wastes accepted for treatment or recovery, EPA has defined three subcategories for the Centralized Waste Treatment Industry.

- Subcategory A: Operations which treat, or treat and recover metal from, metal-bearing waste received from off-site,

- Subcategory B: Operations which treat, or treat and recover oil from, oily waste received from off-site, and
- Subcategory C: Operations which treat, or treat and recover organics from, organic-bearing waste received from off-site.

#### **3.5.2.1      *Metal-Bearing Waste Treatment and Recovery Subcategory***

This subcategory applies to discharges resulting from the treatment or recovery of metal-bearing waste. Currently, 56 facilities have been identified as treating metal-bearing wastes in some cases for recovery of metals for sale in commerce or for return to industrial processes. EPA proposes to regulate the conventional, priority, and non-conventional pollutants in this subcategory. This subcategory also includes facilities which treat highly-concentrated, complex cyanides.

#### **3.5.2.2      *Oily Waste Treatment and Recovery Subcategory***

This subcategory applies to discharges resulting from the treatment or recovery of oily waste. Currently, 35 facilities have been identified as treating and recovering oily waste. EPA proposes to regulate conventional, priority, and non-conventional pollutants in this subcategory. Most of the waste accepted for treatment and recovery in 1989 was stable oil-water emulsions resulting from cleaning fluids and lubricants which are difficult to treat. Other types of oily waste accepted for treatment include bilge waters and tank cleaning wastewater.

### **3.5.2.3      *Organic Waste Treatment and Recovery Subcategory***

This subcategory applies to discharges resulting from the treatment and recovery of organic waste. Currently, 22 facilities operate organic waste treatment processes. Organic recycling processes, such as solvent recycling, are not included in this regulation. The wastes accepted for treatment in this subcategory are typically less concentrated than the wastes treated in the other subcategories. Wastes from clean-up of groundwater and landfill leachate are the most predominate source of wastewater. EPA proposes to regulate the conventional, priority, and non-conventional pollutants in this subcategory.

## **SECTION 4**

### **WASTEWATER USE AND WASTEWATER CHARACTERIZATION**

In 1991, under authority of Section 308 of the Clean Water Act, the Environmental Protection Agency (EPA) distributed the "1991 Waste Treatment Industry Questionnaire," to 455 facilities that EPA had tentatively identified as possible Centralized Waste Treatment facilities. Responses to the questionnaire indicated that 85 facilities received hazardous and non-hazardous industrial waste from off-site for treatment or recovery via any form of shipment in 1989. This section presents information on water use at these facilities. This section also presents information on wastewater characteristics for the Centralized Waste Treatment facilities that were sampled by EPA and for those facilities that provided self-monitoring data.

#### **4.1 WATER USE AND SOURCES OF WASTEWATER**

The Centralized Waste Treatment Industry accepts for treatment large volumes of waste and wastewater from off-site facilities. Water use and wastewater generation occur at various points in a CWT facility's operations.

Wastewater treated at CWT facilities, as noted, includes off-site wastes and wastewater from on-site operations. In general, the primary Centralized Waste Treatment wastewater sources are: waste receipts, solubilization wastewater, tanker truck/drums/roll-off box washes, equipment washes, air pollution control scrubber blow-down, laboratory-derived wastewater, and contaminated stormwater. CWT facilities do not generate "process wastewater" (Process wastewater is defined in 40 CFR 122.2 as "any water which, during manufacturing or processing, comes into direct contact with or results from the production or use of any raw material, by-product, intermediate product, finished product, or waste product.") in the traditional sense. The term is used for manufacturing or processing operations. Because the Centralized Waste Treatment Industry operations do not include or result in "manufacturing processes" or "products," EPA refers to the

wastewater treated in the Centralized Waste Treatment Industry by the terms "waste receipts" for those wastes received from off-site for treatment and "CWT wastewater" for the water which comes into contact with the waste received or waste processing or handling areas as well as waste receipts.

Approximately 2.0 billion gallons of wastewater are generated annually by Centralized Waste Treatment facilities. For most of the individual CWT wastewater sources, it is difficult to determine specific quantities of each wastewater due to facilities mixing the wastewater from different sources prior to treatment. The sources of CWT wastewater are listed below.

- *Waste Receipts.* Most of the waste received from customers comes in a liquid form and constitutes a large portion of the wastewater treated at a CWT facility. Other wastewater sources include wastewater from contact with the waste at receipt or during subsequent handling.
- *Solubilization Water.* Some wastes are received in a solid form. Water may be added to the waste to render it treatable.
- *Waste Oil Emulsion-Breaking Wastewater.* The emulsion breaking process separates difficult water-oil emulsions and generates a "bottom" or water phase. Approximately 99.2 million gallons of wastewater were generated from emulsion-breaking processes in 1989.
- *Tanker Truck/Drum/Roll-Off Box Washes.* Water is used to clean the interior and exterior of equipment used for transporting wastes. The amount of wastewater generated was difficult to assess because the wash water is normally added to the wastes or used as solubilization water.



- *Equipment Washes.* Water is used to clean waste treatment equipment during unit shut downs or in between batches of waste.
- *Air Pollution Control Scrubber Blow-Down.* Water or acidic or basic solution is used in air emission control scrubbers to control fumes from treatment tanks, storage tanks, and other process equipment.
- *Laboratory-Derived Wastewater.* Water is used in on-site laboratories which characterize the incoming waste streams and monitor on-site treatment performance.
- *Contaminated Stormwater.* This is stormwater which comes in direct contact with the waste or waste handling and treatment areas.

The major volume of wastewater effluent discharged from the Centralized Waste Treatment Industry is stormwater. Approximately 100 million gallons are discharged annually. Stormwater may be contaminated by contact with receipts or the waste processing area or it may be noncontaminated. Most of the wastewater monitoring data submitted by facilities in the 1991 Waste Treatment Industry Questionnaire included noncontaminated stormwater.

Many facilities also have other on-site industrial operations, i.e., organic manufacturing. Waste streams from other industrial processes may be mixed with Centralized Waste Treatment process wastewater prior to or after treatment. These other industrial waste streams are not included as wastewater sources reviewed for effluent limitations guidelines and standards for the Centralized Waste Treatment Industry. The monitoring data received from facilities with other industrial waste streams were reviewed to determine if the discharge streams for which data were submitted included other industrial wastewater. In cases where the waste streams included other industrial waste, the monitoring data were adjusted to remove the effect of the other industrial waste stream.

## 4.2 WATER USE BY DISCHARGE

A summary of the CWT wastewater flow by type of discharge was presented in Table 3-5 for the 85 CWT facilities. This information is based upon data collected in the 1991 Waste Treatment Industry Questionnaire. The discharge options are direct, indirect, or zero discharge. "Zero" discharge methods include no discharge, no wastewater generation, land application, deep well injection, evaporation, and off-site disposal or treatment. One facility discharges wastewater by direct discharge and deep well injection.

A large portion of wastewater discharges from the Centralized Waste Treatment Industry is not generated by the CWT operations. As previously explained, facilities may also have other industrial operations which generate non-CWT wastewater and that wastewater may be treated with CWT waste streams. The quantity of non-CWT wastewater, noncontaminated stormwater and other industrial waste streams, is summarized in Table 4-1. Direct dischargers are the most affected by the addition of non-CWT wastewater, because most of these facilities have other industrial operations.

**Table 4-1.** Comparison of total facility discharge to total CWT discharge.

Quantity Discharged	Total Facility Discharge (gal/yr)	Total CWT Discharge (gal/yr)
Total	20,155,462,039	3,016,396,330
Average	279,936,973	41,894,393
Minimum	7,748	2,718
Maximum	12,775,000,000	1,169,975,506

### **4.3 WATER USE BY SUBCATEGORY**

Off-site waste receipt quantities were used to estimate the quantity of wastewater per subcategory. The quantity of waste receipts for each subcategory was calculated from the estimate of waste received from off-site submitted for the 1991 Waste Treatment Industry Questionnaire. As discussed in Section 4, waste receipts were divided into subcategories by the waste form codes and RCRA codes.

Other sources of wastewater were apportioned to each subcategory by reviewing treatment diagrams indicating the origination of the waste stream. In cases where CWT wastewater could not be separated by subcategory, such as laboratory and truck rinsing wastewater, the CWT wastewater was divided on the basis of the subcategory breakdown. For example, the laboratory wastewater for a facility 70% in the Metals Subcategory and 30% in the Oils Subcategory was estimated to be 70% Metals Subcategory wastewater and 30% Oil Subcategory wastewater.

Table 4-2 summarizes the amount of CWT and non-CWT wastewater by subcategory. As previously discussed, many CWT facilities also have other industrial operations. Wastewater from these other industrial operations on-site is commingled with CWT wastewater prior to treatment. The amount of other industrial wastewater for each subcategory is also presented in Table 4-2. As illustrated in Table 4-2, the Centralized Waste Treatment wastewater for facilities in the Organics Subcategory is a minor portion of the facility operation. Most Organics Subcategory facilities have other industrial operations such as organics manufacturing. Facilities began accepting waste for treatment because sufficient capacity existed in the treatment system.

**Table 4-2. Summary of Wastewater by Subcategory**

<b>Type of Wastewater</b>	<b>Quantity of Wastewater (gal/yr)</b>		
	<b>Metal-bearing Waste Subcategory</b>	<b>Oily Waste Subcategory</b>	<b>Organic Waste Subcategory</b>
Subcategory Wastewater	41,795,489,977	226,735,481	1,359,815,755
Non-CWT Wastewater	19,131,768,908	4,732,004,637	19,220,128,314
Number of Facilities	56	35	21

#### **4.4 WASTEWATER CHARACTERIZATION**

A majority of the information reported in this section was collected from the EPA Sampling Programs for the Centralized Waste Treatment Industry as discussed in Section 3. Supplemental information was provided by self-monitoring data supplied in the 1991 Waste Treatment Industry Questionnaire, the Detailed Monitoring Questionnaire, and the Waste Receipt information. The self-monitoring data were not used as extensively as planned because many waste streams for which data were supplied included non-CWT wastewater, and therefore, the data were not useful in properly characterizing Centralized Waste Treatment operations. Also, the self-monitoring data were only available for a limited number of pollutants in comparison to the scope of pollutants studied in the Sampling Program.

The data presented in the following sections were collected at influent points to treatment systems. The concentrations presented are lower than the original waste receipt concentrations as a result of the commingling of a variety of waste streams. In most cases, EPA could not collect samples from individual waste shipments because of physical

constraints as well as the excessive analytical costs associated with the necessary analysis.

#### **4.4.1 Pollutant Parameters**

Different pollutant parameters are used to characterize raw wastewater and wastewater discharged by Centralized Waste Treatment facilities. These include:

- Total Suspended Solids (TSS),
- Biochemical Oxygen Demand (BOD<sub>5</sub>),
- pH, and
- Oil and Grease.

Total solids in wastewater is defined as the residue remaining upon evaporation at just above the boiling point. Total suspended solids (TSS) is the portion of the total solids that can be filtered out of the solution using a 1 micron filter. Raw wastewater TSS content is a function of the type and form of waste accepted for treatment. (Typically, the higher the TSS content the more concentrated the waste stream.) TSS can also be a function of a number of other external factors, including stormwater runoff and runoff from storage areas. The total solids are composed of matter which is settleable, in suspension, or in solution and can be organic, inorganics, or a mixture of both. Settleable portions of the suspended solids can be removed in a variety of ways, such as during the metals precipitation process or by multimedia filtration, depending on a facility's operation. In the Centralized Waste Treatment Industry, raw wastewater TSS is a function of the form in which a waste is received for treatment, such as a solid or liquid. Wastewater that results from the solubilization of solid waste receipts tends to have higher TSS values than waste received in a liquid form. The highest TSS values detected in the Centralized Waste Treatment Industry were found in the Metals Subcategory. Metal-bearing waste contain high TSS levels, due to the industrial waste source as well as many waste receipts being

accepted in solid form. A summary of the raw wastewater TSS levels is presented in Table 4-3.

**Table 4-3.** Influent Concentrations Ranges for Selected Pollutant Parameters

Pollutant Parameter	Influent Concentration Range (mg/l)					
	Metals Subcategory		Oils Subcategory		Organics Subcategory	
	Min	Max	Min	Max	Min	Max
TSS	86	152,767	190	22,258	44	3,700
BOD <sub>5</sub>	4	30,000	4,520	10,067	4,100	48,675
Oil & Grease	3	5,995	492	180,000	16	626

BOD<sub>5</sub> is one of the most important gauges of pollution potential of a wastewater and varies with the amount of biodegradable matter that can be assimilated by biological organisms under aerobic conditions. The nature of chemicals discharged into wastewater effects the BOD<sub>5</sub> due to the differences in susceptibility of different molecular structures to microbiological degradation. Compounds with lower susceptibility to decompose by microorganisms tend to exhibit lower BOD<sub>5</sub> values, even though the total organic loading may be much higher than compounds exhibiting substantially higher BOD<sub>5</sub> values.

The pH of a solution is a unitless measurement which represents the acidity or alkalinity of a wastewater stream (or aqueous solution), based on the dissociation of the acid or base in the solution into hydrogen (H<sup>+</sup>) or hydroxide (OH<sup>-</sup>) ions, respectively. Raw wastewater pH is a function of the source of waste receipts. This parameter can vary widely from facility to facility and can be extremely variable in a single facility's raw wastewater, depending on wastewater sources. Fluctuations in pH are readily reduced by equalization followed by neutralization. Control of pH is necessary to achieve proper removal of pollutants in treatment systems such as metals precipitation.

Raw wastewater Oil and Grease is an important parameter in Centralized Waste Treatment Industry wastewater, especially for the Oils Subcategory. Oil and Grease can interfere with the operation of wastewater treatment plants and, if not removed prior to discharge, can interfere with biological life streams and/or create films along surface waters.

#### **4.4.2 *Priority and Non-Conventional Pollutants***

As discussed previously, most of the data presented in this section was collected during the EPA Sampling Program for the Centralized Waste Treatment Industry. The pollutants detected at Centralized Waste Treatment facilities were dependent on the type of waste accepted for treatment at a facility. The most predominant group of pollutants detected was metals. Metals were detected in all samples collected. The concentration of metals in raw wastewater was the highest found in industrial wastewater samples in comparison to existing effluent limitations guidelines and standards. A summary of the metal pollutants in raw wastewater by subcategory is presented in Table 4-4.

Organic pollutants were detected at varying amounts dependent on the subcategory of the facility sampled. In the Metals subcategory, organic compounds were detected at low levels since the organic compounds were incidental components of the waste receipts. The type of organics detected at Oils and Organics Subcategory facilities varied depending on the subcategory. Organic compounds in the Oils subcategory were more petroleum-based, such as alkanes and glycols, than in the Organics Subcategory. A summary of the organic pollutants in raw wastewater by subcategory is presented in Table 4-5.

**Table 4-4. Range of Metal Pollutant Influent Concentrations (mg/l)**

Pollutant	Metals Subcategory		Oils Subcategory		Organics Subcategory	
	Min	Max	Min	Max	Min	Max
Aluminum	2.867	2,090	1.200	192.58	1.498	157.94
Antimony	0.015	1,160	0.027	0.242	0.066	1.540
Arsenic	0.030	25.961	0.059	0.487	0.047	0.634
Barium	0.016	27.709	0.398	7.049	0.009	2.190
Boron	3.123	1,420	31.363	1,710	3.070	103.33
Cadmium	0.019	307	0.038	0.498	0.009	0.049
Chromium - Hexavalent	0.011	40,000				
Chromium - Total	0.102	16,300	0.363	7.178	0.063	1.265
Cobalt	0.064	232	0.551	0.868	0.026	0.731
Copper	0.199	21,000	1.200	80.482	0.224	2.690
Iron	4.450	3,745	43.60	567.69	2.360	88.828
Lead	0.208	4,390	0.607	21.725	0.094	0.687
Magnesium	3.210	1,360	22.40	247.12	6.310	23.800
Manganese	0.067	102.63	1	20.386	0.179	1.513
Mercury	0.001	3.100	0.5	0.007	0.001	0.007
Molybdenum	0.120	849	0.733	12.400	0.290	6.950
Nickel	0.581	1,700	0.313	62.824	0.069	2.610
Phosphorus	5.931	456			3	15.900
Potassium	147.1	8,895			1,010	1,240
Selenium	0.014	1.520	0.011	0.029		
Silicon	1.990	1,330			1.550	3.600
Silver	0.076	6.060	0.033	7.740		
Sulfur	708.55	24,100			972	1,990
Tin	0.145	15,100	0.592	6.216	0.200	2.530
Titanium	0.020	7,500	0.264	1.407	0.020	20.559
Vanadium	0.086	264				
Zinc	0.600	7,735	10.349	94.543	0.516	2.352



**Table 4-5. Range of Organic Pollutant Influent Concentrations (mg/l)**

Pollutant	Metals Subcategory		Oils Subcategory		Organics Subcategory	
	Min	Max	Min	Max	Min	Max
1,1,1,2-Tetrachloroethane					0.249	0.644
1,1,1-Trichloroethane	0.066	0.628	0.111	14.455	0.181	3.195
1,1,2-Trichloroethane					0.776	1.859
1,1-Dichloroethane	0.010	0.043			0.070	0.108
1,1-Dichloroethene	0.410	2.879			0.112	0.118
1,2,3-Trichloropropane					0.100	0.220
1,2-Dibromoethane					3.081	6.094
1,2-Dichloroethane					1.394	10.681
2,3,4,6-Tetrachlorophenol					1.189	1.734
2,4,5-Trichlorophenol					0.114	0.226
2,4,6-Trichlorophenol					0.148	0.203
2-Butanone	0.065	8.135	0.057	178.75	1.731	322.89
2-Picoline					0.054	0.125
2-Propanone	0.105	64.797	2.395	2,099.3	2.977	447,722.0
4-Chloro-3-Methylphenol	1.880	13.947	4.148	83.825		
4-Methyl-2-Pentanone	0.281	5.568			0.893	4.038
Acetophenone					0.336	0.739
Benzene	0.014	0.111	0.070	20.425	0.097	6.203
Benzoic acid	0.193	39.281	5.450	32.158	3.008	15.760
Benzyl alcohol					2.022	13.651
Bromodichloromethane					0.026	0.073
Carbon disulfide						
Chlorobenzene					0.070	0.101
Chloroform	0.012	0.337			2.819	10.621
Diethyl Ether					0.182	0.211
Diphenyl Ether	0.556	1.394				
Ethyl Benzene			0.057	18.579	0.016	3.813

**Table 4-5. Range of Organic Pollutant Influent Concentrations (mg/l) (continued)**

Pollutant	Metals		Oils		Organics	
	Min	Max	Min	Max	Min	Max
Hexanoic Acid	0.414	5.969	0.807	14.890	1.111	4.963
Isophorone	2.144	2.295			0.060	2.266
Methylene Chloride	0.050	0.734	0.179	6.019	33.113	13.256
m-Xylene	0.018	1.141	0.117	32.639	0.056	2.500
Naphthalene	0.045	2.926			0.112	1.253
n-Decane	0.142	14.086	0.266	579.22		
n-Docosane			0.133	3.954		
n-Dodecane	0.088	4.844	0.901	472.57		
n-Eicosane	0.062	20.253	0.312	319.08		
n-Hexacosane			0.246	2.530		
n-Hexadecane	0.086	24.369	0.795	1,368.0		
n-Octadecane	0.040	11.760	0.369	901.92		
n-Tetradecane	0.032	27.366	0.769	2,560.5		
n,n-Dimethylformamide	0.144	5.090			0.023	264.45
o+p-Xylene	0.011	0.950	0.063	14.820	0.013	1.671
o-Cresol					0.180	14.313
Pentachlorophenol					0.657	1.354
Phenol	0.061	7.739	1.695	12.325	0.553	19.453
Pyridine					0.132	16.715
p-Cresol					0.220	6.457
Tetrachloroethene	0.011	1.378	0.137	12.789	2.235	6.808
Tetrachloromethane					1.391	3.222
Toluene	0.080	8.700	0.477	99.209	0.148	3,761.7
Trans-1,2-dichloroethene					1.171	1.818
Trichloroethene	0.015	0.350			1.194	9.897
Trichlorofluoromethane					0.024	0.034
Tripropyleneglycol Methyl Ether			30.587	383.15		
Vinyl Chloride					0.290	0.485

## 4.5 WASTEWATER POLLUTANT DISCHARGES

As previously discussed, most of the effluent monitoring data received from facilities included non-CWT wastewater, such as other industrial waste streams and stormwater. Due to the lack of effluent data for CWT wastewater, the EPA had to develop various methods to estimate the current wastewater pollutant discharge. This section describes the various methodologies used to estimate current performance.

### 4.5.1 Metals Subcategory Current Performance

As illustrated in Figure 4-1, most of the data supplied by Metals Subcategory facilities represented data that included non-CWT wastewater in the form of noncontaminated stormwater and other industrial stormwater added prior to discharge. Therefore, the amount of a pollutant in the final effluent would be equal to the amount of the pollutant in CWT process and the corresponding amount in the non-CWT process as demonstrated in Equation 4.1.

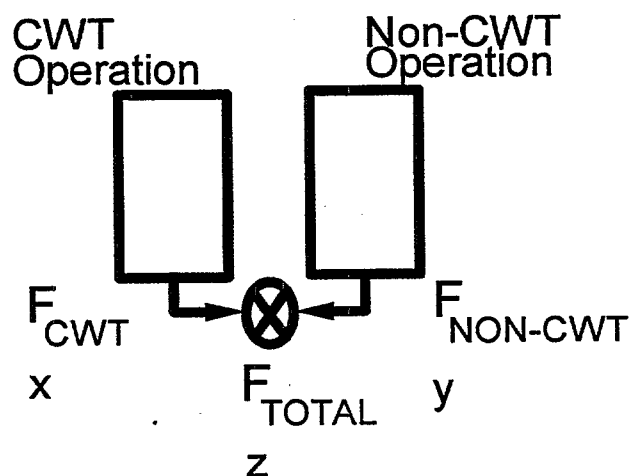


Figure 4-3 Example of Non-CWT Wastewater Addition

$$z * F_{TOTAL} = x * F_{CWT} + y * F_{NON-CWT} \quad (4-1)$$

where:

$z$  = Concentration of Pollutant in Final Effluent (mg/l),

$F_{TOTAL}$  = Total flow at Final Effluent (liters),

$x$  = Concentration of Pollutant in CWT Process Effluent (mg/l),

$F_{CWT}$  = Total flow at CWT Process Effluent (liters),

$y$  = Concentration of Pollutant in Final Effluent (mg/l), and

$F_{NON-CWT}$  = Total flow at Non-CWT Effluent (liters),

The EPA assimilated a database of the available monitoring data for facility effluent discharges. For each facility, the EPA estimated the portion of non-CWT wastewater in the facility discharge and calculated the Centralized Waste Treatment effluent concentration by applying the following formulas (Eqns. 4-2 and 4-3) depending on the source of the non-CWT wastewater. For facilities where the source of non-CWT wastewater was stormwater, the following equation was used:

$$x = \frac{z * F_{TOTAL}}{F_{CWT}} \quad (4-1)$$

For facilities in which the source of non-CWT wastewater was other industrial wastewater, the following equation was used:

$$x = \frac{Z * F_{TOTAL}}{F_{CWT} + .5 * F_{NON-CWT}} \quad (4-1)$$

In Equation 4-1, the value of variable y is dependent on the source of the non-CWT wastewater. If the non-CWT wastewater was non-contaminated stormwater, the noncontaminated stormwater was assumed to be significantly lower in concentration in comparison to the process wastewater, and thus, y was set equal to 0. If the non-CWT wastewater was other industrial wastewater, the other industrial wastewater was assumed to be half as concentrated as CWT wastewater, and thus, the variable y was set equal to .5\*x. EPA concluded this value was a reasonable assumption. A comparison of Centralized Waste Treatment raw wastewater with other promulgated industrial effluent guidelines showed that Centralized Waste Treatment Industry raw wastewater was significantly more concentrated than other industrial wastewater, in some instances 10 times more concentrated.

When possible, a facility's current performance was based upon information for which data were reported. From the information submitted, average discharge concentrations were calculated for each pollutant. Average discharge concentrations were only calculated if more than two data points were available. For facilities that did not submit analytical data, the average discharge concentration for the subcategory was used.

The estimated current performance for facilities in the Metals Subcategory is presented in Table 4-6.

**Table 4-6. Metals Subcategory Current Performance**

<b>Pollutant</b>	<b>Current Discharge Concentration (mg/l)</b>
<b>Classicals</b>	
BOD <sub>5</sub>	1,904.58
Total Cyanide	77.84
Oil & Grease	270.42
TSS	1,371.02
<b>Metals</b>	
Aluminum	1.38
Antimony	2.34
Arsenic	0.81
Barium	3.67
Boron	40.59
Cadmium	0.32
Chromium - Hexavalent	1.83
Chromium - Total	2.30
Cobalt	0.38
Copper	1.35
Iron	12.53
Lead	0.40
Manganese	1.80
Mercury	0.03
Molybdenum	12.63
Nickel	1.91
Selenium	0.15
Silver	0.42
Thallium	0.26
Tin	24.74
Titanium	1.08
Vanadium	9.71
Zinc	2.55

**Table 4-6. Metals Subcategory Current Performance (continued)**

Pollutant	Current Discharge Concentration (mg/l)
<b>Organics</b>	
1,1,1-Trichloroethane	0.08
1,1-Dichloroethane	0.01
1,1-Dichloroethene	0.07
1,4-Dioxane	1.49
2-Butanone	0.59
2-Methylnaphthalene	0.13
2-Propanone	5.53
4-Chloro-3-methylphenol	0.13
4-Methyl-2-pentanone	0.36
Acetophenone	0.07
Benzoic acid	1.95
Benzyl alcohol	0.17
Biphenyl	0.07
Bis(2-ethylhexyl)phthalate	0.04
Carbon disulfide	0.04
Diphenyl ether	0.11
Ethyl benzene	0.02
Hexanoic acid	0.36
Methylene chloride	0.03
Naphthalene	0.18
n,n-Dimethylformamide	0.12
o+p-Xylene	0.04
Phenol	0.64
Styrene	0.47
Tetrachloroethene	0.03
Toluene	0.20

#### **4.5.2 Oils Subcategory Current Performance**

The types of oils that are accepted for treatment can be characterized as stable or unstable oil-water emulsion. Stable oil-water emulsions are difficult to separate because the emulsions were created to make a specific product, such as lubricants and coolants. Chemical emulsion-breaking is necessary to separate the mixture. Unstable oil-water emulsions are more easy to separate than stable emulsions. Gravitational settling is usually sufficient to separate the oil and water phases. The wastewater generated from chemical emulsion-breaking and settling requires treatment prior to discharge. From the information gathered at facilities, the effluent from chemical-emulsion breaking was characterized to be similar to the unstable oil-water emulsions prior to settling.

Most facilities in the Oils Subcategory have operations that are also categorized in other Centralized Waste Treatment Industry subcategories. In most cases, waste receipts were treated in a Chemical Emulsion-Breaking unit, and then commingled with the other subcategory wastewater. In reviewing data collected after emulsion-breaking and at the point of mixing the waste streams, most pollutants of concern for the Oils Subcategory were found at non-detect levels at the point of mixing. Therefore, it was apparent that the pollutants of concern were being diluted prior to treatment.

The EPA estimated the current performance of most Oils Subcategory facilities to be equivalent to the chemical emulsion breaking effluent. Credit was not given for oily wastewater commingled with other wastewater because dilution was normally the form of treatment. A summary of the estimated current performance for the Oils Subcategory is presented in Table 4-7.



**Table 4-7. Oils Subcategory Current Performance**

<b>Pollutant</b>	<b>Current Discharge Concentration (mg/l)</b>
<b>Classical</b>	
BOD <sub>5</sub>	7,164.49
Oil and Grease	29,396.88
TSS	7,209.98
<b>Metals</b>	
Aluminum	48.93
Antimony	1.34
Arsenic	0.22
Barium	2.53
Boron	239.36
Cadmium	0.24
Chromium	2.20
Cobalt	0.72
Copper	15.79
Iron	232.26
Lead	8.15
Manganese	7.39
Molybdenum	3.05
Nickel	26.44
Silver	1.08
Tin	2.10
Titanium	0.38
Zinc	42.00
<b>Organics</b>	
1,1,1-Trichloroethane	3.64
2-Butanone	20.10
2-Propanone	221.07

**Table 4-7. Oils Subcategory Current Performance (continued)**

<b>Pollutant</b>	<b>Current Discharge Concentration (mg/l)</b>
<b>Organics (continued)</b>	
4-Chloro-3-Methylphenol	22.31
Benzene	8.25
Benzoic acid	16.81
Ethyl benzene	6.61
Hexanoic acid	5.38
Methylene chloride	1.47
m-Xylene	11.37
n-Decane	91.78
n-Docosane	3.03
n-Dodecane	70.39
n-Eicosane	42.69
n-Hexacosane	3.08
n-Hexadecane	153.22
n-Octadecane	95.36
n-Tetradecane	282.72
o+p-Xylene	5.19
Phenol	4.59
Tetrachloroethene	2.16
Toluene	33.95
Tripropyleneglycol Methyl Ether	86.47

#### **4.5.3 *Organics Subcategory Current Performance***

The problems in estimating current performance for the Organics Subcategory are similar to that of the Metals Subcategory. Most Organics Subcategory facilities have other industrial operations. The percentage of CWT wastewater in the overall facility flow was minimal as was the amount of monitoring data submitted in the questionnaire. Therefore, the EPA estimated performance based upon the treatment technologies in place.

Four different classifications were used to determine the current performance of facilities in the Organics Subcategory. The first classification was used for facilities with no treatment in place to reduce the pollutants in the organic waste stream. The average raw waste concentration of pollutants was used for facilities in this classification. The second classification was used for facilities which only had multi-media or sand filtration as the on-site treatment technology for the organic waste stream. For these facilities, a 20 percent removal of TSS and metal compounds and no removal of other classical and organic pollutants was assumed to occur from the raw waste concentration levels. The third classification was used for facilities with multi-media or sand filtration units followed by carbon adsorption. Removal of 20 percent for classical pollutants, 10 percent for metal compounds, and 50 percent for organic pollutants from the raw wastewater were estimated. The percent removals used were based on estimates of the treatment unit effectiveness. The current performance for the remaining facilities was based on analytical data collected for biological systems with and without multi-media or sand filtration units.

A summary of the current performance for the Organics Subcategory is presented in Table 4-8.

**Table 4-8. Organics Subcategory Current Performance**

<b>Pollutant</b>	<b>Current Discharge Concentration (mg/l)</b>
<b>Classicals</b>	
BOD <sub>5</sub>	2,288.61
Total Cyanide	1.76
Oil & Grease	9.63
TSS	224.69
<b>Metals</b>	
Aluminum	2.04
Antimony	0.22
Arsenic	0.10
Barium	1.94
Boron	4.89
Chromium	0.11
Cobalt	0.27
Copper	0.32
Iodine	7.60
Iron	3.50
Lead	0.09
Lithium	14.91
Manganese	0.38
Mercury	0.02
Molybdenum	0.52
Nickel	3.37
Phosphorus	3.14
Silicon	2.28
Strontium	4.67
Sulfur	841.15
Tin	0.97

**Table 4-8. Organics Subcategory Current Performance (continued)**

Pollutant	Current Discharge Concentration (mg/l)
<b>Metals (continued)</b>	
Titanium	0.21
Zinc	0.25
<b>Organics</b>	
1,1,1,2-Tetrachloroethane	0.16
1,1,1-Trichloroethane	0.18
1,1,2-Trichloroethane	0.30
1,1-Dichloroethane	0.16
1,1-Dichloroethene	0.15
1,2,3-Trichloropropane	0.15
1,2-Dibromoethane	0.20
1,2-Dichlorobenzene	0.06
1,2-Dichloroethane	0.25
2,3,4,6-Tetrachlorophenol	3.52
2,3-Dichloroaniline	0.10
2,4,5-Trichlorophenol	0.39
2,4,6-Trichlorophenol	0.72
2,4-Dimethyl phenol	0.04
2-Butanone	3.05
2-Chlorophenol	0.06
2-Hexanone	1.19
2-Picoline	0.20
2-Propanone	164.89
4-Methyl-2-pentanone	0.79
Acetophenone	0.04
Benzene	0.20
Benzoic acid	0.36

**Table 4-8. Organics Subcategory Current Performance (continued)**

<b>Pollutant</b>	<b>Current Discharge Concentration (mg/l)</b>
<b>Organics (continued)</b>	
Bromodichloromethane	0.15
Carbon disulfide	0.22
Chlorobenzene	0.15
Chloroform	0.64
Diethyl ether	0.76
Ethyl benzene	0.17
Hexanoic acid	0.19
Isophorone	0.05
Methylene chloride	42.07
m-Xylene	0.17
Naphthalene	0.04
n,n-Dimethylformamide	0.77
o&p-Xylene	0.16
o-Cresol	0.17
Pentachlorophenol	1.79
Phenol	0.36
Pyridine	0.18
p-Cresol	0.10
Tetrachloroethene	0.61
Tetrachloromethane	0.18
Toluene	15.75
trans-1,2-Dichloroethene	0.25
Trichloroethene	0.92
Trichlorofluoromethane	0.16
Vinyl Chloride	0.19

## **SECTION 5**

### **POLLUTANTS AND POLLUTANT PARAMETERS SELECTED FOR REGULATION**

As previously discussed, EPA evaluated all available data characterizing wastewater for this industry in order to determine the pollutants of concern for the Centralized Waste Treatment Industry. This section discusses the pollutants and pollutant parameters detected in the Centralized Waste Treatment Industry.

#### **5.1 *POLLUTANT PARAMETERS***

Pollutant parameters, which include conventional pollutants, such as TSS and Oil and Grease, and non-conventional pollutant parameters, such as chemical oxygen demand (COD) and total organic carbon (TOC), are general indicators of water quality rather than markers of specific compounds. Because most of the industry are indirect dischargers, they are not subject to limitations for conventional pollutants normally included in direct discharge permits but not in indirect discharge permits.

The pollutant parameters proposed for regulating are a function of the subcategory. In the Metals Subcategory, the most important pollutant parameter is total suspended solids because of the correlation to treatment unit effectiveness. In general, TSS is an important parameter for all subcategories because of its correlation to the type of waste accepted for treatment, and will be covered for all subcategories. Oil and Grease is proposed for regulation for the Metals Subcategory because of its ability to interfere with the performance of metals treatment systems. Oil and Grease is an extremely important measure for estimating treatment unit performance for the Oils Subcategory. The most important parameter for the Organics Subcategory is BOD<sub>5</sub> because it measures biodegradability of organic compounds.

## **5.2 PRIORITY AND NON-CONVENTIONAL POLLUTANTS**

In the beginning of the industry study, more than 480 priority and non-conventional pollutants, listed in Appendix B, were analyzed. These pollutants are a combination of all pollutants for which the EPA has approved analytical methods, including RCRA and TSCA compounds. After the initial two sampling episode, Dioxins/Furans and Pesticides/Herbicides were no longer analyzed because they were not detected in the waste streams at treatable concentrations. CWT facilities that are RCRA permitted operations are prohibited from receiving either dioxins/furans or pesticides/herbicides because the RCRA required treatment for these compounds is incineration.

The priority and non-conventional pollutants to be regulated were determined by a series of data reviews. Analytical data from raw wastewater samples collected during the EPA Sampling Program were reviewed to determine the number of times a pollutant was detected at treatable levels. In most cases, treatable levels were set at 10 times the minimum level. This would ensure that pollutants detected only at trace amounts would not be regulated. Regulation would not be required because most pollutants found at trace amounts will be indirectly controlled through regulation of other pollutants by the proposed regulations.

The initial pollutants of concern for each subcategory were derived from the pollutants which were detected at a treatable level a minimum of three times in the subcategory raw waste stream. A minimum number of times (3) for detection was established such that a pollutant infrequently detected would not be regulated for the entire subcategory. The final list of pollutants to be regulated was later refined depending on the quantity of pollutant detected and the ability of a pollutant to be controlled depending upon the regulation of other pollutants.

After evaluating all of these factors, the Agency selected for regulation 63 pollutants. The final list of pollutants to be regulated for each subcategory is presented in Table 5-1.



**Table 5-1**  
**Pollutants Selected for Regulation**

<b>Metals Subcategory</b>	<b>Oils Subcategory</b>	<b>Organics Subcategory</b>
Aluminum	1,1,1-Trichloroethane	1,1,1,2-Tetrachloroethane
Antimony	2-Propanone	1,1,1-Trichloroethane
Arsenic	4-chloro-3-methyl phenol	1,1,2-Trichloroethene
Barium	Aluminum	1,1-Dichloroethane
Cadmium	Barium	1,2,3-Trichloropropane
Chromium	Benzene	1,2-Dibromoethane
Cobalt	Butanone	1,2-Dichloroethane
Copper	Cadmium	2,3-Dichloroaniline
Hexavalent Chromium	Chromium	2-Propanone
Iron	Copper	4-Methyl-2-Pentanone
Lead	Ethyl Benzene	Acetophenone
Magnesium	Iron	Aluminum
Manganese	Lead	Antimony
Mercury	Manganese	Barium
Nickel	Methylene Chloride	Benzene
Silver	m-Xylene	Benzoic Acid
Tin	Nickel	Butanone
Titanium	n-Decane	Carbon Disulfide
Total Cyanide	n-Docosane	Chloroform
Zinc	n-Dodecane	Diethyl Ether
	n-Eicosane	Hexanoic Acid
	n-Hexacosane	Lead
	n-Hexadecane	Methylene Chloride
	n-Octadecane	Molybdenum
	n-Tetradecane	m-Xylene
	o&p-Xylene	o-Cresol
	Tetrachloroethene	p-Cresol
	Tin	Phenol
	Toluene	Pyridine
	Tripropyleneglycol	Tetrachloroethene
	Zinc	Tetrachloromethane
		Toluene
		trans-1,2-Dichloroethene
		Trichloroethene
		Vinyl Chloride
		Zinc

EPA is not selecting pollutants for regulation for various reasons. The initial determination of pollutants to be included in the regulation was the number of times the pollutant was detected in raw wastewater samples. After these pollutants were removed,

pollutants used as treatment chemicals were also removed from all data. Calcium, Sodium, Potassium, and Phosphorus were the pollutants found in treatment chemicals removed from the regulated list for all subcategories. These pollutants are added to the process and are not toxic to water. Pollutants were also removed from the list to be regulated if the pollutant was only detected at one facility, and therefore, not present throughout the industry. The only pollutants excluded from regulation due to the presence at an isolated facility were Gallium and Strontium from the Organics Subcategory.

Additional pollutants were removed from the regulated list if the average influent concentration detected was below a treatable level. For most pollutants, the concentration level for was set at 100 µg/l or 10 times the analytical minimum level. For Mercury, the concentration was less than 5µg/l due to the toxicity of Mercury in water. These pollutants are presented in Table 5-2.

<b>Table 5-2</b> <b>Pollutants Excluded from Regulation Due to the Concentration Detected</b>		
<b>Metals Subcategory</b>	<b>Oils Subcategory</b>	<b>Organics Subcategory</b>
Beryllium Yttrium Endosulfan Sulfate	Antimony Arsenic Beryllium Mercury Selenium Yttrium	Arsenic Cadmium Mercury Titanium Yttrium 1,1-Dichloroethane 1,2-Dimethyl phenol 2-Chlorophenol 2-Hexanone 2-Picoline Benzyl Alcohol Bromodichloromethane Chlorobenzene Ethyl Benzene Isophorone Naphthalene n,n-Dimethylformamide o&p-Xylene Trichlorofluoromethane Endosulfan Sulfate

Pollutants were also excluded from regulation when they were not detected or analyzed at the facilities used for the proposed technology option. Some pollutants were excluded from analysis to reduce the costs of sampling episodes. The pollutants excluded from analysis were found at concentrations similar to the treatability levels discussed previously and are not toxic at these concentrations. These pollutants are listed in Table 5-3.

<b>Table 5-3</b> <b>Pollutants Excluded from Regulation Due to Lack of Detection or Analysis at the Technology Option Facility</b>		
<b>Metals Subcategory</b>	<b>Oils Subcategory</b>	<b>Organics Subcategory</b>
Cerium Gallium Indium Iodine Iridium Lithium Lutetium Neodymium Niobium Osmium Praseodymium Rhenium Selenium Silicon Strontium Sulfur Tantalum Tellurium Thallium Thorium Tungsten Uranium Ytterbium Zirconium All organic pollutants	None	None

Additional pollutants were excluded from regulation because the technology option proposed was not effective in treating the pollutant (i.e., pollutant concentrations increase across the treatment system). These pollutants are listed in Table 5-4.

<b>Table 5-4</b> <b>Pollutants Excluded from Regulation Due to Ineffective Treatment</b>		
<b>Metals Subcategory</b>	<b>Oils Subcategory</b>	<b>Organics Subcategory</b>
None	Benzoic Acid Hexanoic Acid Phenol	2,3,4,6- Tetrachlorophenol 2,4,5-Trichlorophenol 2,4,6-Trichlorophenol Boron Iodine Lithium Magnesium Manganese Nickel Pentachlorophenol Tin

### **5.3     *SELECTION OF POLLUTANTS TO BE REGULATED FOR PSES AND PSNS***

Indirect dischargers in the CWT Industry send their wastewater streams to a POTW for further treatment, unlike direct dischargers, whose wastewater will receive no further treatment once it leaves their facility. Therefore, the levels of pollutants allowable in the wastewater of an indirect discharger are dependent upon 1) whether a given pollutant "passes through" the POTWs treatment system or 2) whether additional treatment provided by the POTW will result in removal of the pollutant to a level equivalent to that obtained through treatment by a direct discharger.

### **5.3.1 *Pass-Through Analysis Approach***

To establish PSES, EPA must first determine which of the CWT pollutants of concern (identified earlier in this section) pass through, interfere with, or are incompatible with the operation of POTWs (including interferences with sludge practices). EPA determines pollutant pass-through by comparing the percentage removed by POTWs with the percentage removed by direct dischargers using BPT/BAT technology. A pollutant "passes through" POTWs when the average percentage removed by well-operated POTWs nationwide (those meeting secondary treatment requirements) is less than the percentage removed by CWT direct dischargers complying with BPT/BAT limitations for a given pollutant. EPA has assumed, for the purposes of this analysis and based upon the data it received, that the untreated wastewater at indirect discharge facilities is not significantly different than that from direct discharge facilities.

This approach to the definition of pass-through satisfies two competing objectives set by Congress: (1) that standards for indirect dischargers be equivalent to standards for direct dischargers and (2) that the treatment capability and performance of the POTW be recognized and taken into account in regulating the discharge of pollutants from indirect dischargers. Rather than compare the mass or concentration of pollutants discharged by the POTW with the mass or concentration of pollutants discharged by a BAT facility, EPA compares the percentage of the pollutants removed by the facility with the POTW removal. EPA takes this approach because a comparison of mass or concentration of pollutants in a POTW effluent with pollutants in a BAT facility's effluent would not take into account the mass of pollutants discharged to the POTW from non-industrial sources nor the dilution of the pollutants in the POTW effluent to lower concentrations from the addition of large amounts of non-industrial wastewater.

### **5.3.2 50 POTW Study Data Base**

For previous effluent guidelines efforts, a study of 50 well-operated POTWs was used to establish POTW removals for comparison with facility removals for the pass-through analysis. The earlier work done with this data base included an in-depth comparison of data editing scenarios. The main concern with using the data is the possibility that low calculated POTW removals might simply reflect low influent concentrations, and would not be true measures of treatment effectiveness. The editing rules used in this guideline were devised to minimize this possibility.

First, a POTW/pollutant combination must have at least three influent values to be kept in the analysis. Then, because the data base includes influent levels that are close to the pollutants' analytical nominal detection limits (NOMDLs), the POTW data were edited to eliminate average POTW/pollutant influent levels less than 10 times the NOMDLs and the corresponding effluent data, except in the cases where the average influent concentration did not exceed 10 times the NOMDL. In these cases, the data were edited to eliminate average POTW/pollutant influent values less than 20  $\mu\text{g/l}$  and the corresponding effluent data. With regard to industry data, EPA considers influent levels in excess of 10 times the pollutant's NOMDL at a facility to be appropriate for use in setting effluent limitations. Secondly, EPA has historically found that pollutants with low influent concentrations (less than 20  $\mu\text{g/l}$ ) have shown corresponding effluent concentrations that were consistently below the NOMDL and could not be quantified.

The remaining averaged POTW/pollutant influent values and the corresponding averaged effluent values were used to calculate the average removal for each POTW/pollutant. The median percent removal achieved for each pollutant was determined from these averaged POTW/pollutant values.

### **5.3.3 RREL Treatability Data Base**

Due to the large number of pollutants considered for this industry, additional data from the EPA Risk Reduction Engineering Laboratory (RREL) Treatability Database were used to supplement the 50 POTW Study data. Due to the organization of this data base, the editing rules used for the POTW data base were modified appropriately.

For each of the pollutants, data from the liquid waste portion of the RREL Treatability Database were obtained. These files were edited so that only treatment technology data for activated sludge, aerobic lagoons, and activated sludge with filtration remained. These technologies are representative of typical POTW secondary treatment operations. The files were further edited to include only information pertaining to domestic or industrial wastewater, unless only other types of wastewater data were available. Only full-scale or pilot-scale data were used; bench-scale data were edited out. Only data from a paper in a peer-reviewed journal or government report or data base were retained; all lesser-quality references were deleted. Additionally, the retained references were reviewed and non-applicable study data were accordingly eliminated. Because the data base is organized into groupings of influent values, the influent editing rules used for the 50 POTW Study data base could not be applied here.

From the remaining pollutant removal data, the average percent removal for each pollutant was calculated.

### **5.3.4 Final POTW Data Editing**

For each pollutant, the edited percent removals from the 50 POTW Study and RREL Treatability Data Base were compared. The final percent removal for each pollutant was chosen based on a data hierarchy, which was related to the quality of the data source. This hierarchy was:

1. 50 POTW Study data (10 times NOMDL edit);
2. 50 POTW Study data (20  $\mu\text{g/l}$  edit);
3. RREL Treatability data (domestic wastewater only edit, if three or more data points);
4. RREL Treatability data (domestic and industrial wastewater edit); then
5. Generic pollutant group removal data (see discussion below).

After the editing of the 50 POTW and RREL Treatability data was finished, there were some CWT pollutants for which no data were available. To determine average removals for these pollutants, all of the CWT pollutants were assigned to a generic group by chemical structure. These groups were:

- A. Inorganic Elements;
- B. Halogenated Hydrocarbons;
- C. Hydrocarbons;
- D. Aromatic Hydrocarbons;
- E. Halogenated Aromatics;
- F. Organic Acids;
- G. Aromatic Alcohols;
- H. Phenolics;
- I. Halogenated Phenolics;
- J. Pesticides;
- K. Heterocyclics;
- L. Ketones;
- M. Aromatic Ketones;
- N. Cyclic Ketones;
- O. Polyaromatic Hydrocarbons;
- P. Phthalates;
- Q. Ethers; and
- R. Amides.

All of the available removals for the pollutants within a given group were averaged; this average removal was then assigned to any pollutant within that group that did not previously have a removal value. After the final selection of CWT pollutants to be regulated, the only generic removals that were applicable were for Groups C



(Hydrocarbons) and Q (Ethers); these group removals are presented in Tables 5-5 and 5-6, respectively. The final POTW removals for the CWT pollutants, determined via the data use hierarchy, are presented in Table 5-7.

**Table 5-5.** Generic Removals for Group C: Hydrocarbons

Pollutant Parameter	Removal (%)	Source of Data
n-Decane	9.00	RREL - All Wastewater Edit
n-Docosane	88.00	RREL - All Wastewater Edit
n-Dodecane	95.05	RREL - All Wastewater Edit
n-Eicosane	92.40	RREL - All Wastewater Edit
n-Hexacosane	-	-
n-Hexadecane	-	-
n-Octadecane	-	-
n-Tetradecane	-	-
<b>Average Group Removal</b>	<b>71.11</b>	-

**Table 5-6.** Generic Removals for Group Q: Ethers

Pollutant Parameter	Removal (%)	Source of Data
Diethyl Ether	7.00	RREL - All Wastewater Edit
Diphenyl Ether	86.53	RREL - All Wastewater Edit
Tripropyleneglycol Methyl Ether	-	-
<b>Average Group Removal</b>	<b>46.77</b>	-

**Table 5-7. Final POTW Removals for CWT Pollutants**

<b>Pollutant Parameter</b>	<b>Removal (%)</b>	<b>Source of Data</b>
1,1,1,2-Tetrachloroethane	23.00	RREL - All Wastewater Edit
1,1,1-Trichloroethane	90.45	50 POTW - 10 x NOMDL Edit
1,1,2-Trichloroethane	55.98	50 POTW - >20 $\mu\text{g/l}$ Edit
1,1-Dichloroethene	75.34	50 POTW - >20 $\mu\text{g/l}$ Edit
1,2,3-Trichloropropane	5.00	RREL - All Wastewater Edit
1,2-Dibromoethane	17.00	RREL - All Wastewater Edit
1,2-Dichloroethane	89.03	50 POTW - 10 x NOMDL Edit
2,3-Dichloroaniline	41.00	RREL - All Wastewater Edit
2-Propanone	83.75	RREL - All Wastewater Edit
4-Chloro-3-methylphenol	63.00	RREL - All Wastewater Edit
4-Methyl-2-pentanone	87.87	RREL - All Wastewater Edit
Acetophenone	95.34	RREL - All Wastewater Edit
Aluminum	16.81	50 POTW - 10 x NOMDL Edit
Antimony	71.13	50 POTW - 10 x NOMDL Edit
Arsenic	90.89	50 POTW - 10 x NOMDL Edit
Barium	90.20	50 POTW - 10 x NOMDL Edit
Benzene	94.76	50 POTW - 10 x NOMDL Edit
Benzoic Acid	80.50	RREL - All Wastewater Edit
Butanone	91.83	RREL - All Wastewater Edit
Cadmium	90.05	50 POTW - 10 x NOMDL Edit
Carbon Disulfide	84.00	RREL - All Wastewater Edit
Chloroform	73.44	50 POTW - 10 x NOMDL Edit
Chromium	91.25	50 POTW - 10 x NOMDL Edit
Cobalt	4.81	50 POTW - 10 x NOMDL Edit
Copper	84.11	50 POTW - 10 x NOMDL Edit
Diethyl Ether	7.00	RREL - All Wastewater Edit
Ethyl Benzene	93.79	50 POTW - 10 x NOMDL Edit
Hexavalent Chromium	5.68	50 POTW - 10 x NOMDL Edit
Hexanoic Acid	84.00	RREL - All Wastewater Edit
Iron	83.00	RREL - Domestic Wastewater Edit
Lead	91.83	50 POTW - 10 x NOMDL Edit
Magnesium	31.83	RREL - All Wastewater Edit

**Table 5-7. Final POTW Removals for CWT Pollutants (continued)**

<b>Pollutant Parameter</b>	<b>Removal (%)</b>	<b>Source of Data</b>
Manganese	40.60	RREL - All Wastewater Edit
Mercury	90.16	50 POTW - 10 x NOMDL Edit
Methylene Chloride	54.28	50 POTW - 10 x NOMDL Edit
Molybdenum	52.17	RREL - Domestic Wastewater Edit
m-Xylene	65.40	RREL - All Wastewater Edit
Nickel	51.44	50 POTW - 10 x NOMDL Edit
n-Decane	9.00	RREL - All Wastewater Edit
n-Docosane	88.00	RREL - All Wastewater Edit
n-Dodecane	95.05	RREL - All Wastewater Edit
n-Eicosane	92.40	RREL - All Wastewater Edit
n-Hexacosane	71.11	Generic removal-Group C
n-Hexadecane	71.11	Generic removal-Group C
n-Octadecane	71.11	Generic removal-Group C
n-Tetradecane	71.11	Generic removal-Group C
o&p-Xylene	95.07	RREL - Domestic Wastewater Edit
o-Cresol	52.50	RREL - All Wastewater Edit
Phenol	95.25	50 POTW - 10 x NOMDL Edit
Pyridine	95.40	RREL - All Wastewater Edit
p-Cresol	71.67	RREL - All Wastewater Edit
Silver	92.42	50 POTW - 10 x NOMDL Edit
Tetrachloroethene	84.61	50 POTW - 10 x NOMDL Edit
Tetrachloromethane	87.94	50 POTW - 10 x NOMDL Edit
Tin	65.20	RREL - All Wastewater Edit
Titanium	68.77	RREL - All Wastewater Edit
Toluene	96.18	50 POTW - 10 x NOMDL Edit
Total Cyanide	70.44	50 POTW - 10 x NOMDL Edit
trans-1,2-Dichloroethene	70.88	50 POTW - >20 $\mu$ g/l Edit
Trichloroethene	86.85	50 POTW - 10 x NOMDL Edit
Tripropyleneglycol Methyl Ether	46.77	Generic removal-Group Q
Vinyl Chloride	93.49	50 POTW - 10 x NOMDL Edit
Zinc	77.97	50 POTW - 10 x NOMDL Edit

### **5.3.5 Final Pass-Through Analysis Results**

For each CWT option/pollutant, the daily removals were calculated using the BPT/BAT data. Then, the average overall BPT/BAT removal was calculated for each pollutant from the daily removals. The averaging of daily removals is appropriate for this industry as the BPT/BAT treatment technologies typically have retention times of less than one day. For the final pass-through analysis, the final POTW removal determined for each CWT pollutant was compared to the percent removal achieved for that pollutant using the BPT/BAT option treatment technologies.

Those pollutants that were deemed to not pass though were then subjected to a volatile override test. A volatile override was applied where the overall percent removal estimated at a POTW included in substantial part the emission of the pollutant to the air rather than actual treatment. Therefore, even though the POTW removal data indicated that a volatile pollutant would not pass through, the volatile override warranted establishment of PSES for that pollutant.

The Henry's Law Constant for a pollutant gives a qualitative indication of its volatility. For pollutants with values less than  $10^{-7}$  atm-m<sup>3</sup>/mole, the chemical is less volatile than water; for pollutants around  $10^{-3}$ , volatilization from water will be rapid. The cut-off used for the volatile override was a Henry's Law Constant of  $2.4 \times 10^{-5}$  atm-m<sup>3</sup>/mole, or  $10^{-3}$  mg/m<sup>3</sup>/mg/m<sup>3</sup>. EPA considers this cut-off to be a conservative edit for pollutants of medium to high volatility.

For the CWT pass-through analysis, 12 organic pollutants were found to not pass through after the preliminary analysis, and were therefore reviewed for volatility. The Henry's Law Constants for these pollutants are presented in Table 5-8. Of these 12 pollutants, eight were affected by the volatile override; therefore, these pollutants are now considered to pass through POTWs.

**Table 5-8. Volatile Override Analysis for CWT Pollutants**

Pollutant Parameter	Henry's Law Constant (atm-m <sup>3</sup> /mole)	Volatile Override
1,1,1-Trichloroethane	$4.8 * 10^{-3}$	Yes
2-Butanone	$2.7 * 10^{-5}$	Yes
2-Propanone	$2.1 * 10^{-5}$	No
Benzene	$5.6 * 10^{-3}$	Yes
Carbon Disulfide	$1.2 * 10^{-2}$	Yes
Methylene Chloride	$3.2 * 10^{-3}$	Yes
o&p-Xylene	$7.0 * 10^{-3}$	Yes
Phenol	$1.3 * 10^{-6}$	No
Pyridine	$2.1 * 10^{-6}$	No
Toluene	$5.9 * 10^{-3}$	Yes
Tripropyleneglycol Methyl Ether	No data available	No
Vinyl Chloride	$2.8 * 10^{-2}$	Yes

Of the 87 pollutants regulated under BAT, 78 were found to pass through for Regulatory Option 1 (the combination of Metals Option 3, Oils Option 2, and Organics Option 1), and 81 were found to pass through under Regulatory Option 2 (the combination of Metals Option 3, Oils Option 3, and Organics Option 1), and are proposed for PSES. The final pass-through analysis results for the CWT Metals, Oils, and Organics Subcategory Options are presented in Tables 5-9, 5-10, and 5-11, respectively.

**Table 5-9. Final Pass-Through Results for Metals Subcategory Option 3**

Pollutant Parameter	Option 3 Removal (%)	POTW Removal (%)	Prelim. Pass-Through	Volatile Override	Final Pass-Through
Aluminum	99.99	16.81	Yes	-	Yes
Antimony	99.76	71.13	Yes	-	Yes
Arsenic	99.88	90.89	Yes	-	Yes
Barium	85.58	90.20	No	NA	No
Cadmium	99.93	90.05	Yes	-	Yes
Chromium	99.99	91.25	Yes	-	Yes
Cobalt	99.20	4.81	Yes	-	Yes
Copper	100.00	84.11	Yes	-	Yes
Hexavalent Chromium	98.55	5.68	Yes	-	Yes
Iron	99.96	83.00	Yes	-	Yes
Lead	99.97	91.83	Yes	-	Yes
Magnesium	99.81	31.83	Yes	-	Yes
Manganese	99.97	40.60	Yes	-	Yes
Mercury	99.81	90.16	Yes	-	Yes
Nickel	99.67	51.44	Yes	-	Yes
Silver	99.55	92.42	Yes	-	Yes
Tin	99.90	65.20	Yes	-	Yes
Titanium	99.98	68.77	Yes	-	Yes
Total Cyanide	95	70.44	Yes	-	Yes
Zinc	99.99	77.97	Yes	-	Yes

**Table 5-10. Final Pass-Through Results for Oils Subcategory Options 2 and 3**

Pollutant Parameter	Option Removal (%)		POTW Removal (%)	Prelim Pass-Through		Volatile Override	Final Pass-Through	
	2	3		2	3		2	3
1,1,1-Trichloroethane	80.21	97.71	90.45	No	Yes	Yes	Yes	Yes
2-Propanone	96.38	95.97	83.75	Yes	Yes	-	Yes	Yes
4-Chloro-3-methylphenol	80.60	98.40	63.00	Yes	Yes	-	Yes	Yes
Aluminum	97.48	99.80	16.81	Yes	Yes	-	Yes	Yes
Barium	99.37	99.96	90.20	Yes	Yes	-	Yes	Yes
Benzene	64.53	93.89	94.76	No	No	Yes	Yes	Yes
Butanone	96.37	95.63	91.83	Yes	Yes	-	Yes	Yes
Cadmium	97.46	99.20	90.05	Yes	Yes	-	Yes	Yes
Chromium	84.67	99.77	91.25	No	Yes	NA	No	Yes
Copper	99.66	99.96	84.11	Yes	Yes	-	Yes	Yes
Ethyl Benzene	94.20	99.63	93.79	Yes	Yes	-	Yes	Yes
Iron	93.24	99.92	83.00	Yes	Yes	-	Yes	Yes
Lead	92.57	99.72	91.83	Yes	Yes	-	Yes	Yes
Manganese	80.60	99.66	40.60	Yes	Yes	-	Yes	Yes
Methylene Chloride	51.74	81.30	54.28	No	Yes	Yes	Yes	Yes
m-Xylene	95.08	99.80	65.40	Yes	Yes	-	Yes	Yes
n-Decane	99.90	99.96	9.00	Yes	Yes	-	Yes	Yes
n-Docosane	97.77	99.02	88.00	Yes	Yes	-	Yes	Yes
n-Dodecane	99.85	99.94	95.05	Yes	Yes	-	Yes	Yes
n-Eicosane	99.69	99.86	92.40	Yes	Yes	-	Yes	Yes
n-Hexacosane	97.81	99.04	71.11	Yes	Yes	-	Yes	Yes
n-Hexadecane	99.76	99.89	71.11	Yes	Yes	-	Yes	Yes
n-Octadecane	99.13	99.62	71.11	Yes	Yes	-	Yes	Yes
n-Tetradecane	99.37	99.72	71.11	Yes	Yes	-	Yes	Yes
Nickel	24.40	98.37	51.44	No	Yes	NA	No	Yes
o&p-Xylene	94.03	99.73	95.07	No	Yes	Yes	Yes	Yes
Tetrachloroethene	91.29	99.13	84.61	Yes	Yes	-	Yes	Yes
Tin	82.87	94.35	65.20	Yes	Yes	-	Yes	Yes
Toluene	83.23	98.53	96.18	No	Yes	Yes	Yes	Yes
Tripropyleneglycol Methyl Ether	27.12	82.46	46.77	No	Yes	NV	No	Yes
Zinc	68.82	98.51	77.97	No	Yes	NA	No	Yes

**Table 5-11. Final Pass-Through Results for Organics Subcategory Option 1**

Pollutant Parameter	Option 1 Removal (%)	POTW Removal (%)	Prelim Pass-Through	Volatile Override	Final Pass-Through
1,1,1,2-Tetrachloroethane	98.86	23.00	Yes	-	Yes
1,1,1-Trichloroethane	91.78	90.45	Yes	-	Yes
1,1,2-Trichloroethane	93.71	55.98	Yes	-	Yes
1,1-Dichloroethene	89.70	75.34	Yes	-	Yes
1,2,3-Trichloropropane	95.82	5.00	Yes	-	Yes
1,2-Dibromoethane	99.74	17.00	Yes	-	Yes
1,2-Dichloroethane	99.17	89.03	Yes	-	Yes
2,3-Dichloroaniline	67.33	41.00	Yes	-	Yes
2-Propanone	79.44	83.75	No	No	No
4-Methyl-2-pentanone	96.00	87.87	Yes	-	Yes
Acetophenone	97.38	95.34	Yes	-	Yes
Aluminum	83.57	16.81	Yes	-	Yes
Antimony	72.13	71.13	Yes	-	Yes
Barium	94.29	90.20	Yes	-	Yes
Benzene	91.40	94.76	No	Yes	Yes
Benzoic Acid	96.88	80.50	Yes	-	Yes
Butanone	69.80	91.83	No	Yes	Yes
Carbon Disulfide	68.01	84.00	No	Yes	Yes
Chloroform	96.22	73.44	Yes	-	Yes
Diethyl Ether	69.83	7.00	Yes	-	Yes
Hexanoic Acid	90.43	84.00	Yes	-	Yes
Lead	66.49	91.83	No	NA	No
Methylene Chloride	97.29	54.28	Yes	-	Yes
Molybdenum	75.38	52.17	Yes	-	Yes
m-Xylene	91.09	65.40	Yes	-	Yes
o-Cresol	99.84	52.50	Yes	-	Yes
Phenol	90.34	95.25	No	No	No
Pyridine	60.17	95.40	No	No	No
p-Cresol	92.32	71.67	Yes	-	Yes
Tetrachloroethene	93.60	84.61	Yes	-	Yes
Tetrachloromethane	99.80	87.94	Yes	-	Yes
Toluene	98.18	96.18	Yes	-	Yes
trans-1,2-Dichloroethene	95.82	70.88	Yes	-	Yes
Trichloroethene	92.28	86.85	Yes	-	Yes
Vinyl Chloride	92.19	93.49	No	Yes	Yes
Zinc	73.75	77.97	No	NA	No



## 5.4 REFERENCES

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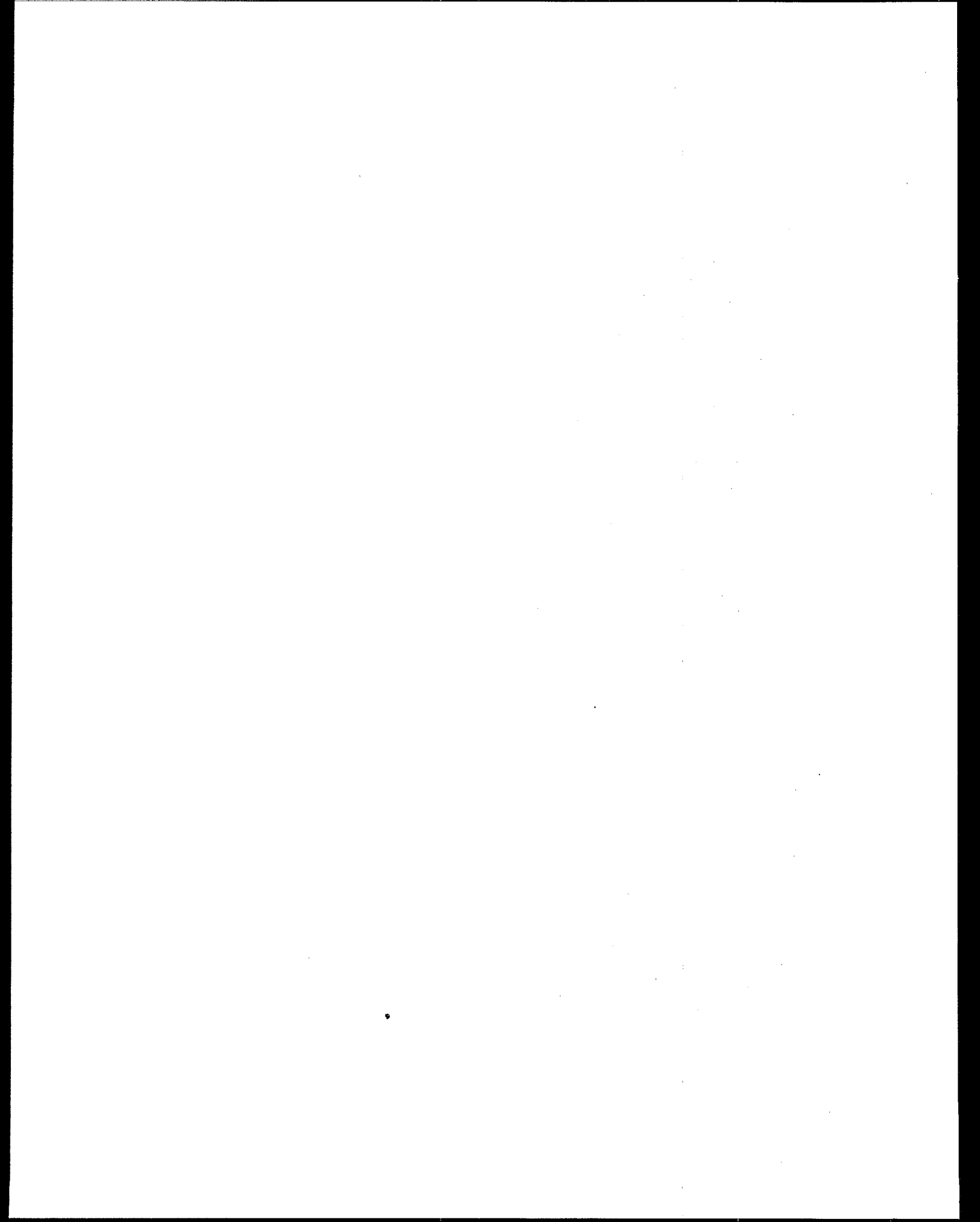
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## **SECTION 6**

### **WASTEWATER TREATMENT TECHNOLOGIES**

This section discusses the technologies available for the treatment of wastewater generated by the CWT Industry. Many of these technologies are currently in operation at CWT facilities; the others were chosen for inclusion in this discussion based on their potential for application in treating the CWT pollutants of concern.

The processes presented here include both those that remove pollutant contaminants in wastewater and those that destroy them. If a wastewater treatment technology that removes, rather than destroys, a pollutant is selected, then a treatment residual will be generated. In many instances, this residual is in the form of a sludge, which is typically further treated on-site to prepare it for disposal. Subsection 6.4 discusses technologies which can be used to dewater sludges to concentrate them prior to disposal. Other types of treatment residuals, such as spent activated carbon and filter media, are generally sent off-site to a vendor facility for management.

#### **6.1 *PHYSICAL/CHEMICAL/THERMAL WASTEWATER TREATMENT TECHNOLOGIES***

The wastewater treatment technologies presented in this subsection comprise the majority of operations found at CWT facilities. These technologies are generally efficient and cost-effective. Included among these technologies are processes, such as filtration, which utilize physical interactions to achieve pollutant removal, and others, such as chemical precipitation, which utilize a chemical reaction to change the form of a pollutant so that it can be removed from the waste stream. Other technologies, such as the thermal destruction of cyanide, use heat to destroy pollutants.

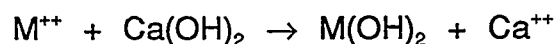
## 6.1.1 *Chemical Precipitation*

### 6.1.1.1 *Technology Description*

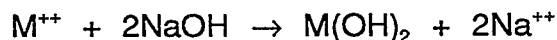
Chemical precipitation is used for the removal of metal compounds from wastewater. In the chemical precipitation process, soluble metallic ions and certain anions are converted to insoluble forms, which precipitate from the solution. The precipitated metals are subsequently removed from the wastewater stream by liquid filtration or clarification. The performance of the process is affected by chemical interactions, temperature, pH, solubility, and mixing effects.

Various chemicals can be used as precipitants; these include caustic (NaOH), lime ( $\text{Ca}(\text{OH})_2$ ), soda ash, sulfide, ferrous sulfate, and acid. Hydroxide precipitation is effective in removing such metals as antimony, arsenic, chromium, copper, lead, mercury, nickel, and zinc. Sulfide precipitation primarily removes mercury, lead, and silver.

Hydroxide precipitation using lime or caustic is the most commonly-used means of chemical precipitation, and of these, lime is used more often than caustic. The chief advantage of lime over caustic is its lower cost. However, lime is more difficult to handle and feed, as it must be slaked, slurried, and mixed, and can plug the feed system lines. Lime also produces a larger volume of sludge, and the sludge is generally not suitable for reclamation due to its homogeneous nature. Also, dewatered metal sludge is typically sold to smelters for reuse, and the calcium compounds in lime precipitation sludge interfere with smelting. The metals from caustic precipitation sludge can often be recovered. The reaction mechanism for precipitation of a divalent metal using lime is shown below:



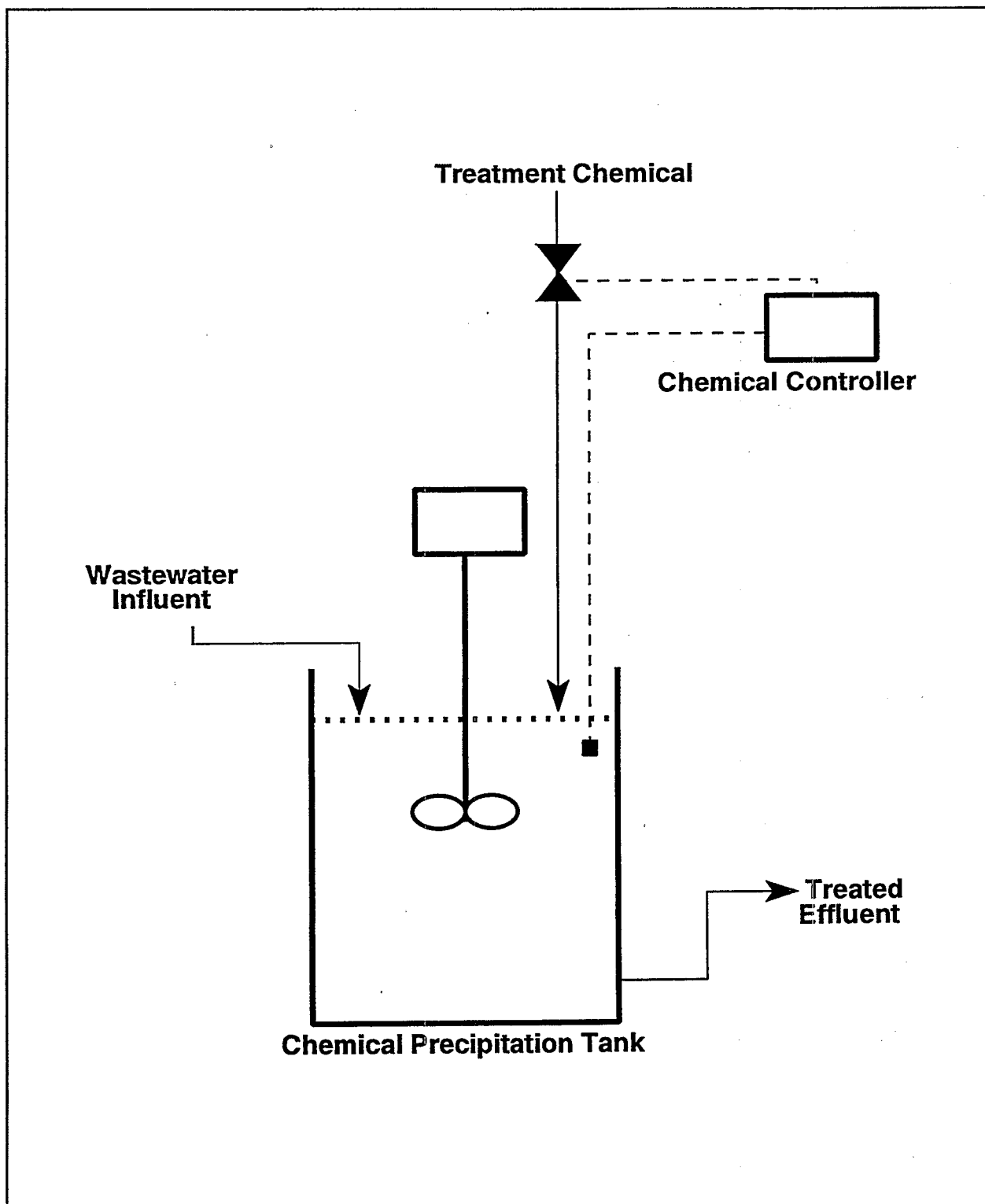
And, the reaction mechanism for precipitation of a divalent metal using caustic is:



In addition to the type of treatment chemical chosen, another important design factor in the chemical precipitation operation is pH. Metal hydroxides are amphoteric, meaning that they can react chemically as acids or bases. As such, their solubilities increase toward both lower and higher pH levels. Therefore, there is an optimum pH for precipitation for each metal, which corresponds to its point of minimum solubility. Another key consideration in a chemical precipitation application is the detention time, which is specific to the wastewater being treated and the desired effluent quality. It may take from less than an hour to several days to achieve adequate precipitation of the dissolved metal compounds.

Chemical precipitation is a two-step process. It is typically performed in batch operations where the wastewater is first mixed with the treatment chemical in a tank. The mixing is typically achieved by mechanical means such as mixers or recirculation pumping. Then, the wastewater undergoes a separation/dewatering process such as clarification or filtration, where the precipitated metals are removed from solution. In a clarification system, a flocculant is sometimes added to aid in the settling process. The resulting sludge from the clarifier or filter must be further treated, disposed, or recycled. A typical chemical precipitation system is shown in Figure 6-1.

The batch operation aspect of chemical precipitation makes it an easily-adapted process for the CWT Industry, where the waste receipts can be highly variable. A facility can hold its wastes and segregate them by pollutant content for treatment. This type of waste treatment management, called selective metals precipitation, can be implemented in order to concentrate on one or two major pollutants of concern. This application of chemical precipitation uses several tanks to allow the facility to segregate its wastes into smaller batches, thereby avoiding interference with other incoming waste receipts and increasing treatment efficiency. These specific operations would also produce specific sludges containing only the target metals, making them suitable for reclamation.



**Figure 6-1.** Chemical Precipitation System Diagram

#### **6.1.1.2      *Treatment Performance***

The effluent quality achievable with chemical precipitation depends upon the metals present in the wastewater and the process operating conditions. It is a demonstrated and widely-used technology, often removing metal pollutants down to levels of 1 µg/l or less.

According to the WTI Questionnaire data base, there are 184 individual applications of chemical precipitation in the CWT Industry. Often a single facility will use several chemical precipitation applications, depending upon the type of waste being treated. Four specialized applications of chemical precipitation were identified as BPT for the Metals Subcategory of the CWT Industry; these are hydroxide chemical precipitation and selective metals precipitation followed by secondary precipitation, then tertiary precipitation.

During the CWT project, EPA conducted sampling at three facilities (CWT QIDs 059, 105, and 230) that use hydroxide chemical precipitation systems. At QID 059, the chemical precipitation effluent was sent through a filter press. The effluents from the chemical precipitation systems at QIDs 105 and 230 were treated in clarifiers. The performance data obtained for these applications are presented in Tables 6-1, 6-2, and 6-3. As these data show, the systems at QIDs 059 and 105 achieved high metals removals, in the 90 to 99.99 percent range. The data for QID 230 shows poorer performance.

EPA also sampled one facility (CWT QID 130) that operates selective metals precipitation processes (for both solid and liquid waste receipts), followed by secondary and tertiary precipitation systems. The effluents from the selective metals precipitation processes and the secondary precipitation system were filtered, and the effluent from the tertiary precipitation system was clarified. The sampling data for these individual systems are presented in Tables 6-4, 6-5, 6-6, and 6-7. The sampling data for the overall metals treatment train at QID 130 (selective metals precipitation, secondary precipitation, and tertiary precipitation) is presented in Table 6-8. As this table shows, the overall system at QID 130 achieved removals of greater than 99 percent for each of the 10 metals presented.

**Table 6-1.** Chemical Precipitation System Performance Data for CWT QID 059

Parameter	Influent Avg (µg/l)	Effluent Avg (µg/l)	Removal (%)
Aluminum	620,080	2,125	99.66
Cadmium	244	5 (ND)	97.95
Chromium	228,772	384	99.83
Copper	286,191	60	99.98
Lead	6,702	50	99.25
Manganese	33,596	72	99.79
Mercury	1,458	86	94.10
Nickel	972,600	90,834	90.66
Silver	1,845	91	95.08
Zinc	90,040	2,257	97.49

**Table 6-2.** Chemical Precipitation System Performance Data for CWT QID 105

Parameter	Influent Avg (µg/l)	Effluent Avg (µg/l)	Removal (%)
Aluminum	400,030	12,133	96.97
Cadmium	48,065	217	99.55
Chromium	3,652,458	3,300	99.91
Copper	454,740	16,300	96.42
Lead	84,462	480 (ND)	99.43
Manganese	26,175	53	99.80
Mercury	106	0.2 (ND)	99.81
Nickel	631,996	4,243	99.33
Silver	2,488	53	97.89
Zinc	473,078	2,427	99.49

ND = Not detected



**Table 6-3.** Chemical Precipitation System Performance Data for CWT QID 230

Parameter	Influent Avg (µg/l)	Effluent Avg (µg/l)	Removal (%)
Aluminum	37,648	11,837	68.56
Cadmium	22	17 (ND)	23.77
Chromium	317	37 (ND)	88.33
Copper	28,136	259	99.08
Lead	415	250 (ND)	39.69
Manganese	2,214	65	97.05
Mercury	5	2 (ND)	57.45
Nickel	970	169	82.55
Zinc	167,583	1,287	99.23

ND = Not detected

**Table 6-4.** Selective Metals Precipitation (Solid Metals Recovery) System Performance Data for CWT QID 130

Parameter	Influent Avg (µg/l)	Effluent Avg (µg/l)	Removal (%)
Copper	4,228,071	19,880	99.53
Lead	487,786	7,334	98.50
Zinc	7,196,571	57,218	99.20

**Table 6-5. Selective Metals Precipitation (Liquid Metals Recovery) System Performance Data for CWT QID 130**

Parameter	Minimum Batch Removal (%)	Maximum Batch Removal (%)	Average Batch Removal (%)
Chromium	(103.39)	93.34	26.70
Copper	28.01	97.85	66.08
Nickel	93.95	99.99	97.73
Silver	(4.69)	99.87	55.35

**Table 6-6. Secondary Precipitation System Performance Data for CWT QID 130**

Parameter	Influent Avg (µg/l)	Effluent Avg (µg/l)	Removal (%)
Aluminum	7,679	337	95.61
Cadmium	1,500	101	93.25
Chromium	211,924	690	99.67
Copper	412,750	970	99.77
Lead	3,119	308	90.14
Manganese	2,346	61	97.40
Mercury	19	1	93.49
Nickel	48,883	1,060	97.83
Silver	280	4 (ND)	98.57
Zinc	28,949	845	97.08

ND = Not detected

**Table 6-7.** Tertiary Precipitation System Performance Data for CWT QID 130

Parameter	Influent Avg (µg/l)	Effluent Avg (µg/l)	Removal (%)
Aluminum	337	97	71.32
Cadmium	101	82	18.85
Chromium	690	37	94.63
Copper	970	145	85.06
Lead	308	50	83.75
Manganese	61	12	80.96
Mercury	1	0.20 (ND)	83.87
Nickel	1,060	1,251	(18.07)
Zinc	845	167	80.29

**Table 6-8.** Overall Metals Precipitation System Performance Data for CWT QID 130

Parameter	Influent Avg (µg/l)	Effluent Avg (µg/l)	Removal (%)
Aluminum	534,585	97	99.98
Cadmium	129,687	82	99.94
Chromium	585,899	37	99.99
Copper	2,927,792	145	99.99
Lead	244,667	50	99.98
Manganese	45,274	12	99.97
Mercury	75	0.20 (ND)	99.73
Nickel	510,184	1,251	99.75
Silver	757	4 (ND)	99.47
Zinc	3,601,529	167	99.99

ND = Not detected

## **6.1.2        *Clarification***

### **6.1.2.1        *Technology Description***

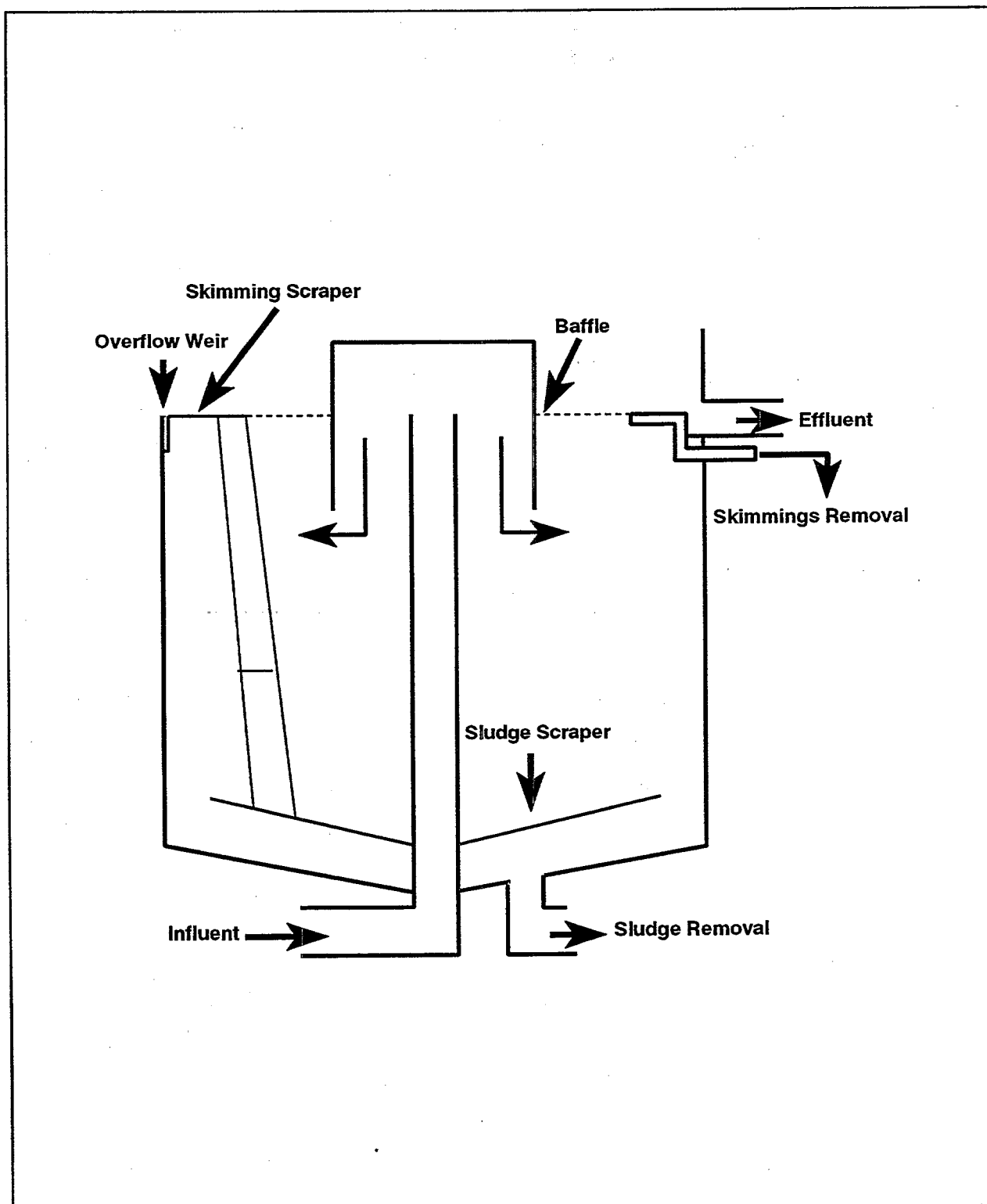
Clarification systems provide continuous, low-cost separation and removal of suspended solids from water by the use of gravity. Clarification is used to remove particulates, flocculated impurities, and precipitates. These systems typically follow wastewater treatment processes which generate suspended solids, such as chemical precipitation and biological treatment.

Clarification units are often preceded by a flocculation step to promote settling. The flocculation process involves the addition of a treatment chemical, or flocculant, to the wastewater. There are three different types of flocculants: inorganic electrolytes, natural organic polymers, and synthetic polyelectrolytes. The flocculant is rapidly mixed with the wastewater to disperse it uniformly. The duration of the rapid mix step is very short, usually about one to two minutes. Slow and moderate mixing is provided to allow the particles to agglomerate into larger, heavier, more settleable particles.

In the clarifier, the wastewater is allowed to flow slowly and uniformly, permitting the solids more dense than water to settle to the bottom. The clarified wastewater is discharged by flowing from the top of the clarifier over a weir. Conventional clarifiers typically consist of a circular or rectangular tank. There are more specialized types of clarifiers which incorporate tubes, plates, or lamellar networks to increase the settling area. The sludge which accumulates at the bottom is periodically removed and must be dewatered and disposed. A circular clarification system is illustrated in Figure 6-2.

### **6.1.2.2        *Treatment Performance***

According to the WTI Questionnaire data base, there are 35 clarification/flocculation systems in operation in the CWT Industry. CWT QID 105, which was sampled by EPA during this rulemaking project, employs a clarifier which treats the wastewater from hydroxide metals precipitation. This clarifier reduces an influent stream



**Figure 6-2.** Clarification System Diagram

of approximately 40,000 mg/l TSS (four percent solids) to an effluent of 500 mg/l. The collected sludge TSS concentration is about 200,000 mg/l or 20 percent solids.

### **6.1.3      *Plate and Frame Pressure Filtration***

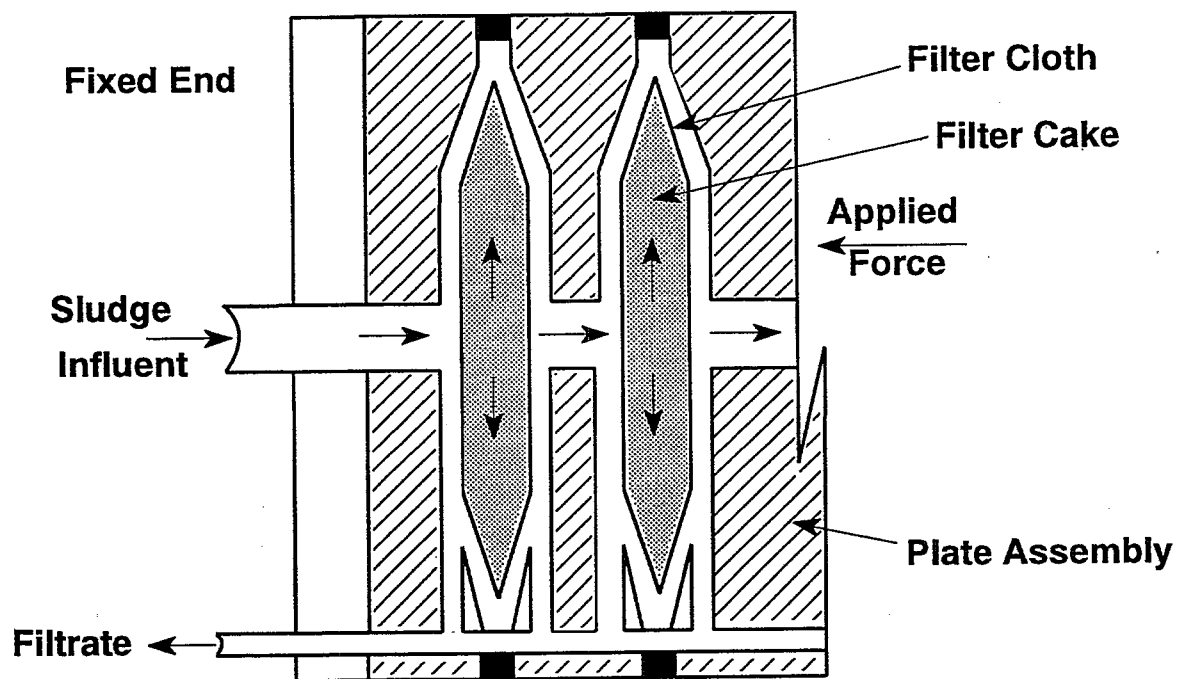
#### **6.1.3.1      *Technology Description***

Plate and frame pressure filtration systems are used for the removal of solids from waste streams. The liquid stream plate and frame pressure filtration system is identical to the system used for the sludge stream (Subsection 6.4.1) with the exception of a lower solids level in the influent stream. The same equipment is used for both applications, with the difference being in the sizing of the sludge and liquid units. A plate and frame filter press is shown in Figure 6-3.

A plate and frame filter press consists of a number of filter plates or trays connected to a frame and pressed together between a fixed end and a moving end. Filter cloth is mounted on the face of each plate. The sludge is pumped into the unit under pressure while the plates are pressed together. The solids are retained in the cavities of the filter press and begin to attach to the filter cloth until a cake is formed. The water, or filtrate passes through the filter cloth and is discharged from a drainage port in the bottom of the press. The sludge influent is pumped into the system until the cavities are filled. Pressure is applied to the plates until the flow of filtrate stops.

At the end of the cycle, the pressure is released and the plates are separated. The filter cake drops into a hopper below the press. The filter cake can then be disposed in a landfill. The filter cloth is washed before the next cycle begins.

The key advantage of plate and frame pressure filtration is that it can produce a drier filter cake than is possible with the other methods of sludge dewatering. The batch operation of the plate and frame filter press makes it a practical choice for the filtration of a batch chemical precipitation process effluent. Therefore, it is well-suited for use in the CWT Industry. However, its batch operating mode results in greater operating labor requirements.



**Figure 6-3.** Plate and Frame Pressure Filtration System Diagram

### **6.1.3.2      *Treatment Performance***

Respondents to the WTI Questionnaire reported that 34 plate and frame filter presses (treating liquid and sludge streams) are in operation in the CWT Industry. In a typical plate and frame pressure filtration unit, the filter cake has a dry solids content between 30 and 50 percent.

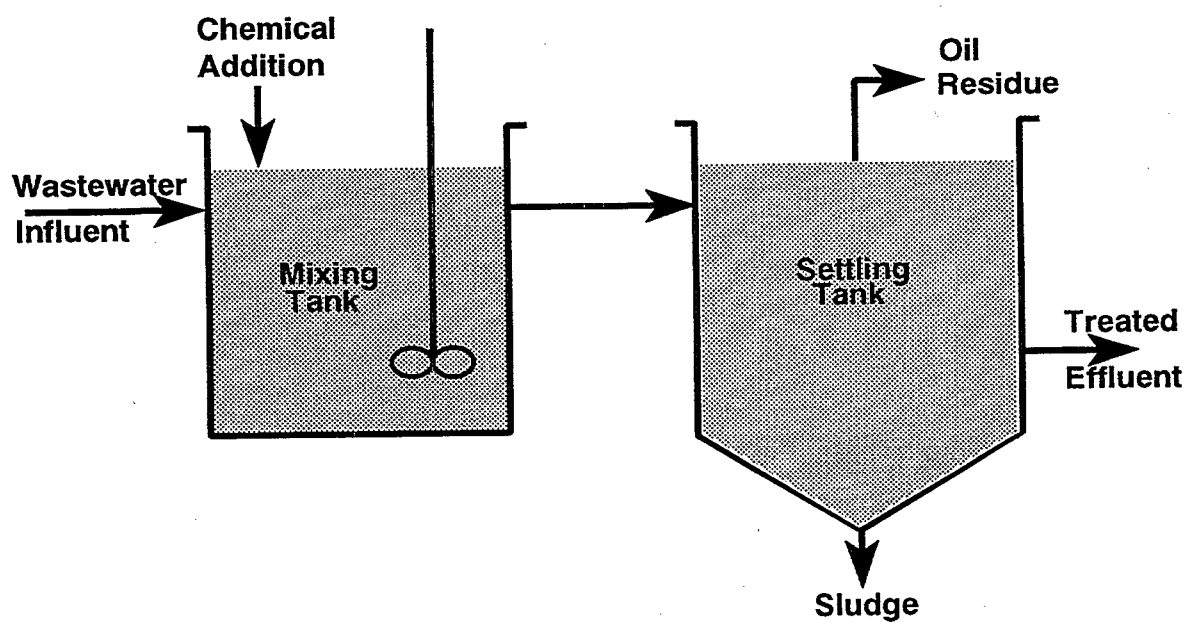
### **6.1.4          *Emulsion Breaking***

#### **6.1.4.1      *Technology Description***

Emulsion breaking is used to treat emulsified oil/water mixtures. An emulsion, by definition, is either stable or unstable. A stable emulsion is one where the droplets of the dispersed phase are so small that settling and coalescence would occur very slowly or not at all. An unstable emulsion, or dispersion, settles very rapidly and does not require treatment to break the emulsion. Stable emulsions are often intentionally formed by chemical addition to stabilize the oil mixture for a specific application. Some examples of stable emulsified oils are coolants, lubricants, and antioxidants.

Emulsion breaking is achieved by the addition of chemicals and/or heat to the waste oil mixture. The most commonly-used method of emulsion breaking is acid-cracking with or without heat addition. Sulfuric or hydrochloric acid is added to the tank containing the oil mixture until the pH reaches 1 or 2. A coagulant is also added. The tank contents are agitated for mixing. After the emulsion bond is broken, the oil residue is allowed to float to the top of the tank. At this point, heat (100 to 150° F) may be applied to speed the separation process. The oil is then skimmed off by mechanical means, or the water is decanted from the bottom of the tank. The oil residue is then further processed or disposed. A diagram of an emulsion breaking system is presented in Figure 6-4.





**Figure 6-4.** Emulsion Breaking System Diagram

An advantage of the emulsion breaking process is the high removals that are possible. A disadvantage, however, is the high operating costs for treatment chemicals and heat generation. One way to minimize operating costs is to pretreat the oil/water mixture to physically separate any free oil that may be present before emulsion breaking is performed.

#### **6.1.4.2      *Treatment Performance***

Emulsion breaking is a highly effective treatment technology for separating oil from water. Typically, emulsions of five to 10 percent oil can be reduced to about 0.01 percent. Emulsion breaking is a common process in the CWT Industry; it is used by most of the facilities identified as belonging in the Oils Subcategory. As such, EPA has concluded that it is the baseline, current performance technology for the Oils Subcategory for those facilities that treat emulsified oily wastes.

#### **6.1.5          *Equalization***

##### **6.1.5.1      *Technology Description***

Waste treatment facilities often need to equalize wastes by holding them in a tank for a certain period of time to get a stable waste stream which is easier to treat. In the CWT Industry, equalization is frequently used to minimize the variability of incoming wastes prior to certain treatment operations. Equalization is found at facilities identified in all of the CWT subcategories.

The equalization tank serves many functions. The influent flow is equalized so that the effluent is discharged to downstream processes at a uniform rate. This levels out the effect of peak and minimum flows. Additionally, waste contaminants are blended together to provide a more constant discharge to the treatment system. This is accomplished by mixing smaller volumes of concentrated wastes with larger volumes at lower concentrations. For example, the pH can be controlled to prevent fluctuations which

could upset the efficiency of downstream treatment system units by mixing acid and alkaline wastes in the equalization tank. Equalization tanks are usually equipped with mixing where the dampening of pollutant concentrations is desired. An equalization system is shown in Figure 6-5.

#### **6.1.5.2      *Treatment Performance***

According to the WTI Questionnaire response data base, there are 81 equalization systems in the CWT Industry. Of these, 36 are unstirred and 45 are stirred or aerated. No performance data were obtained for these systems.

#### **6.1.6          *Air Stripping***

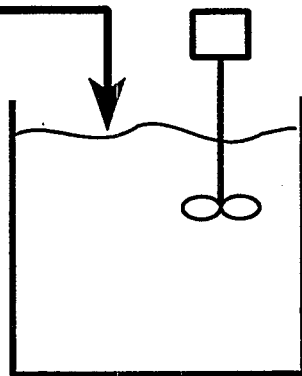
##### **6.1.6.1      *Technology Description***

Air stripping is an effective treatment method for removing dissolved volatile organic compounds from wastewater. The removal is accomplished by passing high volumes of air through the agitated wastewater stream. The process results in a contaminated off-gas stream which, depending upon air emissions standards, usually requires air pollution control equipment.

Stripping can be performed in tanks or in spray or packed towers. Treatment in packed towers is the most efficient application. The packing typically consists of plastic rings or saddles. The two types of towers that are commonly-used, cross-flow and countercurrent, differ in design only in the location of the air inlets. In the cross-flow tower, the air is drawn through the sides for the total height of the packing. The countercurrent tower draws the entire air flow from the bottom. The cross-flow towers have been found to be more susceptible to scaling problems and are less efficient than the countercurrent towers. A countercurrent air stripper is shown in Figure 6-6.

The driving force of the air stripping mass-transfer operation is the difference in concentrations between the air and liquid streams. Pollutants are transferred from the

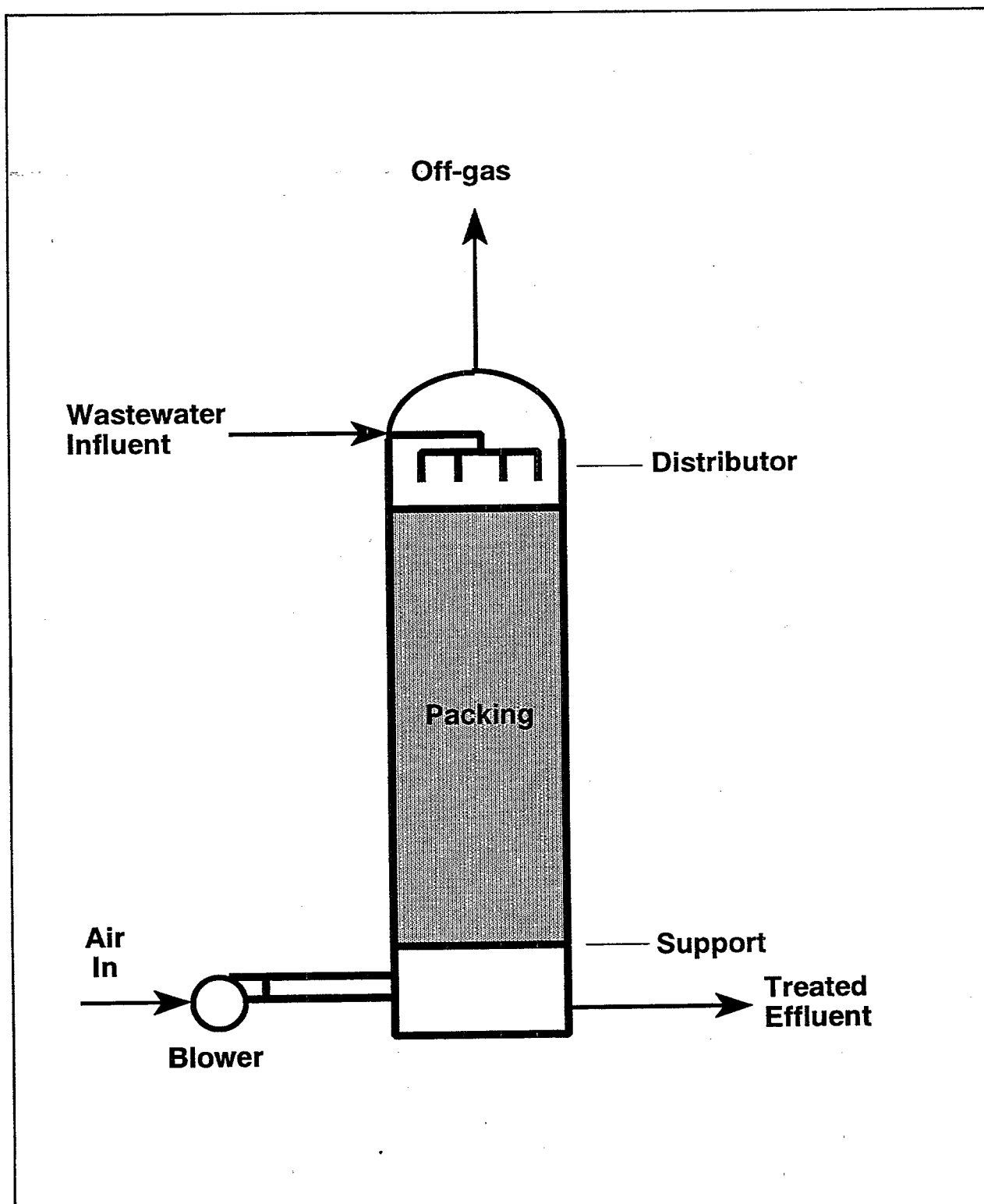
**Wastewater  
Influent**



**Equalized  
Effluent**

**Equalization  
Tank**

**Figure 6-5.** Equalization System Diagram



**Figure 6-6.** Air Stripping System Diagram

more concentrated wastewater stream to the less concentrated air stream until equilibrium is reached; this equilibrium relationship is known as Henry's Law. The strippability of a pollutant is expressed as its Henry's Law Constant, which is a function of both its volatility and solubility.

Air strippers are designed according to the strippability of the pollutants to be removed. For evaluation purposes, the organic pollutants were divided into three general strippability ranges (low, medium, and high) according to their Henry's Law Constants. The low strippability group (Henry's Law Constants of  $10^{-3}$  [mg/m<sup>3</sup> air]/[mg/m<sup>3</sup> water] and lower) are not effectively removed. Pollutants in the medium ( $10^{-1}$  to  $10^{-3}$ ) and high ( $10^{-1}$  and greater) groups are effectively stripped. Pollutants with lower Henry's law constants require greater column height, more trays or packing material, greater pressure and temperature, and more frequent cleaning than pollutants with a higher strippability.

The air stripping process is adversely affected by low temperatures. Air strippers experience lower efficiencies at lower temperatures, with the possibility of freezing within the tower. For this reason, depending on the location of the tower, it may be necessary to preheat the wastewater and the air feed streams. The column and packing materials must be cleaned regularly to ensure that low effluent levels are attained.

#### **6.1.6.2      *Treatment Performance***

Air stripping has proved to be an effective process in the removal of volatile pollutants from wastewater. It is generally limited to influent concentrations of less than 100 mg/l organics. Well-designed and operated systems can achieve over 99 percent removals.

One facility in the CWT Industry uses an air stripper to treat an organic-bearing waste stream. This operation at CWT QID 059 was sampled by EPA, and these results are presented in Table 6-9. The highly volatile constituent toluene had an average influent concentration of 551 µg/l and an effluent level of 10 µg/l (98.2 percent removal). The pollutant 1,2-dichloroethane had an average influent level of 2,211 µg/l and an effluent level of 10 µg/l (99.6 percent removal).

**Table 6-9. Air Stripping System Performance Data**

Parameter	Influent Avg (µg/l)	Stripper #1 Effluent Avg (µg/l)	Stripper #2 Effluent Avg (µg/l)	Removal (%) (Influent to Stripper #2)
1,1,2-Trichloroethane	2,481	95	19	99.24
1,2-Dichloroethane	2,736	37	29	98.93
Chloroform	11,615	50	30	99.75
Methylene Chloride	32,217	98	385	98.80
Tetrachloroethene	6,973	8	12	99.83
Tetrachloromethane	5,527	40	12	99.79
Toluene	551	10 (ND)	10 (ND)	98.18
Trans-1,2-dichloroethene	2,211	16	10 (ND)	99.55
Trichloroethene	9,332	41	22	99.76
Vinyl Chloride	555	10 (ND)	10 (ND)	98.20

ND = Not detected

### 6.1.7 *Multi-media Filtration*

#### 6.1.7.1 *Technology Description*

Multi-media, or granular bed, filtration is used for achieving supplemental removal of residual suspended solids from the effluent of chemical and biological treatment processes. In granular bed filtration, the wastewater stream is sent through a bed containing one or more layers of different granular materials. The solids are retained in the voids between the media particles while the wastewater passes through the bed. Typical media used in granular bed filters include anthracite coal, sand, and garnet. These media can be used alone, such as in sand filtration, or in a multi-media combination. Multi-media filters are designed such that the individual layers of media

remain fairly discrete. This is accomplished by selecting appropriate filter loading rates, media grain size, and bed density.

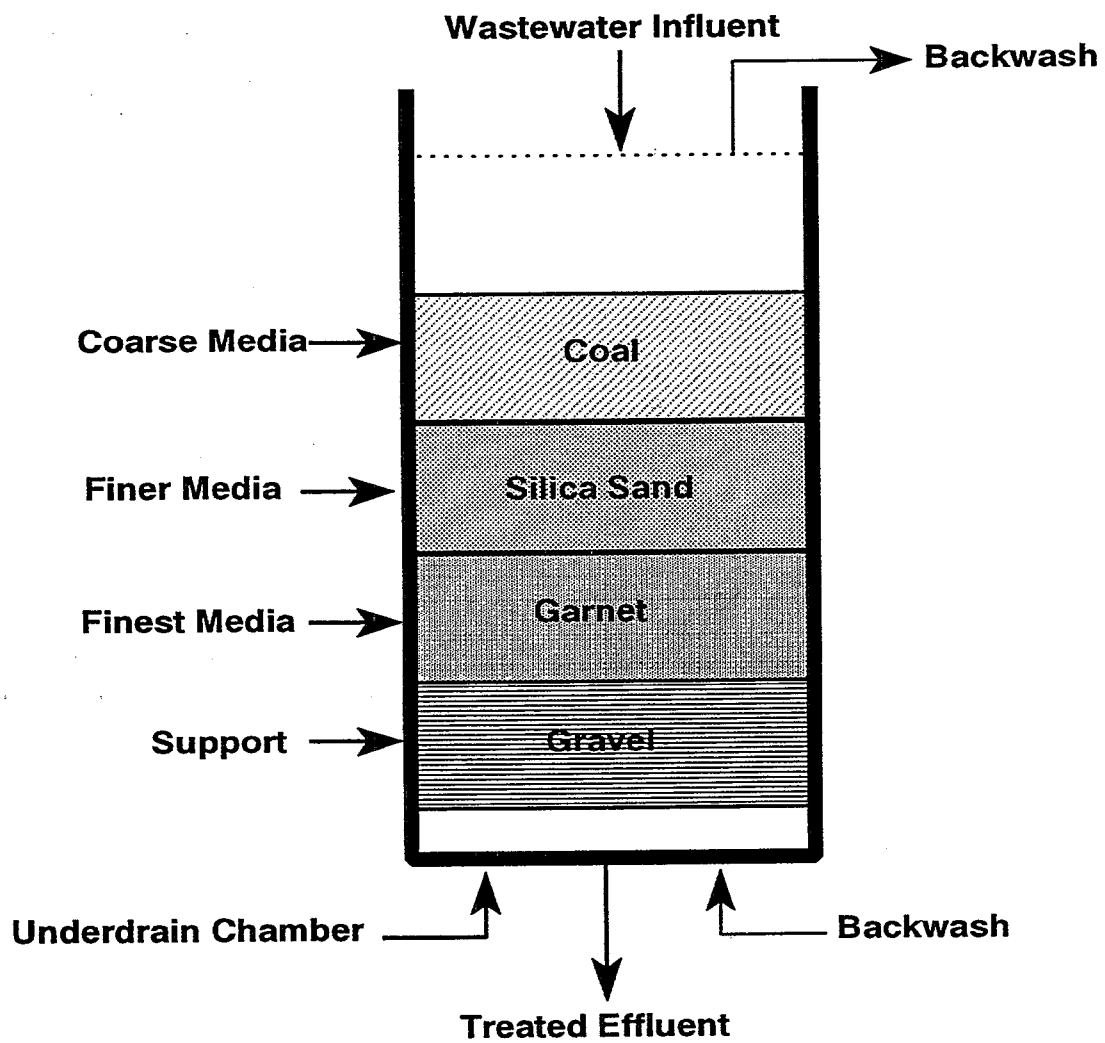
A multi-media filter operates with the finer, denser media at the bottom and the coarser, less dense media at the top. A common arrangement is garnet at the bottom of the bed, sand in the middle, and anthracite coal at the top. Some mixing of these layers occurs and is anticipated. During filtration, the removal of the suspended solids is accomplished by a complex process involving one or more mechanisms, such as straining, sedimentation, interception, impaction, and adsorption. The medium size is the principal characteristic that affects the filtration operation. If the medium is too small, much of the driving force will be wasted in overcoming the frictional resistance of the filter bed. If the medium is too large, small particles will travel through the bed, preventing optimum filtration.

The flow pattern of multi-media filters is usually top-to-bottom. Upflow filters, horizontal filters, and biflow filters are also used. A top-to-bottom multi-media filter is represented in Figure 6-7. The classic multi-media filter operates by gravity; however, pressure filters are occasionally used.

The complete filtration process involves two phases: filtration and backwashing. As the filter becomes filled with trapped solids, the efficiency of the filtration process falls off. Head loss is a measure of solids trapped in the filter. As the head loss across the filter bed increases to a limiting value, the end of the filter run is reached and the filter must be backwashed to remove the suspended solids in the bed. During backwashing, the flow through the filter is reversed so that the solids trapped in the media are dislodged and can exit the filter. The bed may also be agitated with air to aid in solids removal. The backwash water is then recycled back into the wastewater feed stream.

An important feature in filtration and backwashing is the underdrain. The underdrain is the support structure for the filtration bed. The underdrain provides an area for the accumulation of the filtered water without it being clogged from the filtered solids or the media particles. During backwash, the underdrain provides even flow distribution over the bed.





**Figure 6-7.** Multi-Media Filtration System Diagram

#### **6.1.7.2      *Treatment Performance***

Respondents to the WTI Questionnaire report that there are 10 sand filters and 9 multi-media filters in use in the CWT Industry. A multi-media filter, installed following a biological treatment system at CWT QID 059, was sampled by EPA for this project. The results of this sampling show that the average TSS concentration was reduced from 1,164 to 198 mg/l, providing a 83 percent removal. This reduced the BOD<sub>5</sub> of the waste stream from 17,622 to 1,700 mg/l, or by 90 percent. The COD was reduced from 53,451 to 2,400 mg/l, or by 96 percent.

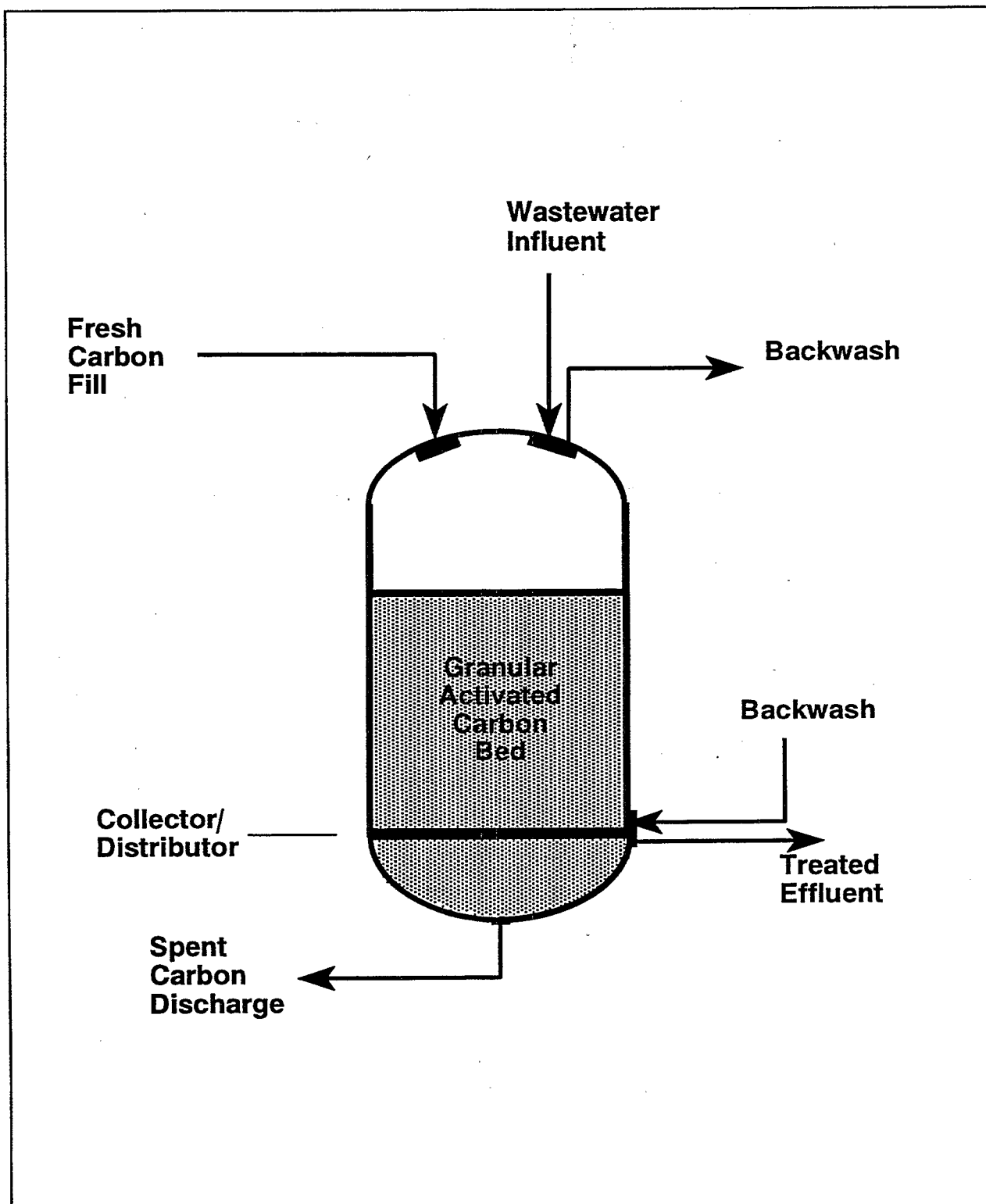
#### **6.1.8      *Carbon Adsorption***

##### **6.1.8.1      *Technology Description***

Activated carbon adsorption is a demonstrated treatment technology for the removal of organic pollutants from wastewater. Most applications use granular activated carbon (GAC) in column reactors. Sometimes powdered activated carbon (PAC) is used alone or in conjunction with another process, such as biological treatment. However, GAC is the more commonly-used method; a diagram of a downflow fixed-bed GAC system is presented in Figure 6-8.

The mechanism of adsorption is a combination of physical, chemical, and electrostatic interactions between the activated carbon and the adsorbate, although the attraction is primarily physical. Activated carbon can be made from many carbonaceous sources including coal, coke, peat, wood, and coconut shells.

The key design parameter is adsorption capacity; this is a measurement of the mass of contaminant adsorbed per unit mass of carbon, and is a function of the compound being adsorbed, the type of carbon used, and the process design and operating conditions. In general, the adsorption capacity is inversely proportional to the adsorbate solubility. Nonpolar, high molecular weight organics with low solubility are readily adsorbed. Polar, low molecular weight organics with high solubilities are more



**Figure 6-8.** Carbon Adsorption System Diagram

poorly adsorbed. Competitive adsorption of other compounds has an effect on adsorption. The carbon may preferentially adsorb one compound over another; this competition could result in an adsorbed compound being desorbed from the carbon.

In a fixed-bed system, the pollutants are removed in increasing amounts as the wastewater flows through the bed. In the upper area of the bed, the pollutants are rapidly adsorbed. As more wastewater passes through the bed, this rapid adsorption zone increases until it reaches the bottom of the bed. At this point, all of the available adsorption sites are filled and the carbon is said to be exhausted. This condition can be detected by an increase in the effluent pollutant concentration, and is called breakthrough.

GAC systems are usually comprised of several beds operated in series. This design allows the first bed to go to exhaustion, while the other beds still have the capacity to treat to an acceptable effluent quality. The carbon in the first bed is replaced, and the second bed then becomes the lead bed. The GAC system piping is designed to allow switching of bed order.

After the carbon is exhausted, it can be removed and regenerated. Usually heat or steam is used to reverse the adsorption process. The light organic compounds are volatilized and the heavy organic compounds are pyrolyzed. Spent carbon can also be regenerated by contacting it with a solvent which dissolves the adsorbed pollutants. Depending on system size and economics, some facilities may choose to dispose of the spent carbon instead of regenerating it. For very large applications, an on-site regeneration facility is sometimes constructed. For smaller applications, such as in the CWT Industry, it is generally cost-effective to use a vendor service to deliver regenerated carbon and remove the spent carbon. These vendors transport the spent carbon to their centralized facilities for regeneration.

#### **6.1.8.2      *Treatment Performance***

GAC adsorption is a widely-used wastewater treatment technology. Generally, the COD of the waste stream can be reduced to less than 10 mg/l and the BOD to less than 2 mg/l. Removal efficiencies typically are in the range of 30 to 90 percent.

According to the WTI Questionnaire data base, there are 11 GAC applications in the CWT Industry, treating both organic and oily waste streams. During this rulemaking project, EPA sampled GAC systems at two Organics Subcategory facilities (CWT QID 059 and 090) and one Oils Subcategory facility (CWT QID 409). The data obtained from these sampling efforts are presented in Tables 6-10 and 6-11.

As these results show, the sampled GAC systems did not perform as well as would be expected. The COD reductions for three of the units were very low (0.2, 1.5, and 23.8 percent), with the organics unit at QID 090 showing an increase in COD. In general, the data for the unit at QID 090 show that many pollutants were not detected in the influent, with very high analytical method detection levels. This makes it difficult to gauge the performance for this unit on an individual pollutant basis. The COD data, however, show that the overall performance of this unit is poor.

Poor GAC system performance can sometimes be attributed to competitive adsorption between compounds in the waste stream. The pollutant methylene chloride is often used as a measure of adsorption competition in a GAC system. This is because it is readily adsorbed, and also desorbed by competitive compounds. The two oils units showed very low methylene chloride removals of 18.8 and 49.4 percent; these beds may have been subject to competitive adsorption effects. Conversely, the two organics units demonstrated methylene removals of 87.0 and 89.5 percent; these numbers are in the range of expected performance.

Another possible explanation for the poor performance of these units is the effect of the pollutant parameter oil and grease. The commonly-applied limit on oil and grease loading to a GAC system is 10 mg/l. Oil and grease can coat the carbon particles, thereby inhibiting the adsorption process. The two oils units and the organics unit at QID 090 had oil and grease loadings of 2,489, 49, and 76 mg/l, respectively. And, all three of these systems showed oil and grease removals in the 60 to 85 percent range. This indicates that the carbon beds may have been adversely effected by oil and grease coating. The organics unit at QID 059 had a significantly lower oil and grease loading of 6 mg/l, which is below the 10 mg/l limit.

**Table 6-10. Carbon Adsorption System Performance Data for Organics Subcategory**

Parameter	CWT QID 059			CWT QID 090		
	Influent LTA (µg/l)	Effluent LTA (µg/l)	Removal (%)	Influent LTA (µg/l)	Effluent LTA (µg/l)	Removal (%)
COD	2.40E6	1.83E6	23.75	127.30E6	128.67E6	(1.07)
Oil & Grease	5,920	1,400	76.35	76,297	15,317	79.92
TSS	198,000	160,200	19.09	1.51E6	704,667	53.18
2,3,4,6-Tetrachlorophenol	3,594	20 (ND)	99.44	251 (ND)	266 (ND)	(5.98)
Methylene Chloride	885	115	87.01	388,923	40,907	89.48
n,n-Dimethylformamide	41	69	(68.29)	86,048 (ND)	133 (ND)	99.85
Pentachlorophenol	1,716	50 (ND)	97.09	628 (ND)	665 (ND)	(5.89)
Phenol	226	10 (ND)	95.58	5,673	133 (ND)	97.66
Pyridine	99	25	74.75	5,701	239	95.81
Trichloroethene	718	12	98.33	1,459 (ND)	34,000 (ND)	(2,230)

LTA = Long-term average

ND = Not detected

**Table 6-11. Carbon Adsorption System Performance Data for Oils Subcategory**

Parameter	CWT QID 409 - 1st System			CWT QID 409 - 2nd System		
	Influent LTA (µg/l)	Effluent LTA (µg/l)	Removal (%)	Influent LTA (µg/l)	Effluent LTA (µg/l)	Removal (%)
COD	9.58E6	9.56E6	0.19	5.04E6	4.96E6	1.52
Oil & Grease	2.49E6	386,928	84.46	48,898	18,423	62.32
TSS	6,300	7,800	(23.81)	1,060	16,375	(1,444)
4-Chloro-3-methylphenol	4,026	332	91.75	332	10 (ND)	96.99
Benzene	5,817	2,019	65.29	1,002	10	99.00
Hexanoic Acid	7,595	5,741	24.41	1,796	10 (ND)	99.44
Methylene Chloride	1,281	1,040	18.81	496	251	49.40
m-Xylene	1,019	69	93.23	41	10 (ND)	75.61
Phenol	1,753	1,062	39.42	1,217	10 (ND)	99.18
Toluene	11,183	2,043	81.73	980	11	98.88

LTA = Long-term average

ND = Not detected

Judging from the data collected, all of these GAC systems have TSS-related problems. The commonly-used TSS loading limit to a GAC system is 50 mg/l. Solids can plug the bed, resulting in excessive head loss. Both of the organics units had TSS loadings (198 and 1,505 mg/l) in excess of this limit. The two oils units had TSS loadings of 6 and 1 mg/l, well below the limit. However, the effluents from the oils units showed increases in wastewater TSS concentrations; this is not expected, as well-operated GAC units usually provide filtration.

All of the wastewaters from the sampled GAC systems showed increases in metals concentrations. This may be a result of pH fluctuations within the units solubilizing metals in the waste stream. Overall, the poor performance of the CWT GAC units may have been caused by the inherent difficulty of operating carbon adsorption units for variable waste streams.

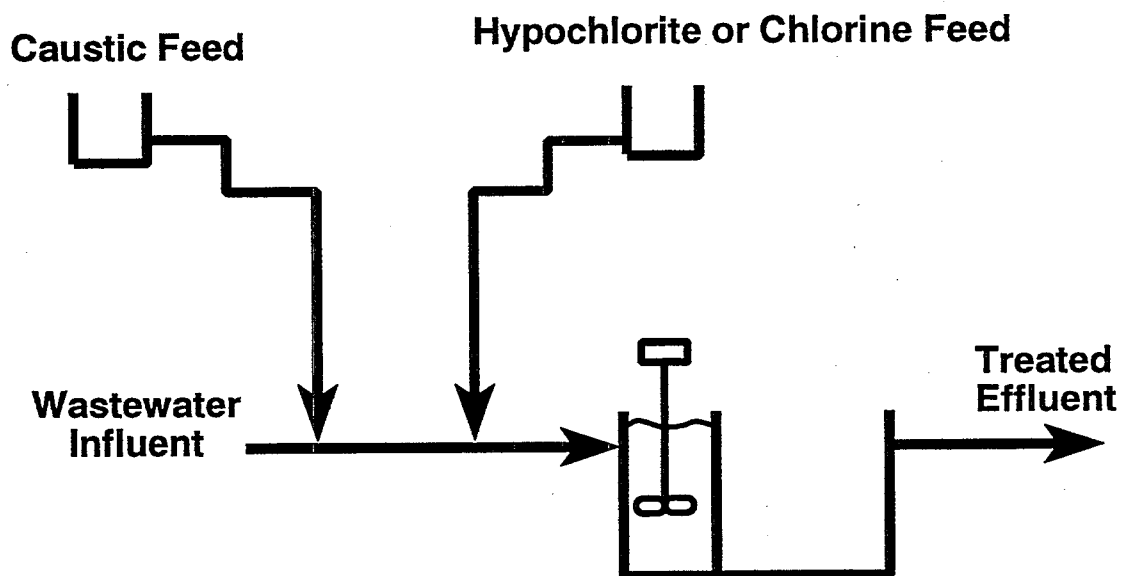
#### **6.1.9            *Cyanide Destruction***

##### **6.1.9.1        *Technology Description***

Cyanide is a very toxic pollutant and, therefore, wastes containing cyanide are an important environmental concern. The major portion of cyanide-bearing wastes are produced by electroplating and metal finishing operations.

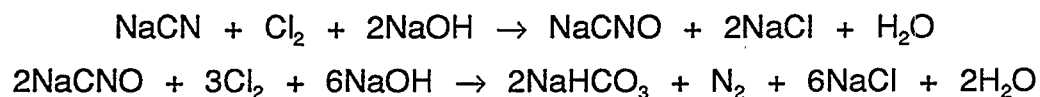
Three procedures used to perform cyanide destruction are discussed here; these are alkaline chlorination with gaseous chlorine, alkaline chlorination with sodium hypochlorite, and confidential business information (CBI) cyanide destruction. A diagram of an alkaline chlorination system is presented in Figure 6-9. Alkaline chlorination can destroy free dissolved hydrogen cyanide and can oxidize all simple and some complex inorganic cyanides; however, it cannot effectively oxidize stable iron, copper, and nickel cyanide complexes. The addition of heat to the alkaline chlorination process can facilitate the more complete destruction of total cyanides.





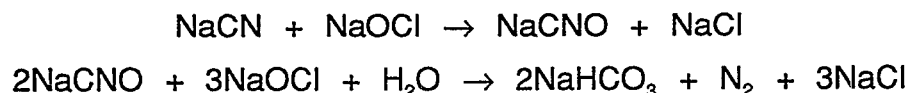
**Figure 6-9.** Cyanide Destruction System Diagram

In alkaline chlorination using gaseous chlorine, the oxidation process is accomplished by direct addition of chlorine ( $\text{Cl}_2$ ) as the oxidizer and sodium hydroxide ( $\text{NaOH}$ ) to maintain pH levels. The reaction mechanism is:



The destruction of the cyanide takes place in two stages. The primary reaction is the partial oxidation of the cyanide to cyanate at a pH above 9. In the second stage, the pH is lowered to the 8 to 8.5 range for the oxidation of the cyanate to nitrogen and carbon dioxide (as sodium bicarbonate). Each part of cyanide requires 2.73 parts of chlorine to convert it to cyanate and an additional 4.1 parts of chlorine to oxidize the cyanate to nitrogen and carbon dioxide. At least 1.125 parts of sodium hydroxide is required to control the pH with each stage.

Alkaline chlorination can also be conducted with sodium hypochlorite ( $\text{NaOCl}$ ) as the oxidizer. The oxidation of cyanide waste using sodium hypochlorite is similar to the gaseous chlorine process. The reaction mechanism is:



In the first step, cyanide is oxidized to cyanate with the pH maintained in the range of 9 to 11. The second step oxidizes cyanate to carbon dioxide (as sodium bicarbonate) and nitrogen at a controlled pH of 8.5. The amount of sodium hypochlorite and sodium hydroxide needed to perform the oxidation is 7.5 parts and 8 parts per part of cyanide, respectively.

### **6.1.9.2      *Treatment Performance***

Respondents to the WTI Questionnaire report that there are 30 cyanide destruction operations in-place in the CWT Industry. Of these, one is a thermal unit, one is the CBI unit, and the rest are chemical reagent systems. During this project, EPA sampled one of each of three cyanide treatment applications discussed in this subsection.

The alkaline chlorination process using gaseous chlorine was sampled at CWT QID 255. The average amenable cyanide concentration was reduced from 1,563 mg/l in the influent to 64.7 mg/l in the effluent; this is a 96 percent removal. The average total cyanide concentration was reduced from 1,721 mg/l in the influent to 354.9 mg/l in the effluent; this equals a removal of 79 percent.

The sodium hypochlorite system, operated at an extended retention time, was sampled at CWT QID 105. The average influent concentration of amenable cyanide was 1,548 mg/l; this was reduced by 82 percent to an effluent concentration of 276.1 mg/l. The average influent concentration of total cyanide was 4,634 mg/l; this was reduced by 97 percent to 135.7 mg/l.

The CBI system was sampled at CWT QID 450. The average influent amenable cyanide concentration was 3,317 mg/l and the effluent concentration was 8.2 mg/l, giving a removal of 99.8 percent. This system reduced the average total cyanide concentration from 6,467 to 10.4 mg/l; this is equal to a 99.8 percent removal.

### **6.1.10      *Chromium Reduction***

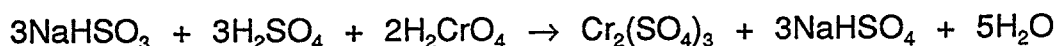
#### **6.1.10.1      *Technology Description***

Reduction is a chemical reaction in which electrons are transferred from one chemical to another. The main application of chemical reduction in wastewater treatment is the reduction of hexavalent chromium to trivalent chromium. The reduction enables the trivalent chromium to be precipitated from solution in conjunction with other metallic salts. Sulfur dioxide, sodium bisulfite, sodium metabisulfite, and ferrous sulfate are strong

reducing agents and are commonly used in industrial wastewater treatment applications. Two types of chromium reduction are discussed here; these are reduction through the use of sodium metabisulfite or sodium bisulfite and reduction through the use of gaseous sulfur dioxide. A diagram of a chromium reduction system is presented in Figure 6-10.

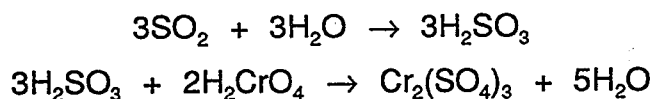
These chromium reduction reactions are reactions are favored by a low pH of 2 to 3. At pH levels above 5, the reduction rate is slow. Oxidizing agents such as dissolved oxygen and ferric iron interfere with the reduction process by consuming the reducing agent. After the reduction process, the trivalent chromium is removed by chemical precipitation.

Chromium reduction using sodium metabisulfite ( $\text{Na}_2\text{S}_2\text{O}_5$ ) and sodium bisulfite ( $\text{NaHSO}_3$ ) are essentially similar. The mechanism for the reaction using sodium bisulfite as the reducing agent is:

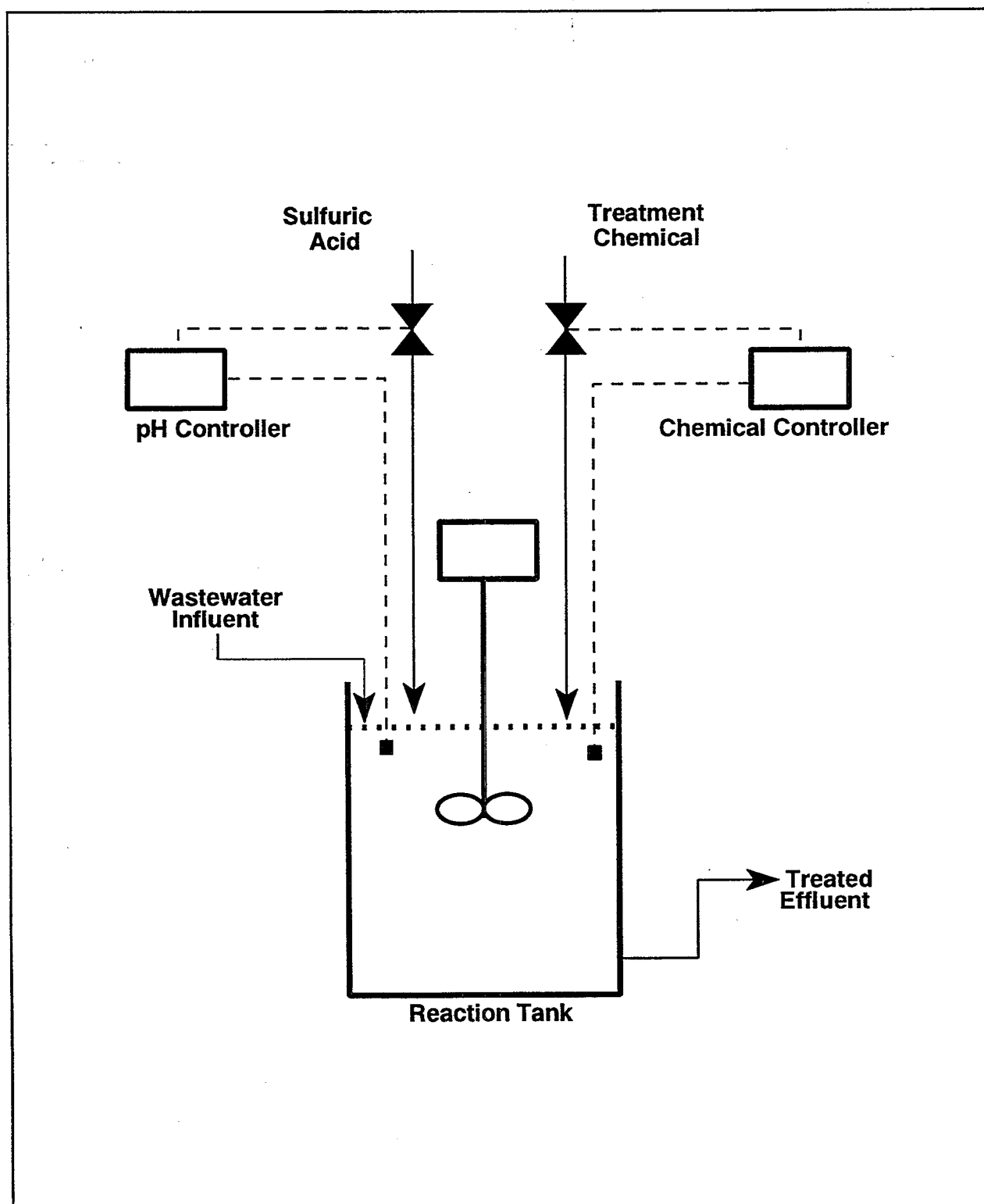


The hexavalent chromium is reduced to trivalent chromium using sodium metabisulfite, with sulfuric acid used to lower the pH of the solution. The amount of sodium metabisulfite needed to reduce the hexavalent chromium is reported as 3 parts of sodium bisulfite per part of chromium, while the amount of sulfuric acid is 1 part per part of chromium. The theoretical retention time is about 30 to 60 minutes.

A second process uses sulfur dioxide ( $\text{SO}_2$ ) as the reducing agent. The reaction mechanism is:



The hexavalent chromium is reduced to trivalent chromium using sulfur dioxide, with sulfuric acid used to lower the pH of the solution. The amount of sulfur dioxide needed to reduce the hexavalent chromium is reported as 1.9 parts of sulfur dioxide per



**Figure 6-10.** Chromium Reduction System Diagram

part of chromium, while the amount of sulfuric acid is 1 part per part of chromium. At a pH of 3, the theoretical retention time is approximately 30 to 45 minutes.

#### **6.1.10.2      *Treatment Performance***

According to the WTI Questionnaire response data base, chromium reduction operations are conducted at 38 facilities in the CWT Industry. Of these 38 facilities, there are four sulfur dioxide processes, 21 sodium bisulfite processes, and two sodium metabisulfite processes. The remaining systems use various other reducing agents. As part of this rulemaking project, EPA sampled one of each of the two types of reduction processes discussed in this subsection.

For the chromium reduction process using sodium metabisulfite, sampling was conducted at CWT QID 067. Only one batch was sampled at this facility; the influent hexavalent chromium concentration was 10 µg/l and the effluent concentration was 285 µg/l. This shows an increase in hexavalent chromium concentration.

The chromium reduction process using sulfur dioxide was sampled at CWT QID 255. The average influent hexavalent chromium concentration was 940,253 µg/l; the average effluent concentration was 30 µg/l. This shows a reduction of 99.99 percent.

#### **6.1.11      *Electrolytic Recovery***

##### **6.1.11.1      *Technology Description***

Electrolytic recovery is used for the reclamation of metals from wastewater. It is a common technology in the electroplating, mining, and electronic industries. It is used for the recovery of copper, zinc, silver, cadmium, gold, and other heavy metals. Nickel is poorly recovered due to its low standard potential.

The electrolytic recovery process uses an oxidation and reduction reaction. Conductive electrodes (anodes and cathodes) are immersed in the metal-bearing wastewater, with electrical energy applied to them. At the cathode, a metal ion is reduced

to its elemental form (electron-consuming reaction). At the same time, gases such as oxygen, hydrogen, or nitrogen form at the anode (electron-producing reaction). After the metal coating on the cathode reaches a desired thickness, it may be removed and recovered. The metal-plated cathode can then be used as the anode.

The equipment consists of an electrochemical reactor with electrodes, a gas-venting system, recirculation pumps, and a power supply. A diagram of an electrolytic recovery system is presented in Figure 6-11. Electrochemical reactors are typically designed to produce high flow rates to increase the process efficiency.

A conventional electrolytic recovery system is effective for the recovery of metals from relatively high-concentration wastewater. A specialized adaptation of electrolytic recovery, called extended surface electrolysis, or ESE, operates effectively at lower concentration levels. The ESE system uses a spiral cell containing a flow-through cathode which has a very open structure and therefore a lower resistance to fluid flow. This also provides a larger electrode surface. ESE systems are often used for the recovery of copper, lead, mercury, silver, and gold.

#### **6.1.11.2      *Treatment Performance***

Respondents to the WTI Questionnaire report that there are three electrolytic recovery units in operation in the CWT Industry. No performance data were obtained for these units.

### **6.1.12          *Ion Exchange***

#### **6.1.12.1      *Technology Description***

Ion exchange is commonly used for the removal of heavy metals from relatively low-concentration waste streams, such as electroplating wastewater. A key advantage of the ion exchange process is that it allows for the recovery and reuse of the metal

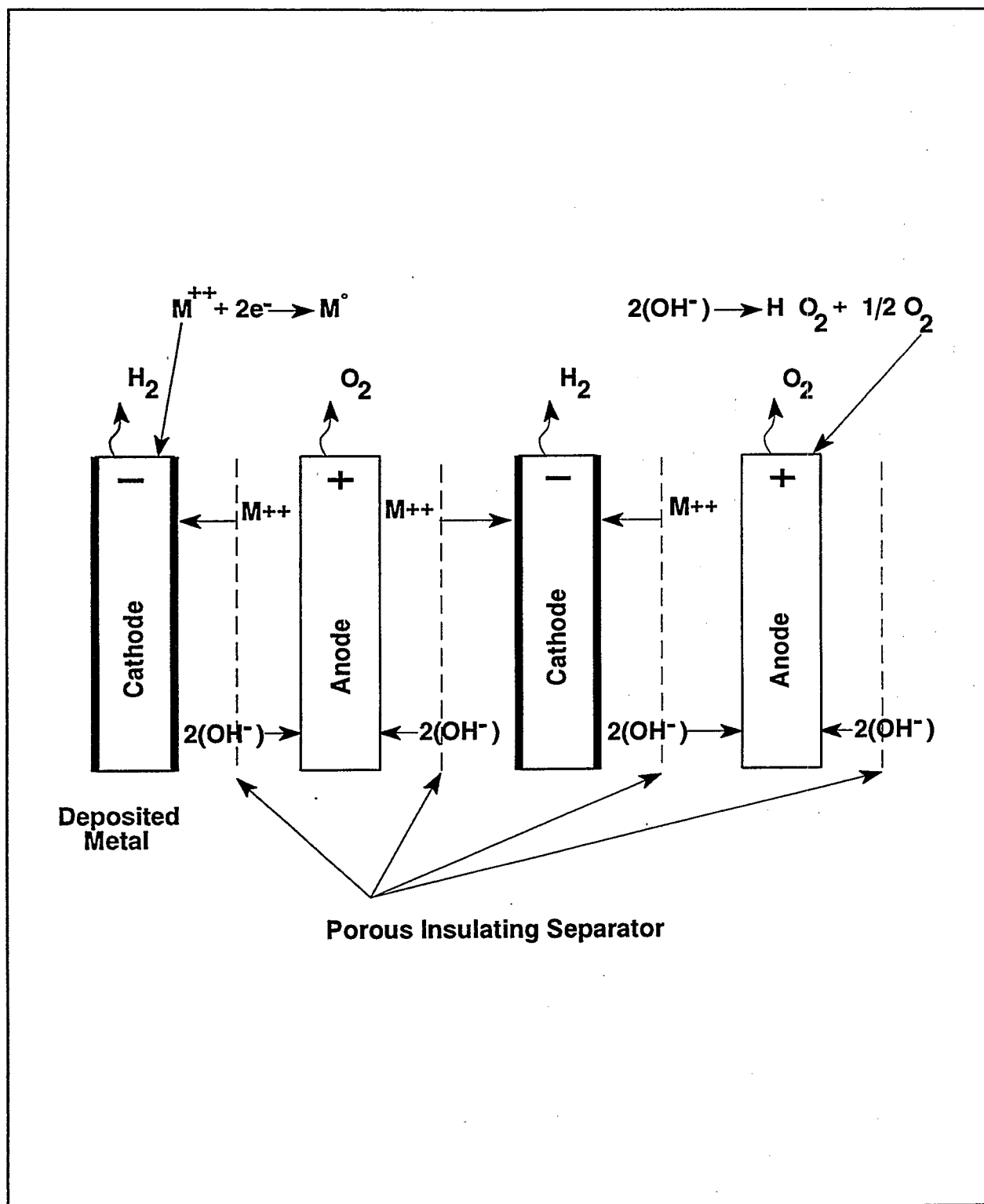


Figure 6-11. Electrolytic Recovery System Diagram



contaminants. Ion exchange can also be designed to be selective to certain metals, and can provide effective removal from wastewater having high background contaminant levels. A disadvantage is that the resins can be fouled by some organic substances.

In an ion exchange system, the wastewater stream is passed through a bed of resin. The resin contains bound groups of ionic charge on its surface, which are exchanged for ions of the same charge in the wastewater. Resins are classified by type, either cationic or anionic; the selection is dependent upon the wastewater contaminant to be removed. A commonly-used resin is polystyrene copolymerized with divinylbenzene.

The ion exchange process involves four steps: treatment, backwash, regeneration, and rinse. During the treatment step, wastewater is passed through the resin bed. The ion exchange process continues until pollutant breakthrough occurs. The resin is then backwashed to reclassify the bed and to remove suspended solids. During the regeneration step, the resin is contacted with either an acidic or alkaline solution containing the ion originally present in the resin. This "reverses" the ion exchange process and removes the metal ions from the resin. The bed is then rinsed to remove residual regenerating solution. The resulting contaminated regenerating solution must be further processed for reuse or disposal. Depending upon system size and economics, some facilities choose to remove the spent resin and replace it with resin regenerated off-site instead of regenerating the resin in-place.

Ion exchange equipment ranges from simple, inexpensive systems such as domestic water softeners, to large, continuous industrial applications. The most commonly-encountered industrial setup is a fixed-bed resin in a vertical column, where the resin is regenerated in-place. A diagram of this type of system is presented in Figure 6-12. These systems can be designed so that the regenerant flow is concurrent or countercurrent to the treatment flow. A countercurrent design, although more complex to operate, provides a higher treatment efficiency. The beds can contain a single type of resin for selective treatment, or the beds can be mixed to provide for more complete deionization of the waste stream. Often, individual beds containing different resins are arranged in series, which makes regeneration easier than in the mixed bed system.

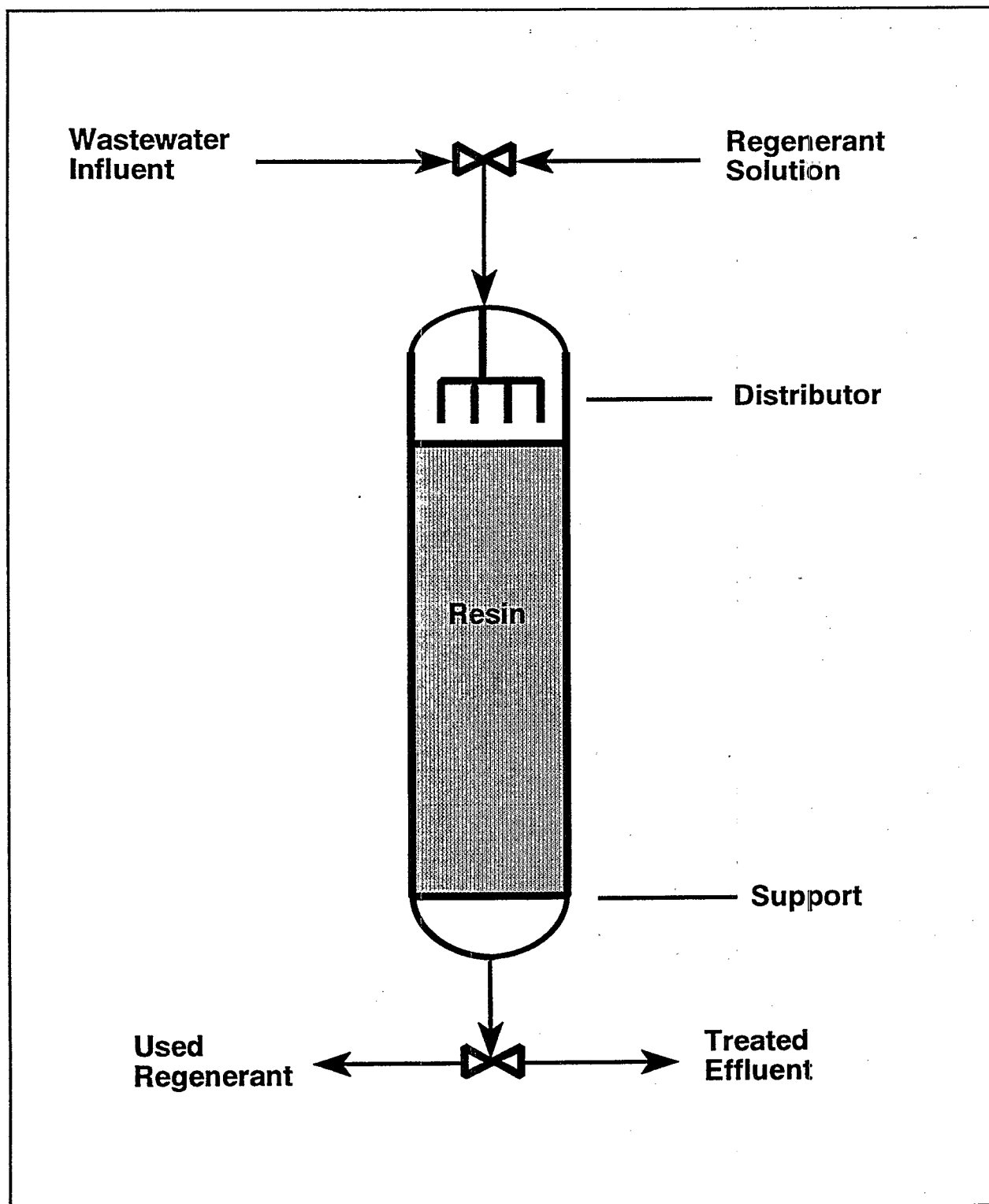


Figure 6-12. Ion Exchange System Diagram

### **6.1.12.2      *Treatment Performance***

Ion exchange is very effective in the treatment of low-concentration metal-bearing wastewater. A common application, chromic acid recovery, has a demonstrated performance of 99.5 percent. Sampling data from the Metal Finishing Industry Study showed a removal of copper from rinsewater of over 99 percent, and nickel removals from 82 to 96 percent.

According to the WTI Questionnaire data base, one facility (CWT QID 255) reported using the ion exchange process. No performance data were obtained for this application.

### **6.1.13          *Gravity Separation***

#### **6.1.13.1      *Technology Description***

Gravity separation is a simple, economical, and widely-used method for the treatment of certain oily wastewater. It is effective in the removal of free and dispersed oils and grease from oil/water mixtures. It is not applicable to the removal of emulsified or soluble oils. Many facilities use gravity separation as a pretreatment step to remove free oils prior to emulsion breaking treatment.

It is necessary to determine the nature of the oily waste stream to be treated before a treatment technology can be selected. The primary factors to be considered include: the concentration of oil in the waste stream and the size of the oil droplets; the specific gravity of the oil compared to that of the wastewater; and the presence of surfactants or chemical emulsifiers. Free, or dispersed oils are present in the wastewater as discrete droplets with little or no water attached to them. These droplets will easily rise to the surface of the oil/water mixture due to their low specific gravity. Large droplets rise more readily than do small droplets.

Once the oil has risen to surface of the wastewater, it must be removed. This is done mechanically via skimmers, baffles, plates, slotted pipes, or dip tubes. Because

gravity separation is such a widely-used technology, there is an abundance of equipment configurations available. A very common unit is the API (American Petroleum Institute) separator, shown in Figure 6-13. This unit uses an overflow and an underflow baffle to skim the floating oil layer from the surface. The resulting oily residue from a gravity separator must then be further processed or disposed.

#### **6.1.13.2      *Treatment Performance***

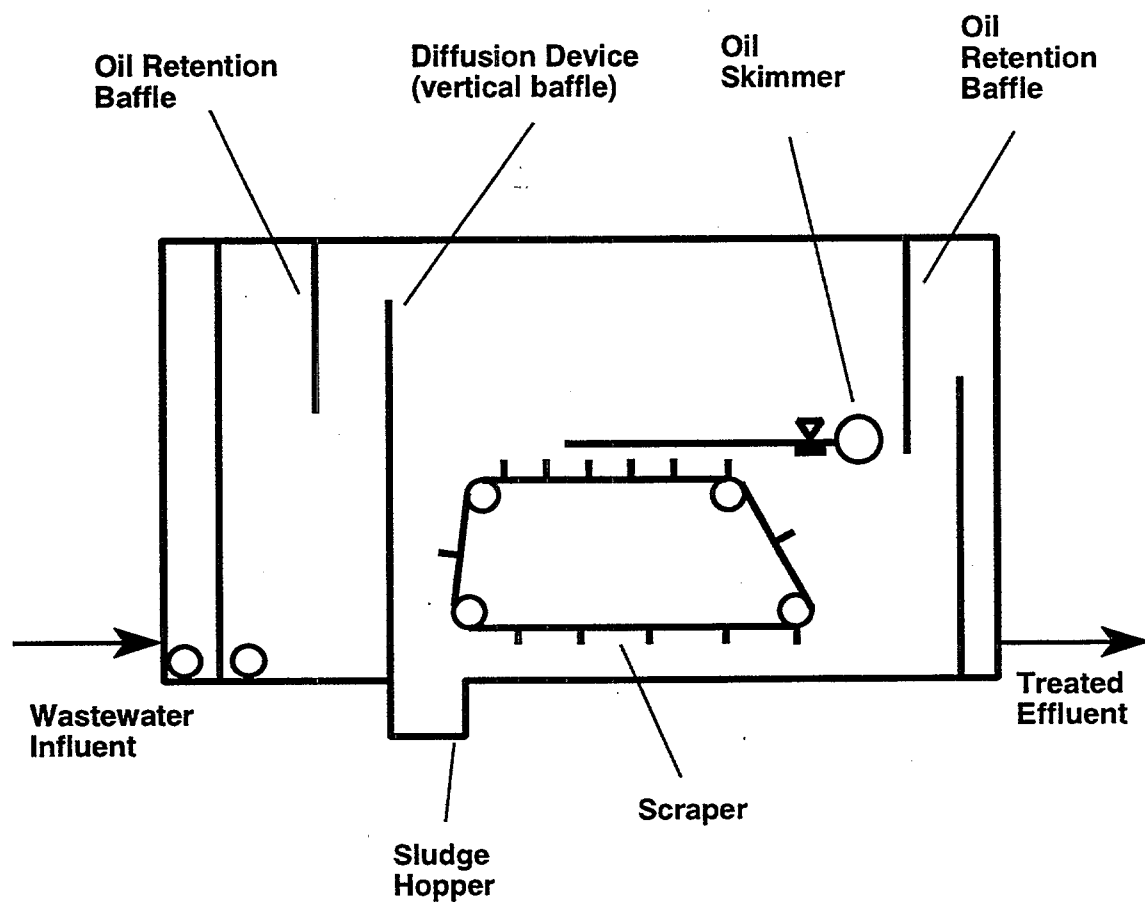
Gravity separation is a demonstrated and effective method for removing free oils and grease from wastewater. Depending upon the nature of the waste stream and the equipment application, gravity separation with mechanical removal can remove over 99 percent of the free oil concentration. There are 18 gravity separation/skimming applications and four plate/tube coalescers used in the CWT Industry. No performance data were obtained for these systems.

#### **6.1.14          *Dissolved Air Flotation***

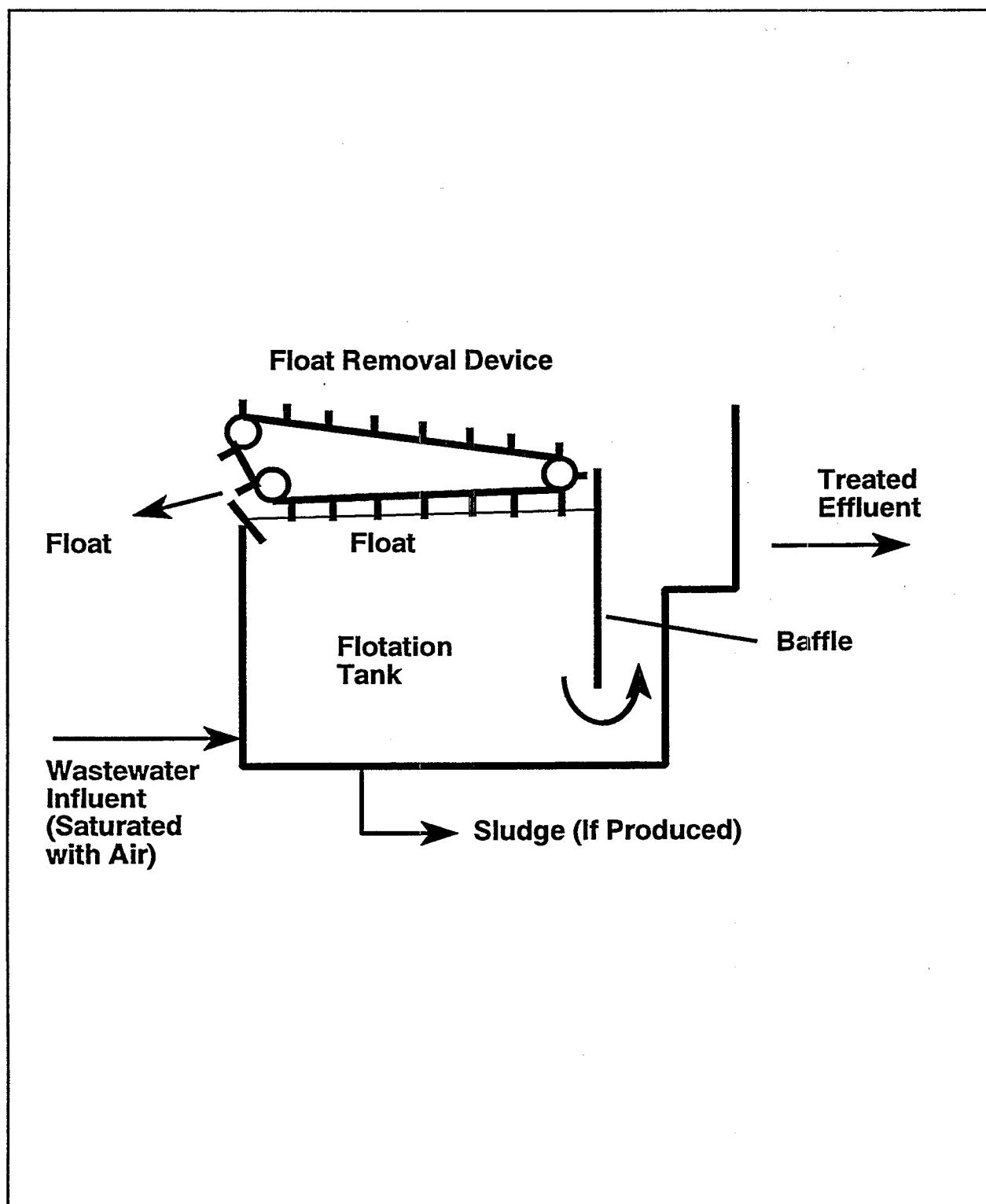
##### **6.1.14.1      *Technology Description***

Flotation is the process of influencing suspended particles to rise to the surface of a tank where they can be collected and removed. Gas bubbles are introduced into the wastewater and attach themselves to the particles, thereby reducing their specific gravity and causing them to float. Flotation processes are utilized because they effectively reduce the sedimentation times of suspended solids that have a specific gravity slightly greater than 1.0.

Dissolved air flotation (DAF) is a one of several flotation techniques employed in the treatment of wastewater. DAF is commonly used to extract free and dispersed oil and grease from oily wastewater. For wastes containing emulsified oils, DAF applied after emulsion breaking can improve treatment performance and shorten retention time. A flow diagram of a DAF system is presented in Figure 6-14.



**Figure 6-13.** Gravity Separation System Diagram



**Figure 6-14.** Dissolved Air Flotation System Diagram

In DAF, air is injected into the wastewater stream while it is under pressure in a pipeline. When the wastewater enters the flotation tank, the pressure is reduced and fine air bubbles are released. These bubbles make contact with the suspended particles via two separate mechanisms. If a flocculant is used, the rising air bubbles can be trapped inside of the flocculated masses as they increase in size. The other type of contact is adhesion, which is a result of the intermolecular attraction between the solid particle and the air bubble.

The performance of the DAF unit relies on having adequate air bubbles present to float all of the suspended solids to the surface of the tank. Partial flotation of solids will occur if inadequate or excessive amounts of air bubbles are present. Therefore, the air-to-solids ratio in the DAF unit determines the effluent quality and the solids concentration in the float.

#### **6.1.14.2      *Treatment Performance***

DAF technology is a well-demonstrated and an effective method of treating certain oily wastewater. Respondents to the WTI Questionnaire report that there were five DAF units in operation in the CWT Industry; no performance data were obtained for these units.

### **6.2      *BIOLOGICAL WASTEWATER TREATMENT TECHNOLOGIES***

A portion of the CWT Industry accepts waste receipts containing organic pollutants, which are often amenable to biological degradation. This subset of CWT facilities is referred to as the Organics Subcategory.

Biological treatment systems use microbes which consume, and thereby destroy, organic compounds as a food source. In addition to the carbon supplied by the organic pollutants, these microbes also need energy and supplemental nutrients, such as nitrogen and phosphorus, for growth. Aerobic microbes require oxygen to grow, whereas

anaerobic microbes are destroyed by oxygen. An adaptive type of anaerobic microbe, a facultative anaerobe, can grow with or without oxygen.

The success of biological treatment is also dependent on other factors, such as the pH and temperature of the wastewater, the nature of the pollutants, the nutrient requirements of the microbes, the presence of other inhibiting pollutants, and variations in the feed stream loading. Certain compounds, such as heavy metals, are toxic to the microorganisms and must be removed from the waste stream prior to biological treatment. Load variations are a major concern, especially in the CWT Industry, where waste receipts vary over time in both concentration and volume.

There are several adaptations of biological treatment. These adaptations differ in three basic ways. First, a system can be aerobic, anaerobic, or facultative. Second, the microorganisms can either be attached to a surface (as in a trickling filter), or be unattached in a liquid suspension (as in an activated sludge system). The third difference is whether the system operation is batch or continuous. In this industry, commercial facilities which receive all of their wastes from off-site are restricted to consideration of a batch process, which is not effected by waste load variations. Continuous biological treatment systems, such as conventional activated sludge systems, are typically only found at CWT facilities which receive their wastes from both on-site and off-site sources. At many of these facilities, on-site manufacturing operations produce a relatively constant waste stream that can support a continuous biological treatment system. The effect of the off-site waste receipt variability is dampened by the presence of the on-site waste stream.

According to the WTI Questionnaire data base, there are 12 activated sludge systems (one with PAC addition), four aerobic systems, two facultative systems, one denitrification system, one sequencing batch reactor (SBR), two biotowers, one surface impoundment, and one land application system in the CWT Industry. There were no anaerobic processes reported. The types of biological treatment processes which are found in the CWT Industry and are discussed in this subsection are SBRs, biotowers, and activated sludge systems.



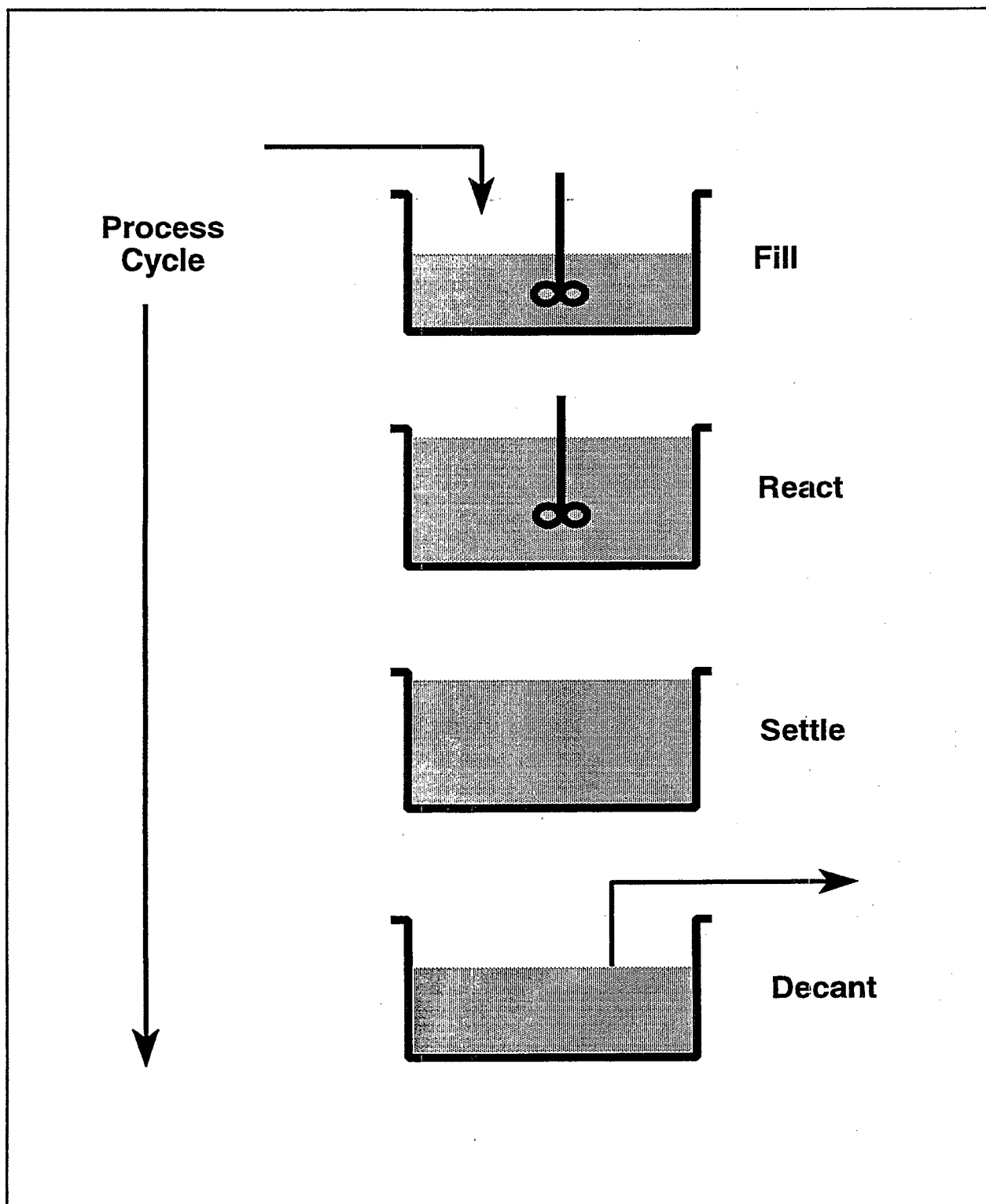
## **6.2.1      *Sequencing Batch Reactors***

### **6.2.1.1      *Technology Description***

A sequencing batch reactor (SBR) is a suspended growth system in which wastewater is mixed with existing biological floc in an aeration basin. SBRs are unique in that a single tank acts as an equalization tank, an aeration tank, and a clarifier. An SBR is operated on a batch basis where the wastewater is mixed and aerated with the biological floc for a specific period of time. The contents of the basin are allowed to settle and the supernatant is decanted. The batch operation of an SBR makes it a feasible biological treatment option for the CWT Industry, where the wastewater volumes and characteristics are often highly variable. An SBR is shown in Figure 6-15.

The SBR has a four cycle process: fill, react, settle, and decant. The fill cycle has three phases. The first phase, called static fill, introduces the wastewater to the system under static conditions. This is the anaerobic period for biological phosphorus uptake. The second phase of the fill cycle is where the wastewater is mixed to eliminate the scum layer and prepare the microorganisms to receive oxygen. In the third phase, aeration is added if aerobic conditions are desired. The react cycle is a time-dependent process that continually mixes and aerates the wastewater while allowing the biological degradation process to complete. The settling cycle utilizes a large surface area and a lower settling rate to allow settling under quiescent conditions. During the decant cycle, approximately one-third of the tank volume is decanted by subsurface withdrawal. This treated, clarified effluent can then be further treated or discharged.

Excess biomass is periodically removed from the SBR when the quantity exceeds that needed for operation. The sludge that is removed from the SBR can be reduced in volume by thickening using a filter press. The sludge can be disposed in a landfill or used as an agricultural fertilizer.



**Figure 6-15.** Sequencing Batch Reactor System Diagram

### 6.2.1.2 *Treatment Performance*

According to the WTI Questionnaire respondents, one SBR was in operation in the CWT Industry. EPA sampled this application at CWT QID 059; the sampling results are given in Table 6-12. This SBR reduced the average BOD<sub>5</sub> concentration from 4,800 to 1,750 mg/l, for a 63.5 percent removal. The average nitrate-nitrite (as N) concentration was reduced from 46.6 to 1.5 mg/l, for a 96.8 percent removal. The pollutants phenol and carbon disulfide were reduced by 82 and 90.3 percent, respectively. The effluent from this SBR was further treated in a carbon adsorption system.

**Table 6-12.** Sequencing Batch Reactor System Performance Data

Parameter	Influent Avg (µg/l)	Effluent Avg (µg/l)	Removal (%)
BOD <sub>5</sub>	4,800,000	1,750,000	63.54
COD	6,525,000	3,525,000	45.98
D-COD	53,500,000	28,500,000	46.73
TOC	2,225,000	1,047,500	52.92
2-Propanone	10,608	2,558	75.88
Ammonia as N	992,500	1,050,000	(5.79)
Carbon Disulfide	158	15	90.32
Nitrate-Nitrite as N	46,550	1,475	96.83
Pentachlorophenol	949	814	14.24
Phenol	2,000	359	82.03

## **6.2.2        *Biotowers***

### **6.2.2.1        *Technology Description***

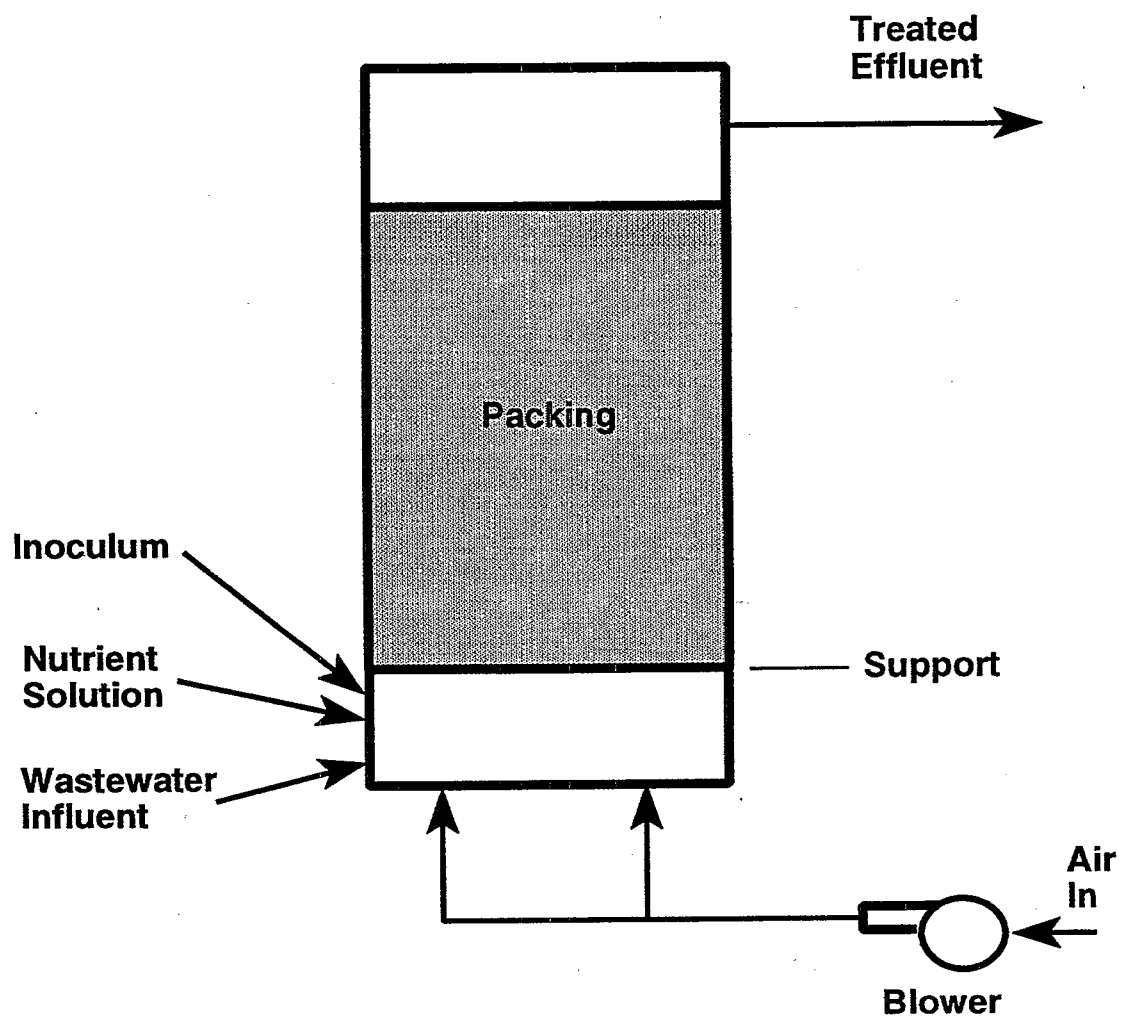
A biological treatment tower, or biotower, is an adaptation of biological treatment which can be operated in a continuous or semi-continuous manner. A waste stream is inoculated with bacteria and is passed through a packed reactor where biological degradation occurs. The system is operated in a one-pass, flow-through configuration. A diagram of a biotower is presented in Figure 6-16.

The biotower is a tank which is packed approximately two-thirds full with plastic honeycomb waffles. These waffles provide an increased reaction surface area. An inoculum is prepared which consists of a commercially-available freeze-dried bacteria culture which has been rehydrated in water. A separate nutrient solution consisting of ammonia and phosphorus is also prepared. The inoculum, nutrient solution, and wastewater stream are fed into the bottom of the biotower. They are mixed and passed up through the packing by air blowers. The treated effluent exits from the top of the biotower.

After biological treatment, the effluent is sent to a separator where a flocculant is added to aid in settling of the solids. The settled solids can then be dewatered and disposed.

### **6.2.2.2        *Treatment Performance***

There are two biotowers in operation in the CWT Industry. One system treats a waste stream which is primarily composed of leachate from an on-site landfill operation. No performance data was obtained for this application. The other system at CWT QID 130 treats high-TOC wastewater from a metals recovery operation. EPA conducted sampling at this facility during the CWT project; the biotower performance data that were collected shows poor performance of the unit. No significant BOD<sub>5</sub>, COD, or TOC removals were recorded during the sampling period.



**Figure 6-16.** Biotower System Diagram

### **6.2.3        *Activated Sludge***

#### **6.2.3.1        *Technology Description***

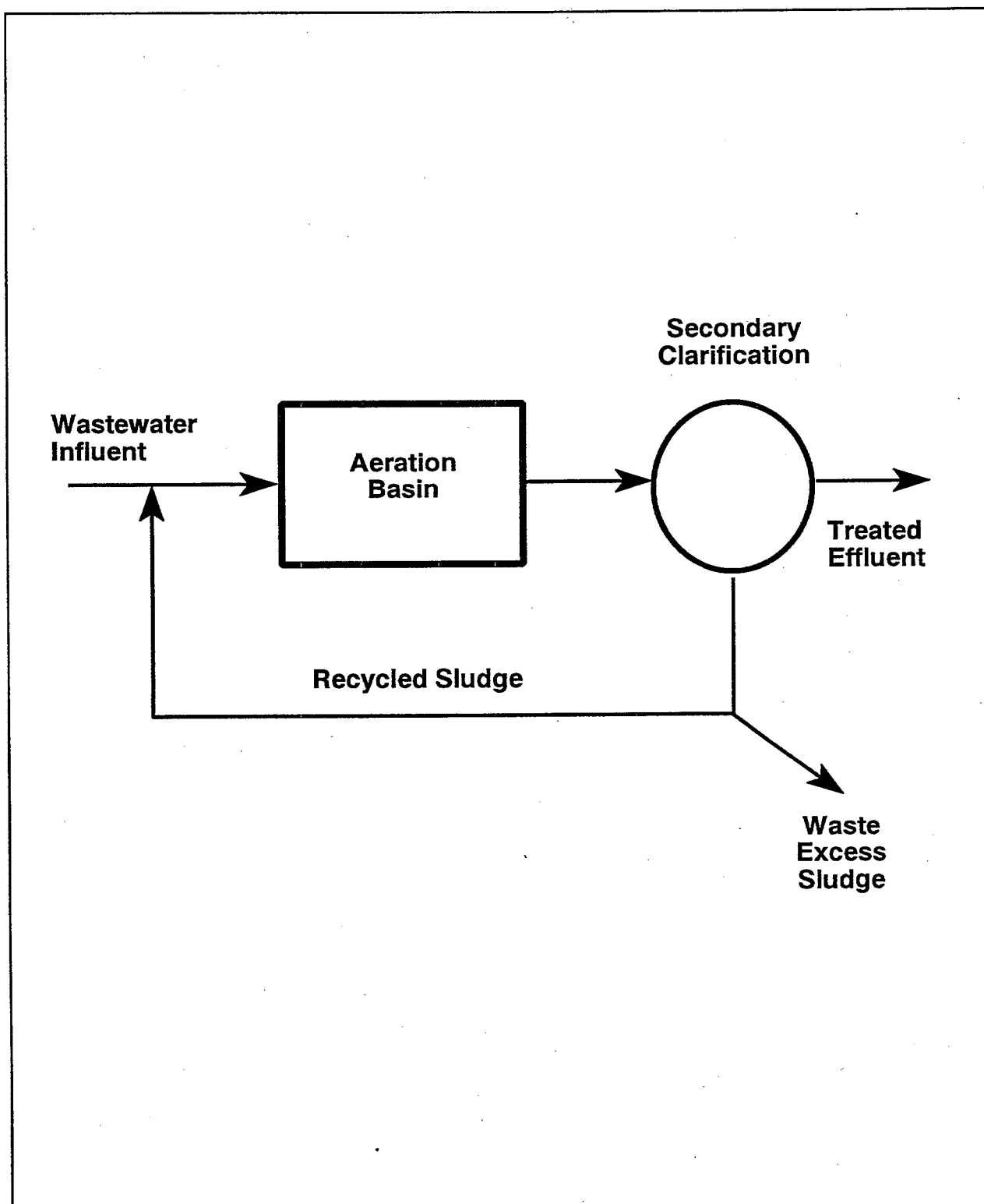
The activated sludge process is a continuous-flow, aerobic biological process. The microorganisms are kept in suspension in the wastewater by mixing. This suspension is called a mixed liquor. The microorganisms oxidize soluble and suspended organics to carbon dioxide and water using oxygen. Types of activated sludge systems include extended aeration, contact stabilization, high-rate modified aeration, step aeration, and oxygen-activated sludge.

The principal design parameters for an activated sludge system are the mixed liquor suspended solids (MLSS) of the system and the biological oxygen demand (BOD) or chemical oxygen demand (COD) of the influent stream. The MLSS is a measure of the quantity of microorganisms available for biodegradation, while the BOD or COD is a measure of the organic loading to the system. Other key design parameters are the detention time, the length of time that the wastewater must remain in contact with the microorganisms to achieve the desired level of treatment, and F/M, the food-to-microorganism ratio. F/M is the loading rate of BOD (or food) applied to the MLSS (or microorganisms).

A diagram of a conventional activated sludge system is shown in Figure 6-17. The system consists of an aeration basin, which is both aerated and mixed. An activated sludge system is typically followed by a secondary clarifier to remove the suspended solids. The resulting sludge from the secondary clarifier must then be dewatered and disposed.

#### **6.2.3.2        *Treatment Performance***

Respondents to the WTI Questionnaire report that there are 12 conventional activated sludge systems in operation in the CWT Industry. These applications are



**Figure 6-17.** Activated Sludge System Diagram

primarily found at facilities that treat on-site wastes in conjunction with off-site waste receipts. No performance data were obtained for activated sludge systems.

### **6.3    *ADVANCED WASTEWATER TREATMENT TECHNOLOGIES***

The technologies presented here can be used as independent operations or as advanced wastewater treatment processes to remove the pollutants remaining after preliminary treatment. These operations are not as commonly-found as those discussed in the preceding subsections.

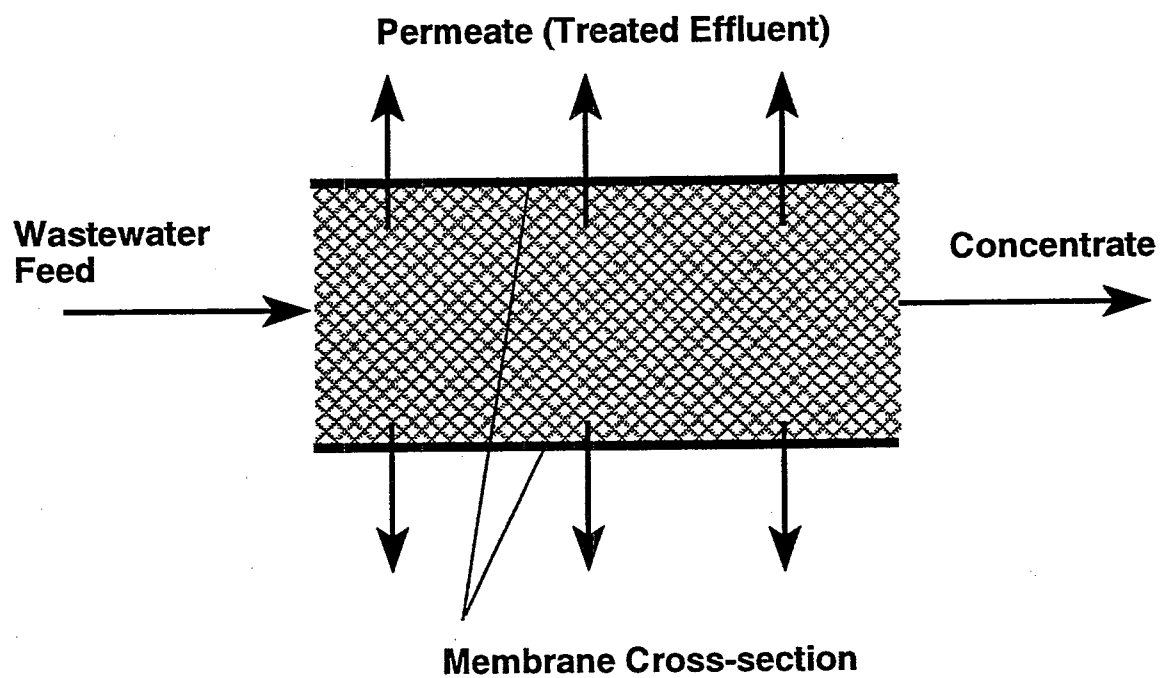
#### **6.3.1        *Ultrafiltration***

##### **6.3.1.1      *Technology Description***

Ultrafiltration (UF) is used for the treatment of metal-finishing wastewater and oily wastes. It can remove substances with molecular weights greater than 500, including suspended solids, oil and grease, large organic molecules, and complexed heavy metals. UF is used when the solute molecules are greater than ten times the size of the solvent molecules, and are less than one-half micron. In the CWT Industry, UF is applied in the treatment of oil/water emulsions. Oil/water emulsions contain both soluble and insoluble oil. Typically the insoluble oil is removed from the emulsion by gravity separation assisted by chemical addition. The soluble oil is then removed by UF. Oily wastewater containing 0.1 to 10 percent oil can be effectively treated by UF. A UF system is typically used as an in-plant treatment technology, treating the oil/water emulsion prior to mixing with other wastewater. A UF system is shown in Figure 6-18.

In UF, a semi-permeable microporous membrane performs the separation. Wastewater is sent through membrane modules under pressure. Water and low-molecular-weight solutes (for example, salts and some surfactants) pass through the membrane and are removed as permeate. Emulsified oil and suspended solids are rejected by the membrane and are removed as concentrate. The concentrate is





**Figure 6-18.** Ultrafiltration System Diagram

recirculated through the membrane unit until the flow of permeate drops. The permeate can either be discharged or passed along to another treatment unit. The concentrate is contained and held for further treatment or disposal.

The primary design consideration in UF is the membrane selection. A membrane pore size is chosen based on the size of the contaminant particles targeted for removal. Other design parameters to be considered are the solids concentration, viscosity, and temperature of the feed stream, and the membrane permeability and thickness.

### 6.3.1.2 *Treatment Performance*

According to the WTI Questionnaire data base, there are three UF applications in the CWT Industry. A UF system which treats oily wastewater at CWT QID 409 was sampled by EPA; these results are presented in Table 6-13. This system removed 87.5 percent of the influent oil and grease and 99.9 percent of the TSS. Several organic and metal pollutants were over 90 percent removed.

**Table 6-13.** Ultrafiltration System Performance Data

Parameter	Influent Avg (µg/l)	Effluent Avg (µg/l)	Removal (%)
Barium	2,790	18	99.36
2-Butanone	39,276	1,426	96.37
COD	54,976,900	9,601,850	82.53
Copper	14,101	48	99.66
Ethylbenzene	12,220	734	94.00
Lead	9,930	738	92.57
m-Xylene	19,585	1,019	94.80
n-Decane	55,561	60	99.89
Oil & Grease	19,926,350	2,489,185	87.51
TSS	6,388,400	6,300	99.90

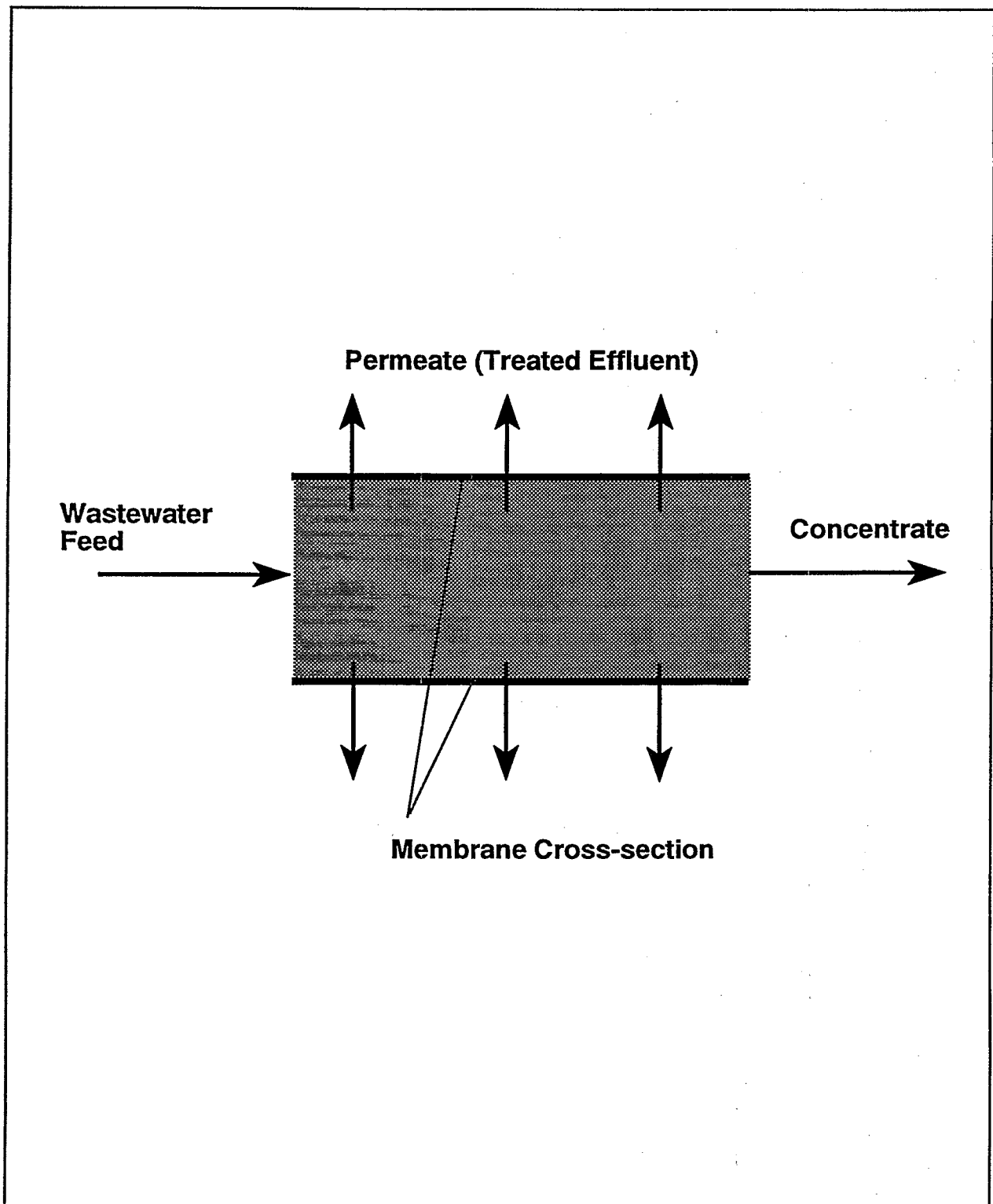
## 6.3.2 *Reverse Osmosis*

### 6.3.2.1 *Technology Description*

Reverse osmosis (RO) is a process for separating dissolved solids from water. It is commonly used to treat oily or metal-bearing wastewater. RO is applicable when the solute molecules are approximately the same size as the solvent molecules. A semi-permeable, microporous membrane and pressure are used to perform the separation. RO systems are typically used as end-of-pipe polishing processes, prior to final discharge of the treated wastewater.

Osmosis is the diffusion of a solvent (such as water) across a semi-permeable membrane from a less concentrated solution into a more concentrated solution. In the reverse osmosis process, pressure greater than the normal osmotic pressure is applied to the more concentrated solution (the waste stream being treated), forcing the purified water through the membrane and into the less concentrated stream which is called the permeate. The low-molecular-weight solutes (for example, salts and some surfactants) do not pass through the membrane. They are referred to as concentrate. The concentrate is recirculated through the membrane unit until the flow of permeate drops. The permeate can either be discharged or passed along to another treatment unit. The concentrate is contained and held for further treatment or disposal. An RO system is shown in Figure 6-19.

The performance of an RO system is dependent upon the dissolved solids concentration and temperature of the feed stream, the applied pressure, and the type of membrane selected. The key RO membrane properties to be considered are: selectivity for water over ions, permeation rate, and durability. RO modules are available in various membrane configurations, such as spiral-wound, tubular, hollow-fiber, and plate and frame. In addition to the membrane modules, other capital items needed for an RO installation include pumps, piping, instrumentation, and storage tanks. The major operating cost is attributed to membrane replacement.



**Figure 6-19.** Reverse Osmosis System Diagram

### 6.3.2.2 Treatment Performance

Respondents to the WTI Questionnaire reported that there were three RO systems in operation in the CWT Industry. A spiral-wound RO system treating an oily waste stream at CWT QID 409 was sampled by EPA. The performance data obtained are presented in Table 6-14. As the data show, this unit reduced the average oil and grease concentration by 87.4 percent. Many of the metal pollutants were also effectively removed, most notably aluminum, barium, calcium, chromium, cobalt, iron, magnesium, manganese, nickel, and titanium, all of which were over 98 percent reduced.

**Table 6-14.** Reverse Osmosis System Performance Data

Parameter	Influent LTA (µg/l)	Effluent LTA (µg/l)	Removal (%)
Oil & Grease	386,928	48,898	87.36
Aluminum	3,785	32	99.15
Chromium	254	4 (ND)	98.43
Cobalt	441	4	99.09
Iron	15,494	147	99.05
Lead	986	28	97.16
Magnesium	25,162	292	98.84
Manganese	1,164	16	98.63
Nickel	43,862	820	98.13
Zinc	5,396	201	96.28

LTA = Long-term average

ND = Not detected

### **6.3.3        *Lancy Filtration***

#### **6.3.3.1        *Technology Description***

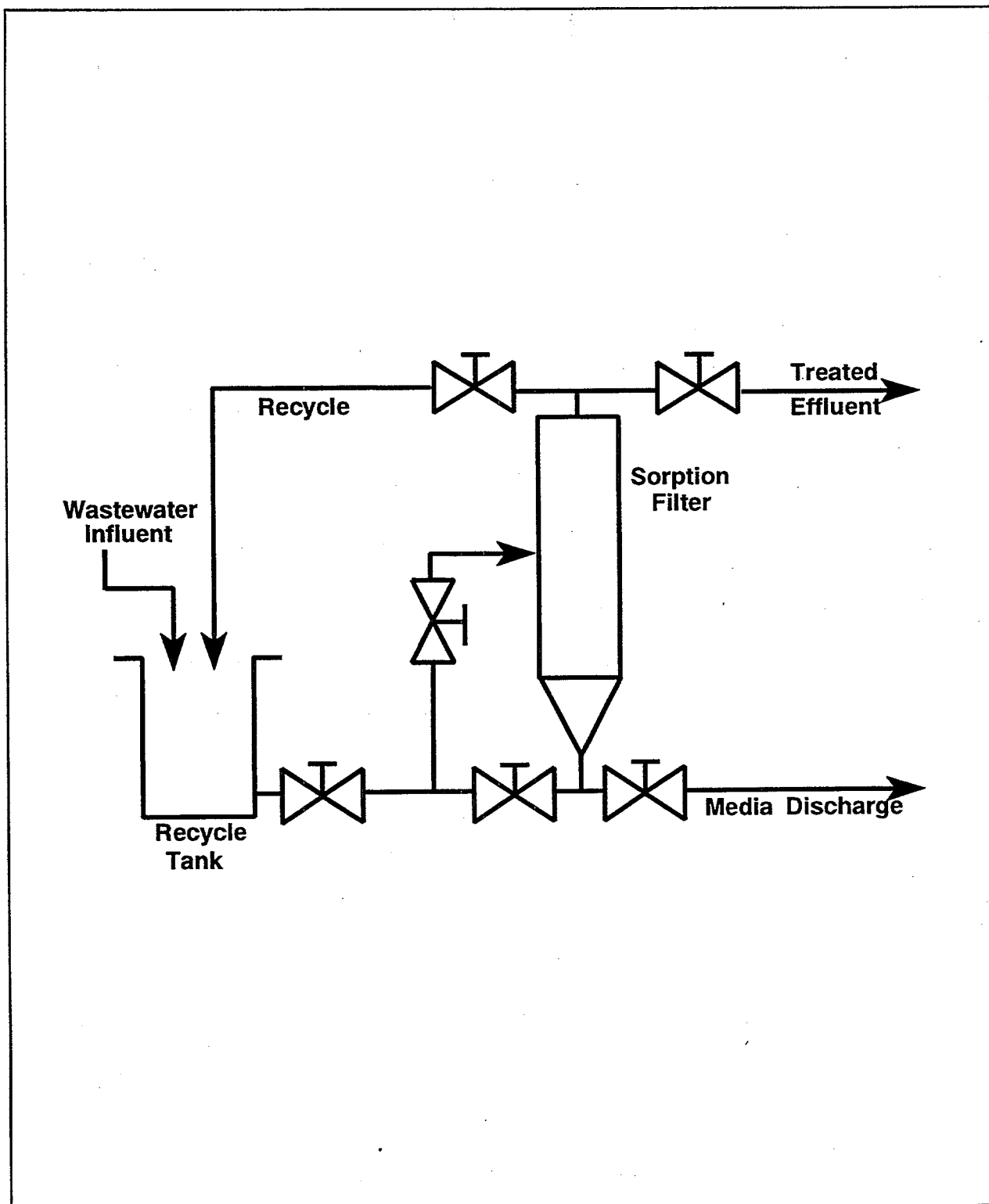
The Lancy Sorption Filter System is a patented method for the continuous recovery of heavy metals. Metals not removed by conventional waste treatment technologies can be reduced to low concentrations by the Lancy sorption filtration process.

In the first stage of the Lancy filtration process, a soluble sulfide is added to the wastewater in a reaction tank, converting most of the heavy metals to sulfides. From the sulfide reaction tank, the solution is passed through the sorption filter media. Precipitated metal sulfides and other suspended solids are filtered out. Any remaining soluble metals are absorbed by the media. Excess soluble sulfides are also removed from the waste stream.

The Lancy filtration process can reportedly reduce zinc, silver, copper, lead, and cadmium to less than 0.05 mg/l and mercury to less than 2 µg/l. In addition to the effective removal of heavy metals, the system has a high solids filtration capacity and a fully automatic, continuous operation. The system continuously recycles and reuses the same filter media thereby saving on operating costs. The system can be installed with a choice of media discharge - slurry or solid cake. The Lancy Sorption Filtration System is shown in Figure 6-20.

#### **6.3.3.2        *Treatment Performance***

A Lancy sorption filtration application at CWT QID 255 was sampled by EPA. This unit is a polishing treatment for the effluent from a chemical precipitation, clarification, and sand filtration treatment sequence. The data from this system are presented in Table 6-15. These data show, that of the target metals, mercury was reduced to a concentration of 2 µg/l. None of the other target metals, however, were reduced to concentrations as low as 0.05 mg/l. In fact, many of the pollutant concentrations actually increased. This



**Figure 6-20.** Lancy Filtration System Diagram

poor performance may not be representative of the normal operation of this Lancy application, as the unit was being tested during the sampling episode.

**Table 6-15.** Lancy Filtration System Performance Data

Parameter	Influent LTA (µg/l)	Effluent LTA (µg/l)	Removal (%)
TSS	638,900	471,600	26.19
Cadmium	120	58	51.67
Chromium	461	306	33.62
Copper	1,382	252	81.77
Hexavalent Chromium	73	34	53.42
Lead	631	536	15.05
Manganese	1,396	75	94.63
Mercury	15	2	86.67
Silver	142	138	2.82
Zinc	4,047	974	75.93

LTA = Long-term average

### 6.3.4 *Liquid Carbon Dioxide Extraction*

#### 6.3.4.1 *Technology Description*

Liquid carbon dioxide (CO<sub>2</sub>) extraction is used to extract and recover organic contaminants from aqueous waste streams. A licensed, commercial application of this technology is utilized in the CWT Industry under the name "Clean Extraction System (CES)". The process can be effective in the removal of organic substances such as hydrocarbons, aldehydes and ketones, nitriles, halogenated compounds, phenols, esters, and heterocyclics. It is not effective in the removal of some compounds which are very



water-soluble, such as ethylene glycol, and low molecular weight alcohols. It can provide an alternative in the treatment of waste streams which historically have been incinerated.

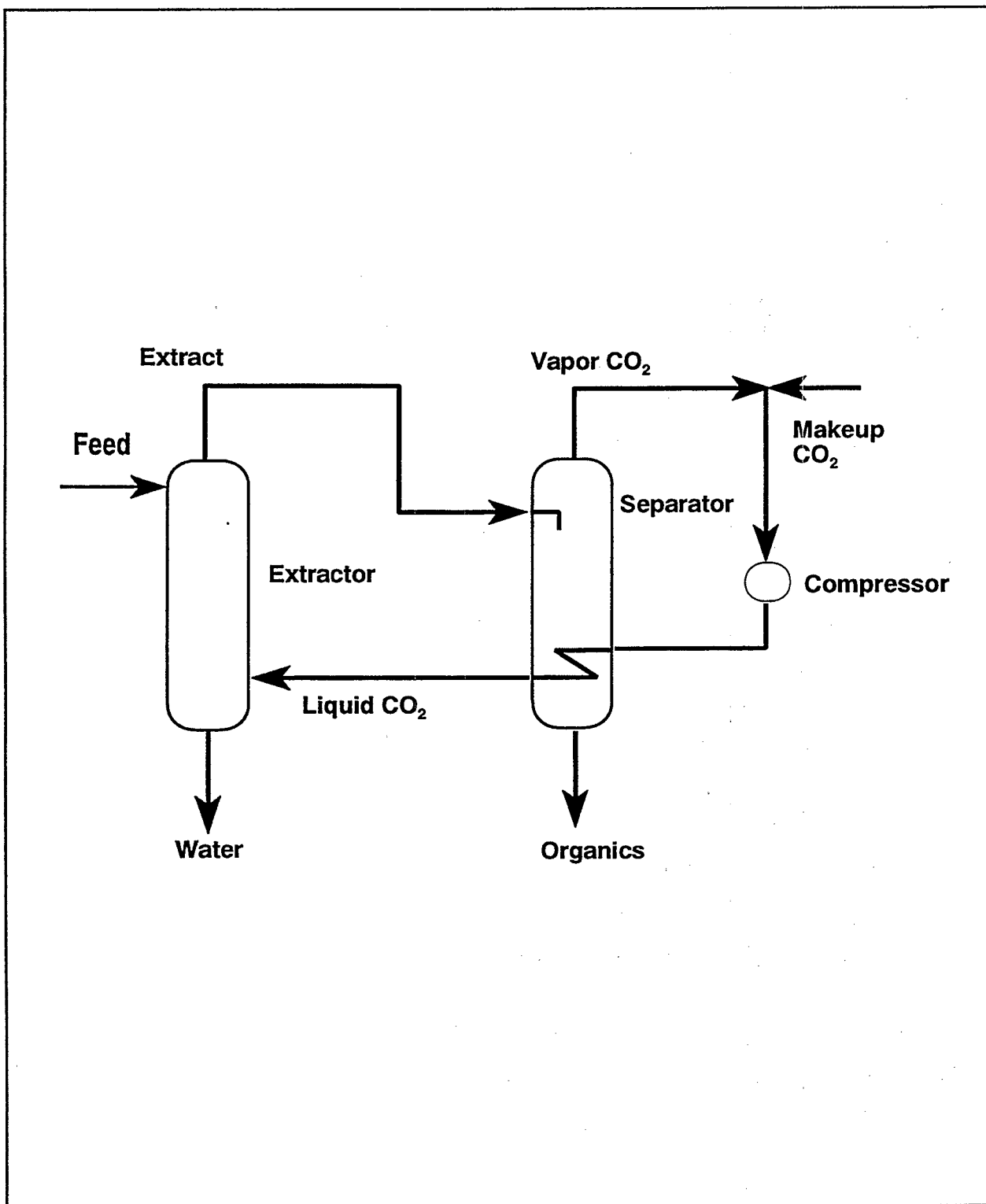
The waste stream is fed into the top of a pressurized extraction tower containing perforated plates, where it is contacted with a countercurrent stream of liquefied CO<sub>2</sub>. The organic contaminants in the waste stream are dissolved in the CO<sub>2</sub>; this extract is then sent to a separator, where the CO<sub>2</sub> is redistilled. The distilled CO<sub>2</sub> vapor is compressed and reused. The concentrated organics bottoms from the separator can then be disposed or recovered. The treated wastewater stream which exits the extractor (raffinate) is pressure-reduced, and may be further treated for residual organics removal if necessary to meet discharge standards. A diagram of the CES is presented in Figure 6-21.

#### **6.3.4.2      *Treatment Performance***

Pilot-scale operational data for a commercial CES unit are presented in Table 6-16. This information was submitted to EPA by the CWT company which operates the system. These data show high removals for a variety of organic compounds ranging up to 99.99 plus percent for methylene chloride. The commercial CWT CES unit was sampled by EPA during this rulemaking effort. The percent removals achieved during the sampling episode are also presented in Table 6-16. These removals are not as high as those reported for the pilot-scale unit.

### **6.4      *SLUDGE TREATMENT AND DISPOSAL***

There are several waste treatment processes used in the CWT Industry which generate a sludge. These processes include chemical precipitation of metals, clarification, and biological treatment. Some oily waste treatment processes, such as emulsion breaking and dissolved air flotation, also produce sludges. These sludges typically contain between one and five percent solids. They require dewatering to concentrate them and prepare them for transport and/or disposal.



**Figure 6-21.** Liquid CO<sub>2</sub> Extraction System Diagram

Table 6-16. Liquid CO Extraction System Performance Data

Parameter	CES Pilot Scale Data			EPA Sampling Data		
	Influent (mg/l)	Effluent (mg/l)	Removal (%)	Influent Average (mg/l)	Effluent Average (mg/l)	Removal Average (%)
2-Propanone	27,500 11.70	123 0.39	99.55 96.70	13,696.53	3,871.80	71.73
Chloroform	40	0.10	99.75	2.50	1.00(ND)	60.00
1,2-Dichloroethane	250	0.10	99.96	6.24	1.00(ND)	83.97
Ethylbenzene	160 8	91 5.36	96.65 98.75	3.02	1.00(ND)	66.89
Methylene Chloride	3,050	0.10	99.99	3,885.14	448.2	88.46
2-Butanone	1,500	0.10	99.99	116.84	18.32	84.32
Phenol	61,750	10,658	82.74	10.83	5.67	47.65
Toluene	165 1,225	0.10 11.16	99.94 99.09	1,489.84	667.74	55.18

ND = Not detected

Sludges are dewatered using pressure, which is caused by applied force, gravity, vacuum, or centrifugal force. There are several widely-used, commercially-available methods for sludge dewatering. The methods which are found in the CWT Industry and are discussed in this subsection are: plate and frame pressure filtration, belt pressure filtration, and vacuum filtration. A plate and frame filter press can produce the driest filter cake of these three systems, followed by the belt press, and lastly, the vacuum filter.

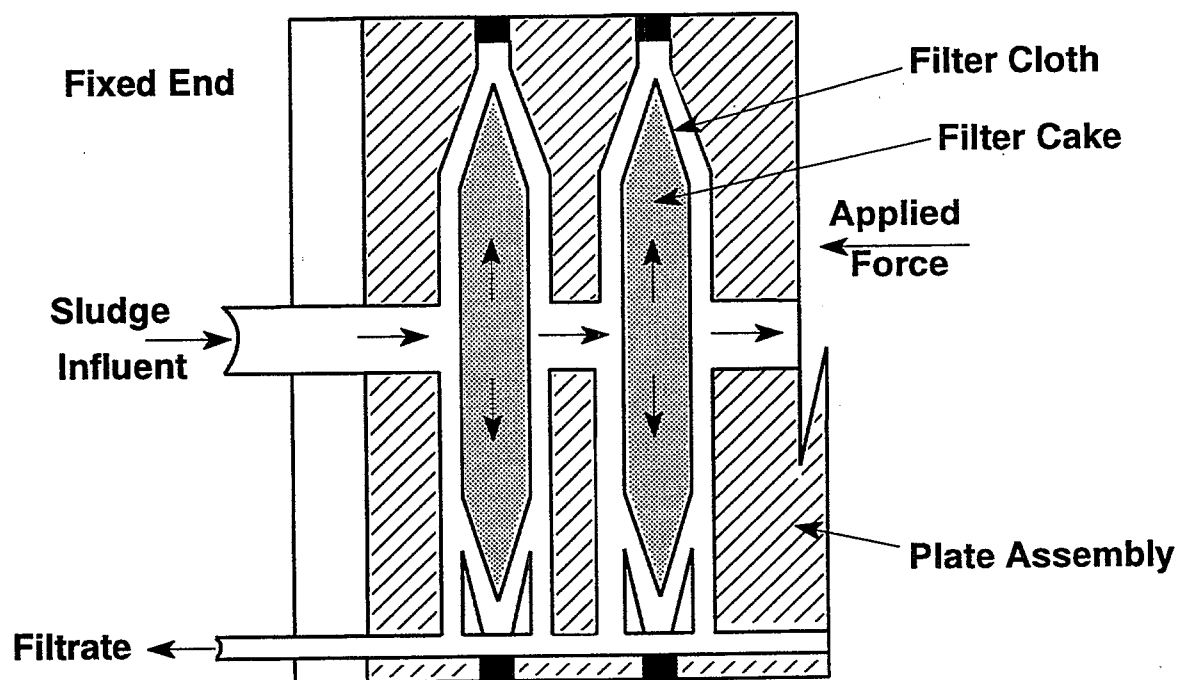
In some instances, depending upon the nature of the sludge and the dewatering process used, the sludge may first be stabilized, conditioned, and/or thickened prior to dewatering. Certain sludges require stabilization (via chemical addition or biological digestion) because they have an objectionable odor or are a health threat. Sludges produced by the CWT Industry usually do not fall into this category. Sludge conditioning is used to improve dewaterability; it can be accomplished via the addition of heat or chemicals. Sludge thickening, or concentration, reduces the volume of sludge to be dewatered and is accomplished by gravity settling, flotation, or centrifugation.

#### **6.4.1        *Plate and Frame Pressure Filtration***

##### **6.4.1.1      *Technology Description***

Plate and frame pressure filtration systems are used for the removal of solids from waste streams. The sludge stream plate and frame pressure filtration system is identical to the system used for the liquid stream (Subsection 6.1.3) with the exception of the increase of higher solids level in the influent stream. The same equipment is used for both applications, with the difference being in the sizing of the sludge and liquid units. A plate and frame filter press is shown in Figure 6-22.

A plate and frame filter press consists of a number of filter plates or trays connected to a frame and pressed together between a fixed end and a moving end. Filter cloth is mounted on the face of each plate. The sludge is pumped into the unit under pressure while the plates are pressed together. The solids are retained in the cavities of the filter press and begin to attach to the filter cloth until a cake is formed. The water,



**Figure 6-22.** Plate and Frame Pressure Filtration System Diagram

or filtrate passes through the filter cloth and is discharged from a drainage port in the bottom of the press. The sludge influent is pumped into the system until the cavities are filled. Pressure is applied to the plates until the flow of filtrate stops.

At the end of the cycle, the pressure is released and the plates are separated. The filter cake drops into a hopper below the press. The filter cake can then be disposed in a landfill. The filter cloth is washed before the next cycle begins.

The key advantage of plate and frame pressure filtration is that it can produce a drier filter cake than is possible with the other methods of sludge dewatering. It is well-suited for use in the CWT Industry as it is a batch process. However, its batch operation results in greater operating labor requirements.

#### **6.4.1.2      *Treatment Performance***

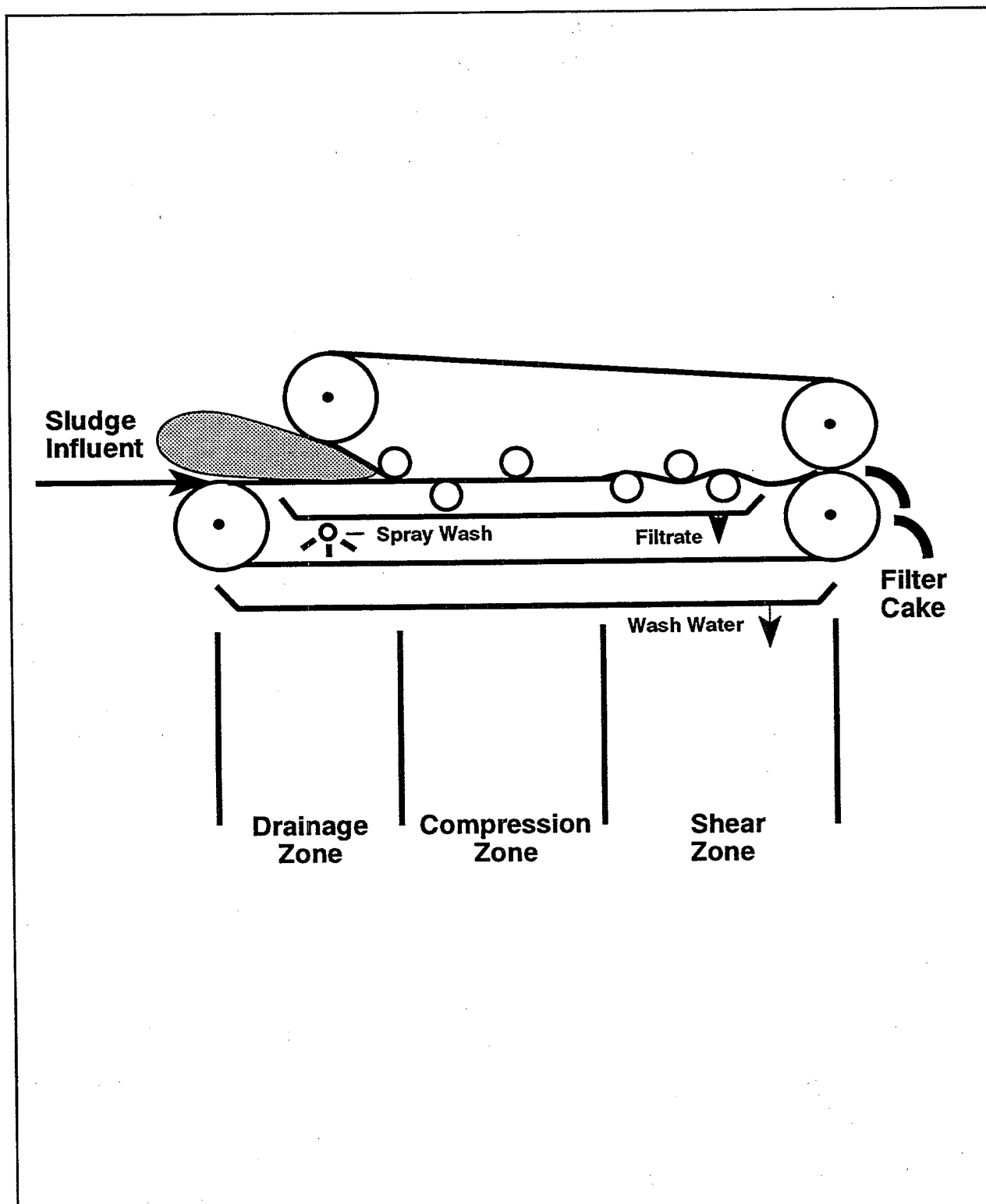
Respondents to the WTI Questionnaire reported that 34 plate and frame filter presses (treating liquid and sludge streams) are used in the CWT Industry. In a typical plate and frame pressure filtration unit, the filter cake can exhibit a dry solids content between 30 and 50 percent.

#### **6.4.2          *Belt Pressure Filtration***

##### **6.4.2.1      *Technology Description***

A belt pressure filtration system uses gravity followed by mechanical compression and shear force to produce a sludge filter cake. Belt filter presses are continuous systems which are commonly used to dewater biological treatment sludge. Most belt filter installations are preceded by a flocculation step, where polymer is added to create a sludge which has the strength to withstand being compressed between the belts without being squeezed out. A typical belt filter press is illustrated in Figure 6-23.

During the press operation, the sludge stream is fed onto the first of two moving cloth filter belts. The sludge is gravity-thickened as the water drains through the belt. As



**Figure 6-23.** Belt Pressure Filtration System Diagram

the belt holding the sludge advances, it approaches a second moving belt. As the first and second belts move closer together, the sludge is compressed between them. The pressure is increased as the two belts travel together over and under a series of rollers. The turning of the belts around the rollers shear the cake which furthers the dewatering process. At the end of the roller pass, the belts move apart and the cake drops off. The feed belt is washed before the sludge feed point. The dropped filter cake can then be disposed.

The advantages of a belt filtration system are its lower labor requirements and lower power consumption. On the minus side, belt filter presses produce a poorer quality filtrate, and require a relatively large volume of belt wash water.

#### **6.4.2.2      *Treatment Performance***

Typical belt filtration applications can dewater an undigested activated sludge to a cake containing 15 to 25 percent solids. Heat-treated, digested sludges can be reduced to a cake of up to 50 percent solids. According to the WTI Questionnaire data base, there are six belt filter presses in-place in the CWT Industry; however, no performance data were obtained for these systems.

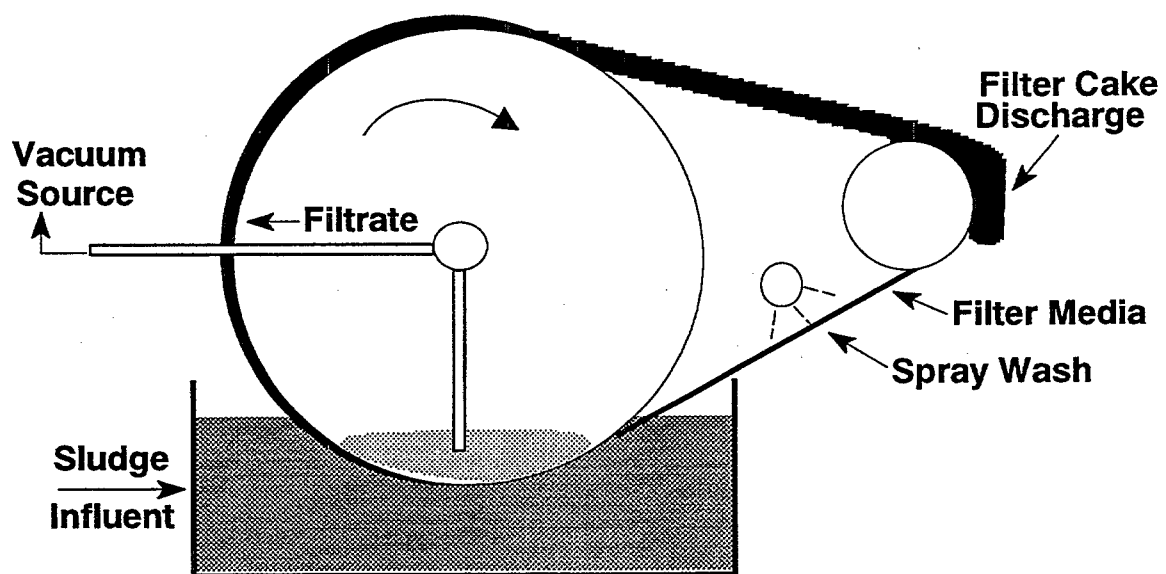
#### **6.4.3          *Vacuum Filtration***

##### **6.4.3.1      *Technology Description***

A commonly-used process for dewatering sludge is rotary vacuum filtration. These filters come in drum, coil, and belt configurations. The filter medium can be made of cloth, coil springs, or wire-mesh fabric. A typical application is a rotary vacuum belt filter; a diagram of this equipment is shown in Figure 6-24.

A continuous belt of filter fabric is wound around a horizontal rotating drum and rollers. The drum is perforated and is connected to a vacuum. The drum is partially immersed in a shallow tank containing the sludge. As the drum rotates, the vacuum





**Figure 6-24.** Vacuum Filtration System Diagram

which is applied to the inside of the drum draws the sludge onto the filter fabric. The water from the sludge passes through the filter and into the drum, where it exits via a discharge port. As the fabric leaves the drum and passes over the roller, the vacuum is released. The filter cake drops off of the belt as it turns around the roller. The filter cake can then be disposed.

Because vacuum filtration systems are relatively expensive to operate, they are usually preceded by a thickening step which reduces the volume of sludge to be dewatered. It is a continuous process and therefore requires less operator attention.

#### **6.4.3.2      *Treatment Performance***

Vacuum filtration can reduce activated sludge to a cake containing 12 to 20 percent solids. Lime sludge can be reduced to a cake of 25 to 40 percent solids. According to the WTI Questionnaire respondents, there are 10 vacuum filtration installations in the CWT Industry. No performance data were obtained for these installations.

#### **6.4.4          *Filter Cake Disposal***

After a sludge is dewatered, the resultant filter cake must be disposed. The most common method of filter cake management used in the CWT Industry is transport to an off-site landfill for disposal. Other disposal options are incineration or land application. Land application is usually restricted to biological treatment residuals.

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## **SECTION 7**

### **COST OF TREATMENT TECHNOLOGIES**

This section presents the costs estimated for compliance with the CWT effluent limitations guidelines and standards. Subsection 7.1 provides a general description of how the individual treatment technology and regulatory option costs were developed. In Subsections 7.2 through 7.5, the development of capital costs, operating and maintenance (O & M) costs, and land requirements for each of the specific wastewater and sludge treatment technologies is described in detail.

Additional compliance costs to be incurred by facilities, which are not dependent upon a regulatory option or treatment technology, are presented in Subsection 7.6. These additional items are retrofit costs, monitoring costs, RCRA permit modification costs, and land costs.

#### **7.1 COSTS DEVELOPMENT**

##### **7.1.1 Technology Costs**

Cost information for the technologies selected is available from several sources. The first source of information is the data base developed from the 1991 Waste Treatment Industry (WTI) Questionnaire responses. A second source of information is the Organic Chemical and Plastics and Synthetic Fibers (OCPSF) industrial effluent limitations guidelines and standards development document, which utilizes the 1983 U.S. Army Corps of Engineers' Computer Assisted Procedure for Design and Evaluation of Wastewater Treatment Systems (CAPDET). A third source is engineering literature. The fourth source of information is the CWT sampling facilities. The fifth source of information is vendors' quotations. Vendors' recommendations were used extensively in the costing of the various technologies. The data from the WTI Questionnaire contained a limited amount of process cost information, and was used wherever possible.

The total costs developed include the capital costs of the investment, annual O & M costs, land requirement costs, sludge disposal costs, monitoring costs, RCRA permit modification costs, and retrofit costs. All of the costs were either scaled up or scaled down to 1989 dollars using the Engineering News Record (ENR) Construction Cost Index, as 1989 is the base year for the WTI Questionnaire.

The capital costs for the technologies are primarily based on vendors' quotations. The equipment costs typically include the cost of the treatment unit and some ancillary equipment associated with that technology. Investment costs added to the equipment cost include piping, instrumentation and controls, pumps, installation, engineering, and contingency. The standard factors used to estimate the capital costs are listed in Table 7-1.

**Table 7-1. Standard Capital Cost Factors**

<b>Factor</b>	<b>Capital Cost</b>
Equipment Cost	Technology-Specific Cost
Installation	25 to 55 percent of equipment cost
Piping	31 to 66 percent of equipment cost
Instrumentation and Controls	6 to 30 percent of equipment cost
Total Construction Cost (TCC)	Equipment + Installation + Piping + Instrumentation and Controls
Engineering	15 percent of TCC
Contingency	15 percent of TCC
Total Indirect Cost	Engineering + Contingency
Total Capital Cost	Total Construction Cost + Total Indirect Cost

The annual O & M costs for the various systems were derived from the vendors' information or from engineering literature. The annual O & M cost is comprised of energy, maintenance, taxes and insurance, labor, treatment chemicals (if needed), and

residuals management (also if needed). The standard factors used to estimate the O & M costs are listed in Table 7-2. All of the parameters used in costing the CWT Industry are explained further in this section.

**Table 7-2.** Standard O & M Cost Factors

<b>Factor</b>	<b>O &amp; M Cost (1989 \$)</b>
Maintenance	4 percent of Total Capital Cost
Taxes and Insurance	2 percent of Total Capital Cost
Labor	\$30,300 to \$31,200 per man-year
Electricity	\$0.08 per kilowatt-hour
Residuals Management	Technology-Specific Cost
Granular Activated Carbon	\$0.70 per pound
Lime (Calcium Hydroxide)	\$57 per ton
Polymer	\$3.38 per pound
Sodium Hydroxide (100 percent solution)	\$560 per ton
Sodium Hydroxide (50 percent solution)	\$275 per ton
Sodium Hypochlorite	\$0.64 per pound
Sulfur Dioxide	\$230 per ton
Sulfuric Acid	\$80 per ton
Total O & M Cost	Maintenance + Taxes and Insurance + Labor + Electricity + Chemicals + Residuals

### **7.1.2 Option Costs**

Engineering costs were developed for each of the individual treatment technologies which comprise the CWT regulatory options. These technology-specific costs, broken down into capital, O & M, and land components, are explained further in this section.

To estimate the cost of an entire regulatory option, it is necessary to sum the costs of the individual treatment technologies which make up that option. In some instances, an option consists of only one treatment technology; for those cases, the option cost is equal to the technology cost.

The CWT subcategory regulatory options are described in Table 7-3. The treatment technologies included in each option are listed, and the subsections which contain the corresponding cost information are indicated.

## **7.2 PHYSICAL/CHEMICAL/THERMAL WASTEWATER TREATMENT TECHNOLOGY COSTS**

### **7.2.1 Chemical Precipitation**

Chemical precipitation systems are used to remove dissolved metals from wastewater. Lime and caustic were selected as the precipitants because of their effectiveness in removing dissolved metals. The chemical precipitation capital and O & M costs were calculated for a flow rate range of 0.000001 to 5.0 MGD.

#### **7.2.1.1 Chemical Precipitation - Metals Option 1**

The CWT Metals Option 1 chemical precipitation system equipment consists of a mixed reaction tank with pumps, a treatment chemical feed system, and an unmixed wastewater holding tank. The system is operated on a batch basis, treating one batch per day, five days per week. The average chemical precipitation batch duration reported by respondents to the WTI Questionnaire was four hours. Therefore, a one batch per day



**Table 7-3. CWT Subcategory Options**

Subcategory/Option	Treatment Technology	Subsection
Metals 1	Chemical Precipitation	7.2.1.1
	Liquid Filtration or Clarification/Sludge Filtration	7.2.3.1 or 7.2.2/7.5.1
Metals 2	Selective Metals Precipitation	7.2.1.2
	Liquid Filtration	7.2.3.2
	Secondary Precipitation	7.2.1.3
	Liquid Filtration or Clarification/Sludge Filtration	7.2.3.2 or 7.2.2/7.5.1
Metals 3	Metals Option 2 Technologies	(above)
	Tertiary Precipitation	7.2.1.4
	Clarification	7.2.2
	pH Adjustment	7.2.1.4
Metals - Hexavalent Chromium Waste Pretreatment	Chromium Reduction using Sulfur Dioxide	7.2.9
Metals - Cyanide Waste Pretreatment	Cyanide Destruction at Special Operating Conditions	7.2.8
Oils 2	Ultrafiltration	7.4.1
Oils 3	Oils Option 2 Technology	(above)
	Carbon Adsorption	7.2.7
	Reverse Osmosis	7.4.2
Oils 4	Oils Option 3 Technologies	(above)
	Carbon Adsorption	7.2.7
Organics 1	Equalization	7.2.4
	Air Stripping	7.2.5
	Sequencing Batch Reactor	7.3.1
	Multi-Media Filtration	7.2.6
Organics 2	Organics Option 1 Technologies	(above)
	Carbon Adsorption	7.2.7

treatment schedule would provide sufficient time for the average facility to pump, treat, and test its waste. A holding tank, equal to the daily waste volume, up to a maximum size of 5,000 gallons (equivalent to one tank truck receipt), was provided to allow facilities flexibility in managing waste receipts.

Total capital cost estimates were developed for the Metals Option 1 chemical precipitation systems. For facilities with no chemical precipitation system in-place, the components of the chemical precipitation system included the precipitation tank with a mixer, pumps, and a feed system. In addition, the holding tank equal to the size of the precipitation tank, up to 5,000 gallons, was also included. These cost estimates were obtained from manufacturers' recommendations.

For facilities that already have a precipitation tank (treatment in-place), a capital cost upgrade was determined; this consists of the cost of a holding tank only.

The resulting chemical precipitation capital cost and capital upgrade cost equations for Metals Option 1 are presented as Equations 7-1 and 7-2, respectively.

$$\ln(Y1) = 14.019 + 0.481\ln(X) - 0.00307(\ln(X))^2 \quad (7-1)$$

$$\ln(Y1) = 10.671 - 0.083\ln(X) - 0.032(\ln(X))^2 \quad (7-2)$$

where:

X = Flow Rate (MGD) and

Y1 = Capital Cost (1989 \$).

The O & M cost estimates for facilities with no treatment in-place were based on estimated energy usage, maintenance, labor, taxes and insurance, and chemical usage cost. The energy costs included electricity, lighting, and controls. The labor cost was approximated at two hours per batch.

Chemical cost estimates were calculated based on stoichiometric, pH adjustment, and buffer adjustment requirements. For facilities with no chemical precipitation in-place, the stoichiometric requirements were based on the amount of chemicals required to precipitate each of the metals from the Metals Subcategory average raw influent

concentrations to Metals Option 1 levels. The chemicals used were lime at 75 percent of the required removals and caustic at 25 percent of the required removals. The pH adjustment and buffer adjustment requirements were estimated to be 50 percent of the stoichiometric requirement. Finally, a 10 percent excess of chemical dosage was added.

The O & M cost equation for Metals Option 1 chemical precipitation is:

$$\ln(Y2) = 15.206 + 1.091\ln(X) + 0.05(\ln(X))^2 \quad (7-3)$$

where:

X = Flow Rate (MGD) and

Y2 = O & M Cost (1989 \$).

An O & M upgrade cost was estimated for facilities with the chemical precipitation treatment in-place. It was assumed that these facilities already meet current Metals Subcategory performance levels. The ratio of current-to-Metals Option 1 versus raw-to-current levels is approximately 0.03, therefore, the energy, maintenance, and labor components of the O & M upgrade cost were calculated at three percent of the total O & M cost for these components. Taxes and insurance were based on the total capital cost for the holding tank.

Chemical upgrade costs were calculated based on current-to-Metals Option 1 removals with no additional chemicals used for pH adjustment and solution buffering, as these steps would be part of the in-place treatment system. A 10 percent excess of chemical dosage was added to the stoichiometric requirements.

The O & M upgrade cost equation for Metals Option 1 chemical precipitation is:

$$\ln(Y2) = 11.702 + 1.006\ln(X) + 0.044(\ln(X))^2 \quad (7-4)$$

where:

X = Flow Rate (MGD) and

Y2 = O & M Cost (1989 \$).

Land requirements for the chemical precipitation systems were estimated for facilities with no chemical precipitation in-place and for facilities requiring only an upgrade. The land requirements were obtained by adding a perimeter of 20 feet around the equipment dimensions. These data were plotted and the land area equation was determined. The land requirement and land requirement upgrade equations for metals Option 1 chemical precipitation are presented as Equations 7-5 and 7-6, respectively.

$$\ln(Y3) = -1.019 + 0.299\ln(X) + 0.015(\ln(X))^2 \quad (7-5)$$

$$\ln(Y3) = -2.866 - 0.023\ln(X) - 0.006(\ln(X))^2 \quad (7-6)$$

where:

X = Flow Rate (MGD) and

Y3 = Land Requirement (Acres).

#### **7.2.1.2      *Selective Metals Precipitation - Metals Option 2***

The CWT Metals Option 2 selective metals precipitation system equipment consists of four mixed reaction tanks, each sized for 25 percent of the total daily flow, with pumps and treatment chemical feed systems. Four tanks are included to allow the facility to segregate its wastes into smaller batches, thereby facilitating metals recovery and avoiding interference with other incoming waste receipts. A four batch per day treatment schedule was used, where the sum of four batch volumes equal the facility's daily incoming waste volume.

Capital cost estimates for the selective metals precipitation systems were estimated using the same methodology as outlined for the Metals Option 1 chemical precipitation systems. However, four precipitation tanks were costed, each tank sized to receive 25 percent of the overall flow.

The capital cost equation for Metals Option 2 selective metals precipitation is:

$$\ln(Y1) = 14.461 + 0.544\ln(X) + 0.0000047(\ln(X))^2 \quad (7-7)$$

where:

X = Flow Rate (MGD) and

Y1 = Capital Cost (1989 \$).

The O & M cost estimates for the selective metals precipitation system for facilities with no chemical precipitation treatment in-place were estimated using the same methodology as outlined for Metals Option 1. However, since the proposed design included four tanks instead of one, the labor cost was estimated at four times the labor cost of the single chemical precipitation unit. Maintenance and taxes and insurance were based on the total capital cost. Energy requirements were estimated the same as for the Metals Option 1 chemical precipitation systems since energy is related to the flow of the system.

Treatment chemical costs were estimated based on the same principles as for Metals Option 1 chemical precipitation. The stoichiometric requirements were calculated based on the Metals Subcategory average raw influent concentrations to Metals Option 1 removal levels. The chemicals used were caustic at 40 percent of the required removals and lime at 60 percent of the required removals.

For facilities with chemical precipitation in-place, an O & M upgrade cost was estimated using the same methodology as for Metals Option 1 with the exception of the chemical costs. Chemical costs were estimated using a different methodology since these facilities already meet Metals Option 1 levels. The in-place treatment system is assumed to use a dosage ratio of 25 percent caustic and 75 percent lime to achieve the raw influent to current performance removals. The selective metals precipitation upgrade requires these facilities to change their existing dosage mix to 40 percent caustic and 60 percent lime to reach current performance levels, then apply the full 40 percent/60 percent dosage to further achieve the current performance to Metals Option 1 removals. The increase in caustic cost (to increase from 25 percent to 40 percent) minus the lime credit (to decrease from 75 percent to 60 percent) were accounted for in the in-place treatment removals from raw to current levels. Metals Option 2 uses a higher percentage

of caustic than does Metals Option 1 because the sludge resulting from caustic precipitation facilitates metals recovery.

The O & M cost and O & M upgrade cost equations for Metals Option 2 selective metals precipitation are presented as Equations 7-8 and 7-9, respectively.

$$\ln(Y2) = 15.566 + 0.999\ln(X) + 0.049(\ln(X))^2 \quad (7-8)$$

$$\ln(Y2) = 14.276 + 0.789\ln(X) + 0.041(\ln(X))^2 \quad (7-9)$$

where:

X = Flow Rate (MGD) and

Y2 = O & M Cost (1989 \$).

The land requirements for selective metals precipitation were calculated based on the equipment dimensions. The system dimensions were scaled up to represent the total land required for the system plus peripherals (pumps, controls, access areas, etc.). The rule-of-thumb used to scale the dimensions adds a 20-foot perimeter around the unit. The land requirement equation for Metals Option 2 selective metals precipitation is:

$$\ln(Y3) = -0.575 + 0.420\ln(X) + 0.025(\ln(X))^2 \quad (7-10)$$

where:

X = Flow Rate (MGD) and

Y3 = Land Requirement (Acres).

#### **7.2.1.3      *Secondary Precipitation - Metals Option 2***

The CWT Metals Option 2 secondary precipitation system follows the selective metals precipitation/filtration step. This equipment consists of a mixed reaction tank with pumps and a treatment chemical feed system, sized for the full daily batch volume.

The capital cost estimates for the secondary precipitation treatment systems were estimated using the same methodology as outlined for Metals Option 1. However, in this

case, no costs were included for a holding tank. These cost estimates are for those facilities that have no chemical precipitation in-place. For the facilities that already have chemical precipitation in-place, the capital cost for the secondary precipitation treatment systems were assumed to be zero. These in-place chemical precipitation systems would serve as secondary precipitation systems after the installation of upstream selective metals precipitation units.

The capital cost equation for Metals Option 2 secondary precipitation is:

$$\ln(Y1) = 13.829 + 0.544\ln(X) + 0.00000496(\ln(X))^2 \quad (7-11)$$

where:

X = Flow Rate (MGD) and

Y1 = Capital Cost (1989 \$).

O & M cost estimates were developed for the secondary precipitation treatment systems for facilities with and without chemical precipitation in-place. For facilities with no treatment in-place, the annual O & M costs were developed using the same methodology used for Metals Option 1. However, the chemical cost estimates were based on stoichiometric requirements only. Lime was used to precipitate the metals from Metals Option 1 to Metals Option 2 levels with a 10 percent excess dosage factor.

For facilities with chemical precipitation in-place, an O & M upgrade cost was calculated. The O & M upgrade cost assumed that all of the components of the annual O & M cost except chemical costs were zero. The chemical costs are the same as calculated for the full O & M costs.

The O & M cost and O & M upgrade cost equations for Metals Option 2 secondary precipitation are presented as Equations 7-12 and 7-13, respectively.

$$\ln(Y2) = 11.684 + 0.477\ln(X) + 0.024(\ln(X))^2 \quad (7-12)$$

$$\ln(Y2) = 10.122 + 1.015\ln(X) + 0.00151(\ln(X))^2 \quad (7-13)$$

where:

X = Flow Rate (MGD) and

Y2 = O & M Cost (1989 \$).

Land requirements for the secondary precipitation treatment systems were estimated by adding a perimeter of 20 feet around the equipment dimensions. The land requirement equation for Metals Option 2 secondary precipitation is:

$$\ln(Y3) = -1.15 + 0.449\ln(X) + 0.027(\ln(X))^2 \quad (7-14)$$

where:

X = Flow Rate (MGD) and

Y3 = Land Requirement (Acres).

#### **7.2.1.4      *Tertiary Precipitation - Metals Option 3***

The CWT Metals Option 3 tertiary precipitation system equipment consists of a rapid mix tank and a pH adjustment tank (following Metals Option 3 clarification). The wastewater is fed to the rapid mix neutralization tank where lime slurry is added to raise the pH. Effluent from the neutralization tank then flows to the clarifier for solids removal. The clarifier overflow goes to a pH adjustment tank where sulfuric acid is added to achieve the desired final pH. The following discussion explains the development of the cost estimates (i.e. capital, O & M, and land) for the rapid mix tank and the pH adjustment tank. Cost estimates for the clarifier are discussed in Subsection 7.2.2 of this report.

The capital cost estimates for the rapid mix tank were developed assuming one tank with a continuous flow and a 15-minute detention time. The equipment cost includes one tank, one agitator, and one lime feed system.

The capital cost estimates for the pH adjustment tank were developed assuming continuous flow and a five-minute detention time. The equipment cost includes one tank, one agitator, and one sulfuric acid feed system.



The other components (i.e. piping, instrumentation and controls, etc.) of the total capital cost for both the rapid mix and pH adjustment tank were estimated using the Metals Option 1 methodology. The capital cost equations for the rapid mix and pH adjustment tanks are presented as Equations 7-15 and 7-16, respectively.

$$\ln(Y1) = 12.318 + 0.543\ln(X) - 0.000179(\ln(X))^2 \quad (7-15)$$

$$\ln(Y1) = 11.721 + 0.543\ln(X) + 0.000139(\ln(X))^2 \quad (7-16)$$

where:

X = Flow Rate (MGD) and

Y1 = Capital Cost (1989 \$).

The O & M cost estimates for the rapid mix and pH adjustment tank were estimated using the Metals Option 1 methodology. The labor requirements were estimated at one man-hour per day.

Chemical costs for the rapid mix tank were estimated based on lime addition to achieve the stoichiometric requirements for Metals Option 2 to Metals Option 3 removals with a 10 percent excess. The chemical requirements for the pH adjustment tank were estimated based on the addition of sulfuric acid to lower the pH from 11.0 to 9.0. The O & M cost equations for the rapid mix tank and pH adjustment tank are presented as Equations 7-17 and 7-18, respectively.

$$\ln(Y2) = 10.011 + 0.385\ln(X) + 0.022(\ln(X))^2 \quad (7-17)$$

$$\ln(Y2) = 9.695 + 0.328\ln(X) + 0.019(\ln(X))^2 \quad (7-18)$$

where:

X = Flow Rate (MGD) and

Y2 = O & M Cost (1989 \$).

The land requirement equations for the rapid mix and pH adjustment tank are presented as Equations 7-19 and 7-20, respectively.

$$\ln(Y3) = -2.330 + 0.352\ln(X) + 0.019(\ln(X))^2 \quad (7-19)$$

$$\ln(Y3) = -2.67 + 0.30\ln(X) + 0.033(\ln(X))^2 \quad (7-20)$$

where:

X = Flow Rate (MGD) and

Y3 = Land Requirement (Acres).

### **7.2.2 Clarification**

Clarification systems provide continuous, low-cost separation and removal of suspended solids from water. Clarification is used to remove particulates, flocculated impurities, and precipitates. These clarification systems are equipped with a flocculation unit and are costed with the addition of the flocculation step.

The costs for clarification systems were obtained from vendors. The influent total suspended solids (TSS) design concentration used was 40,000 mg/l or four percent solids. The effluent sludge TSS concentration was 200,000 mg/l or 20 percent solids. The effluent overflow TSS concentration was 500 mg/l at a flow rate of 80 percent of the influent flow. These parameters were taken from CWT QID 105. The clarification system was evaluated for a flow rate range of 0.000001 to 1.0 MGD.

The clarification system includes a clarification unit, flocculation unit, pumps, motor, foundation, and necessary accessories. The total construction cost includes the system costs, installation, installed piping, and instrumentation and controls.

The O & M costs for all Metals Options were determined by energy usage, maintenance, labor, flocculant cost, and taxes and insurance. Energy was divided into cost for electricity, lighting, and controls. The labor requirements for Metals Options 1 and 2 were estimated between three hours per day (for the smaller systems) to four hours per day (for the larger systems), while the labor requirement for Metals Option 3

was one hour per day. The polymer dosage used in the flocculation step was 2.0 mg polymer per liter of wastewater. This dosage was taken from the MP&M cost model.

The clarification capital cost equation for all the Metals Options is presented as Equation 7-21. The clarification O & M cost equations for Metals Options 1 and 2 and Metals Option 3 are presented as Equations 7-22 and 7-23, respectively.

$$\ln(Y1) = 11.552 + 0.409\ln(X) + 0.020(\ln(X))^2 \quad (7-21)$$

where:

X = Flow Rate (MGD) and

Y1 = Capital Cost (1989 \$).

$$\ln(Y2) = 10.429 + 0.174\ln(X) + 0.0091(\ln(X))^2 \quad (7-22)$$

where:

Y2 = O & M Cost (1989 \$).

$$\ln(Y2) = 10.294 + 0.362\ln(X) + 0.019(\ln(X))^2 \quad (7-23)$$

where:

Y2 = O & M Cost (1989 \$).

A clarification system upgrade was calculated to estimate the increase in O & M costs for facilities that already have a clarification system in-place. These facilities would need to improve pollutant removals from their current performance levels to Metals Option 1 levels. To determine the required increase from current performance to Metals Option 1 levels, a comparison of the sum of the Metals Subcategory current performance pollutant concentrations to Metals Option 1 levels versus the Metals Subcategory raw influent pollutant concentrations to current performance levels was calculated. This increase was determined to be three percent, as follows:

$$\text{O \& M Upgrade Increase} = \frac{\text{Current} - \text{Metals Option 1}}{\text{Raw} - \text{Current}} = 0.03 = 3\% \quad (7-24)$$

Therefore, in order for these facilities to perform at Metals Option 1 levels, an O & M cost upgrade of three percent of the total O & M costs would be realized for each facility. The O & M upgrade cost equation for Metals Option 1 clarification is:

$$\ln(Y2) = 7.166 + 0.238\ln(X) + 0.013(\ln(X))^2 \quad (7-25)$$

where:

X = Flow Rate (MGD) and

Y2 = O & M Cost (1989 \$).

To develop the clarification land requirements, the overall system dimensions were scaled up to represent the total land required for the system plus peripherals (pumps, controls, access areas, etc.). The equation relating the flow of the clarification system to the land requirement for all Metals Options is:

$$\ln(Y3) = -1.773 + 0.513\ln(X) + 0.046(\ln(X))^2 \quad (7-26)$$

where:

X = Flow Rate (MGD) and

Y3 = Land Requirement (Acres).

### **7.2.3 Plate and Frame Pressure Filtration - Liquid Stream**

Pressure filtration systems are used for the removal of solids from waste streams. These systems typically follow chemical precipitation or clarification.

#### **7.2.3.1 Plate and Frame Filtration - Metals Option 1**

The plate and frame pressure filtration system costs were estimated for a liquid stream; this is the full effluent stream from a chemical precipitation process. The liquid stream consists of 96 percent liquid and four percent (40,000 mg/l) solids. These influent

parameters were taken from CWT QID 105. The capital and O & M costs were calculated for a range of 0.000001 to 1.0 MGD.

The components of the plate and frame pressure filtration system include: filter plates; filter cloth; hydraulic pumps; pneumatic booster pumps; control panel; connector pipes; and support platform. Equipment and operational costs were obtained from manufacturers' recommendations. The capital cost equation for Metals Option 1 liquid filtration is:

$$\ln(Y1) = 14.826 + 1.089\ln(X) + 0.050(\ln(X))^2 \quad (7-27)$$

where:

X = Flow Rate (MGD) and

Y1 = Capital Cost (1989 \$).

The O & M costs were based on estimated electricity usage, maintenance, labor, taxes and insurance, and filter cake disposal costs. The labor requirements were approximated at thirty minutes per cycle per filter press.

Filter cake disposal costs were derived from responses to the WTI Questionnaire. The disposal cost was estimated at \$0.74 per gallon of filter cake; this is based on the cost of contract hauling and disposal in a Subtitle C or Subtitle D landfill. A more detailed explanation of the filter cake disposal costs development is presented in Subsection 7.5.2. To determine the total annual O & M costs for a plate and frame filtration system, the filter cake disposal cost must be added to the other O & M costs. The O & M cost equation for Metals Option 1 liquid filtration is:

$$\ln(Y2) = 12.406 + 0.381\ln(X) + 0.014(\ln(X))^2 \quad (7-28)$$

where:

X = Flow Rate (MGD) and

Y2 = O & M Cost (1989 \$).

A pressure filtration system upgrade was calculated to estimate the increase in O & M costs for facilities that already have a pressure filtration system in-place. These facilities would need to improve pollutant removals from their current performance levels to Metals Option 1 levels. To determine the percentage increase from current performance to Metals Option 1 levels, the ratio of the current performance to Metals Option 1 levels versus the raw data to current performance levels was calculated. This incremental increase was determined to be three percent, as follows:

$$\text{O \& M Upgrade Increase} = \frac{\text{Current} - \text{Metals Option 1}}{\text{Raw} - \text{Current}} = 0.03 = 3\% \quad (7-29)$$

Therefore, in order for the facilities to perform at Metals Option 1 levels, an O & M cost upgrade of three percent of the total O & M costs (except for taxes and insurance, which are a function of the capital cost) would be realized for each facility. The filter cake disposal upgrade costs are presented in Subsection 7.5.2. The O & M upgrade cost equation for Metals Option 1 liquid filtration is:

$$\ln(Y2) = 8.707 + 0.333\ln(X) + 0.012(\ln(X))^2 \quad (7-30)$$

where:

X = Flow Rate (MGD) and

Y2 = O & M Cost (1989 \$).

The land requirements for the plate and frame pressure filtration systems were calculated by adding a perimeter of 20 feet around the equipment dimensions. The land requirement equation for Metals Option 1 liquid filtration is:

$$\ln(Y3) = -1.971 + 0.281\ln(X) + 0.018(\ln(X))^2 \quad (7-31)$$

where:

X = Flow Rate (MGD) and

Y3 = Land Requirement (Acres).

### **7.2.3.2 Plate and Frame Filtration - Metals Option 2**

The plate and frame pressure filtration system liquid stream costs for Metals Option 2 are based on the same parameters and are from the same vendors as Metals Option 1. The capital and O & M costs were computed the same as for the Metals Option 1 liquid filtration systems. The Metals Option 2 capital and O & M costs are based on two pressure filtration units processing two batches per day. These units were sized at 25 percent of the total liquid stream flow each.

The Metals Option 2 O & M costs parameters were similar to the Metals Option 1 parameters. The electricity costs were similar because electricity usage is based on wastewater flow rate. The labor costs were scaled up by four to account for the two units at two batches per day. The maintenance and taxes and insurance were based on the Metals Option 2 capital costs. The filter cake disposal costs were the same as for Metals Option 1 and are presented in Subsection 7.5.2. The total O & M costs for Metals Option 2 are calculated by adding the filter cake disposal costs to the O & M costs. The capital and O & M cost equations for Metals Option 2 liquid filtration are presented as Equations 7-32 and 7-33, respectively.

$$\ln(Y1) = 14.024 + 0.859\ln(X) + 0.040(\ln(X))^2 \quad (7-32)$$

where:

X = Flow Rate (MGD) and

Y1 = Capital Cost (1989 \$).

$$\ln(Y2) = 13.056 + 0.193\ln(X) + 0.00343(\ln(X))^2 \quad (7-33)$$

where:

Y2 = O & M Cost (1989 \$).

The land requirements for the plate and frame pressure filtration systems were calculated by adding a perimeter of 20 feet around the equipment dimensions for one

system and doubling the area to account for the two systems. The land requirement equation for Metals Option 2 liquid filtration is:

$$\ln(Y3) = -1.658 + 0.185\ln(X) + 0.009(\ln(X))^2 \quad (7-34)$$

where:

X = Flow Rate (MGD) and

Y3 = Land Requirement (Acres).

#### **7.2.4 Equalization**

Waste treatment facilities often need to equalize wastes by holding them in a tank for a period of time to get a stable waste stream which is easier to treat. In the CWT Industry, equalization is frequently used to minimize the variability of incoming wastes.

The equalization cost estimates were obtained from OCPSF's use of the 1983 CAPDET program. The equalization process utilizes a mechanical aeration basin. The following default design parameters were used:

- Aerator mixing requirements = 0.03 hp per 1,000 gallons;
- Oxygen requirements = 15.0 mg/l per hour;
- Dissolved oxygen in basin = 2.0 mg/l;
- Depth of basin = 6.0 feet; and
- Detention time = 24 hours.

A detention time of 24 hours is appropriate, as this was the median equalization detention time reported by respondents to the WTI Questionnaire. The range of wastewater flows selected for these analyses was 0.001 to 5.0 MGD.

Capital costs were calculated based upon total project costs less: miscellaneous nonconstruction costs, 201 planning costs, technical costs, land costs, interest during construction, and laboratory costs. O & M costs were obtained directly from the initial year O & M costs. The capital and O & M cost equations for the equalization systems are presented as Equations 7-35 and 7-36, respectively.

$$\ln(Y1) = 12.057 + 0.433\ln(X) + 0.043(\ln(X))^2 \quad (7-35)$$



where:

X = Flow Rate (MGD) and

Y1 = Capital Cost (1989 \$).

$$\ln(Y2) = 11.723 + 0.311\ln(X) + 0.019(\ln(X))^2 \quad (7-36)$$

where:

Y2 = O & M Cost (1989 \$).

The CAPDET program was used to develop land requirements for the equalization systems. The requirements are scaled up to represent the total land required for the system plus peripherals (pumps, controls, access areas, etc.). The equation relating the flow of the equalization system to the land requirement is:

$$\ln(Y3) = -0.912 + 1.120\ln(X) + 0.011(\ln(X))^2 \quad (7-37)$$

where:

X = Flow Rate (MGD) and

Y3 = Land Requirement (Acres).

### **7.2.5 Air Stripping**

Air stripping is an effective wastewater treatment method for removing dissolved gases and highly volatile odorous compounds from wastewater streams by passing high volumes of air through an agitated gas-water mixture.

The air stripping technology cost was based on removing medium volatile pollutants. The medium volatile pollutant 1,2-dichloroethane was used for the calculations with an influent level of 4,000 µg/l and effluent level of 68 µg/l. The equipment costs were calculated for a flow rate range of 0.0001 to 1.0 MGD and were obtained from vendor services. The air stripping unit costs included transfer pumps, control panels, blowers, and ancillary equipment. Catalytic oxidizers were also included in the capital cost for air pollution control purposes. The capital cost equation for air stripping systems is:

$$\ln(Y1) = 12.899 + 0.486\ln(X) + 0.031(\ln(X))^2 \quad (7-38)$$

where:

X = Flow Rate (MGD) and

Y1 = Capital Cost (1989 \$).

The O & M costs were determined by electricity usage, maintenance, labor, catalyst replacement, and taxes and insurance. The electricity usage for the air strippers was determined by the amount of horsepower needed to operate the systems. The electricity usage for the catalytic oxidizers was approximated at 50 percent of the electricity used for the air strippers. The labor requirement for the air strippers was three hours per day. The catalysts used in the catalytic oxidizer are precious metal catalysts and their lifetime is approximately four years. Therefore, the catalyst beds are completely replaced about every four years. The costs for replacing the spent catalysts were divided by four to convert them to annual costs. The O & M cost equation for air stripping systems is:

$$\ln(Y2) = 10.865 + 0.298\ln(X) + 0.021(\ln(X))^2 \quad (7-39)$$

where:

X = Flow Rate (MGD) and

Y2 = O & M Cost (1989 \$).

To develop land requirements for the air stripping and catalytic oxidizer systems, the individual system dimensions were combined, and a 20-foot perimeter was added to the plot. The dimensions of the air strippers, in terms of length and width, are very small compared to the catalytic oxidizers. The equation relating the flow of the system to the land requirement is:

$$\ln(Y) = -2.207 + 0.536\ln(X) + 0.042(\ln(X))^2 \quad (7-40)$$

where:

X = Flow Rate (MGD) and

Y3 = Land Requirement (Acres).

### **7.2.6 Multi-Media Filtration**

Filtration is a proven technology for the removal of residual suspended solids from wastewater. The media used in the CWT multi-media filtration process are sand and anthracite coal, supported by gravel. Large particulate matter is captured by the coarse, lighter media near the top of the filter bed. Flow controls are self-adjusting to regulate treatment and backwash rates regardless of fluctuations in water pressure, thus helping to prevent a loss of filter media from the tank.

To size the multi-media filtration systems, the design average influent total suspended solids design concentration used was 165 mg/l. The design average effluent total suspended solids concentration was 124 mg/l. These concentrations were taken from the data for CWT QID 059. The system costs were calculated for a flow rate range of 0.001 to 1.0 MGD and were obtained from vendor services.

The total capital costs for the multi-media filtration systems represent equipment and installation costs. The total construction cost includes the costs of the filter, instrumentation and controls, pumps, piping, and installation. The capital cost equation for multi-media filtration systems is:

$$\ln(Y1) = 11.218 + 0.865\ln(X) + 0.066(\ln(X))^2 \quad (7-41)$$

where:

X = Flow Rate (MGD) and

Y1 = Capital Cost (1989 \$).

The O & M costs include energy usage, maintenance, labor, and taxes and insurance. Energy is the cost of electricity to run the pumps, lighting, and instrumentation

and controls. The labor requirement for the multi-media filtration system was four hours per day. The O & M cost equation for multi-media filtration systems is:

$$\ln(Y2) = 11.290 + 0.580\ln(X) + 0.057(\ln(X))^2 \quad (7-42)$$

where:

$$Y2 = \text{O \& M Cost (1989 \$)}.$$

To develop land requirements for multi-media filtration systems, overall system dimensions were provided by the vendor. The equation relating the flow of the system to the land requirement is:

$$\ln(Y3) = -2.971 + 0.097\ln(X) + 0.008(\ln(X))^2 \quad (7-43)$$

where:

$$X = \text{Flow Rate (MGD) and}$$

$$Y3 = \text{Land Requirement (Acres)}.$$

### **7.2.7 Carbon Adsorption**

Activated carbon adsorption is an effective treatment technology for the removal of organic pollutants from wastewater. It is included in Oils Options 3 and 4 and Organics Option 2. The considered application for the CWT Industry is granular activated carbon (GAC) in column reactors. The equipment consists of two beds operated in series. This configuration allows the beds to go to exhaustion and be replaced on a rotating basis. The GAC capital costs are the same for all of the regulatory options considered. The capital and O & M costs were calculated for a flow rate range of 0.00001 to 0.24 MGD. The capital costs consist of the adsorber construction cost, initial carbon fill, freight, and supervision. The GAC capital cost equation is:

$$\ln(Y1) = 15.956 + 1.423\ln(x) + 0.050(\ln(X))^2 \quad (7-44)$$

where:

X = Flow Rate (MGD) and

Y1 = Capital Cost (1989 \$).

The O & M costs are primarily attributed to carbon usage. The key design parameter is adsorption capacity; this is a measurement of the mass of pollutant adsorbed per unit mass of carbon. For each regulatory option system, the pollutants of concern and their associated removals were tabulated. Using the adsorption capacities, the specific carbon requirements were calculated. The carbon usage for each option was scaled down by one-third; this accounts for the series-bed design of the systems.

The total O & M cost components are electricity, maintenance, labor, freight, and taxes and insurance, in addition to the carbon usage. The freight cost for shipping the carbon is dependent upon the amount of carbon and the distance that it is shipped. The average freight cost used is \$3,000 per 20,000-pound shipment. Labor requirements are three hours per day. The GAC O & M cost equations for Oils Option 3, Oils Option 4, and Organics Option 2 are presented as Equations 7-45, 7-46, and 7-47, respectively.

$$\ln(Y2) = 14.516 + 1.086\ln(X) + 0.060(\ln(X))^2 \quad (7-45)$$

$$\ln(Y2) = 15.949 + 1.310\ln(X) + 0.068(\ln(X))^2 \quad (7-46)$$

$$\ln(Y2) = 17.621 + 1.455\ln(X) + 0.067(\ln(X))^2 \quad (7-47)$$

where:

X = Flow Rate (MGD) and

Y2 = O & M Cost (1989 \$).

The land requirement estimates for the GAC systems are the same for all three options. The equipment dimensions supplied by the vendor were used to determine the land needed. A standard 20-foot perimeter was added to the equipment dimensions to account for access, piping, and controls. The resultant land requirement equation is:

$$\ln(Y_3) = -1.780 + 0.319\ln(X) + 0.017(\ln(X))^2 \quad (7-48)$$

where:

X = Flow Rate (MGD) and

Y<sub>3</sub> = Land Requirement (Acres).

### 7.2.8 Cyanide Destruction

Cyanide destruction oxidation is capable of achieving removal efficiencies of 99 percent or greater and to the levels of detection. Chlorine is primarily used as the oxidizing agent in this process, which is called alkaline chlorination, and can be utilized in the elemental or hypochlorite form.

The capital and O & M costs curves for cyanide destruction systems with special operating conditions were obtained from vendor services. The concentration used for influent amenable cyanide was 1,548,000 µg/l and for total cyanides was 4,633,710 µg/l. The effluent for these pollutants was 276,106 µg/l for amenable cyanides and 135,661 µg/l for total cyanides. These rates show a removal of 82 percent for amenable cyanide and 97 percent for total cyanides. These concentrations were taken from the sampling data for CWT QID 105.

The oxidation of cyanide waste using sodium hypochlorite is a two step process. In the first step, cyanide is oxidized to cyanate in the presence of hypochlorite and sodium hydroxide with the base required to maintain a pH range of 9 to 11. The second step oxidizes cyanate to carbon dioxide and nitrogen at a controlled pH of 8.5. The amounts of sodium hypochlorite and sodium hydroxide needed to perform the oxidation are 7.5 parts and 8.0 parts per part of cyanide, respectively. At these levels, the total reduction occurs at a retention time of 16 to 20 hours. The application of heat can facilitate the more complete destruction of total cyanide. The system costs were calculated on a batch volume range from 1.0 to 1,000,000 gallons per day and because of the extended retention time, a basis of one batch per day is used.

The capital cost equation for the cyanide destruction system represents equipment and installation costs. The equipment items include a two-stage reactor with a retention

time of 16 hours, feed system and controls, pumps, piping, and foundation. The two-stage reactor includes a covered tank, mixer, and containment tank. The total construction cost includes the tank costs, instrumentation and controls, pumps, piping, and installation. The capital cost equation is:

$$\ln(Y1) = 13.977 + 0.546\ln(X) + 0.0033(\ln(X))^2 \quad (7-49)$$

where:

X = Batch Size (MGD) and

Y1 = Capital Cost (1989 \$).

The O & M costs were determined by energy usage, chemical costs, maintenance, labor, and taxes and insurance. The labor requirement for the cyanide destruction system was three hours per day. The O & M cost equation is:

$$\ln(Y2) = 18.237 + 1.318\ln(X) + 0.04993(\ln(X))^2 \quad (7-50)$$

where:

X = Flow Rate (MGD) and

Y2 = O & M Cost (1989 \$).

The vendor information was used to develop land requirements for the cyanide destruction systems with special operating conditions. The equation relating the flow of the system to the land requirement is:

$$\ln(Y3) = -1.168 + 0.419\ln(X) + 0.021(\ln(X))^2 \quad (7-51)$$

where:

X = Flow Rate (MGD) and

Y3 = Land Requirement (Acres).

### **7.2.9 Chromium Reduction**

Reduction is a chemical reaction in which electrons are transferred from one chemical to another. The main application of chemical reduction to the treatment of wastewater is in the reduction of hexavalent chromium to trivalent chromium. The reduction enables the trivalent chromium to be precipitated from solution in conjunction with other metallic salts.

To develop the costs for chromium reduction systems using sulfur dioxide, costs were obtained from vendors. The average influent hexavalent chromium design concentration used was 752,204  $\mu\text{g/l}$ ; the maximum concentration was 3,300,000  $\mu\text{g/l}$ . The average effluent concentration was 30  $\mu\text{g/l}$ . These concentrations were taken from the sampling data for CWT QID 255.

The hexavalent chromium is reduced to trivalent chromium using sulfur dioxide and sulfuric acid. The sulfuric acid is used to lower the pH of the solution and the sulfur dioxide is used for the reduction process. After the reduction process, the trivalent chromium is then removed by precipitation. The amount of sulfur dioxide needed to reduce the hexavalent chromium was reported as 1.9 parts of sulfur dioxide per part of chromium, while the amount of sulfuric acid was 1.0 part per part of chromium. At these levels, the total reduction occurs at a retention time of 45 to 60 minutes. The system costs were calculated for a batch volume range from 1,000 gallons to 1,000,000 gallons on a basis of two batches per day.

The capital cost equation for the chromium reduction system represents equipment and installation costs. The equipment items include a reduction reactor, feed system and controls, pumps, piping, and foundation. The reactor includes a covered tank, mixer, and containment tank. The total construction cost includes the tank costs, instrumentation and controls, pumps, piping, and installation.

Capital costs for system upgrades were developed to estimate the incremental cost required to install a new chemical feed mechanism on an existing chromium reduction system that utilizes a treatment chemical other than sulfur dioxide. For the upgrade



costs, the piping and instrumentation and controls equipment items were used to determine the total construction cost.

The capital cost and capital upgrade cost equations are presented as Equations 7-52 and 7-53, respectively.

$$\ln(Y1) = 13.737 + 0.600\ln(X) \quad (7-52)$$

$$\ln(Y1) = 12.068 + 0.492\ln(X) - 0.000496(\ln(X))^2 \quad (7-53)$$

where:

X = Volume per Day (MGD) and

Y1 = Capital Cost (1989 \$).

The O & M costs were determined by energy usage, chemical costs, maintenance, labor, and taxes and insurance. The labor requirement for the chromium reduction system was four hours per day.

O & M costs for system upgrades were developed to estimate the incremental cost required to operate an existing chromium reduction system that utilizes a treatment chemical, other than sulfur dioxide, that is a waste product for which a facility does not incur a purchase cost. The chemical cost items were used to determine the total O & M cost.

The O & M cost and O & M upgrade cost equations are presented as Equations 7-54 and 7-55, respectively.

$$\ln(Y2) = 13.167 + 0.998\ln(X) + 0.079(\ln(X))^2 \quad (7-54)$$

$$\ln(Y2) = 13.123 + 1.365\ln(X) + 0.059(\ln(X))^2 \quad (7-55)$$

where:

X = Flow Rate (MGD) and

Y2 = O & M Cost (1989 \$).

To develop land requirements for chromium reduction systems, approximate dimensions were calculated using the diameters of the systems. The land was calculated by estimating the size for the reaction tank, storage tanks, and feed system. The equation relating the flow of the system to the land requirement is:

$$\ln(Y3) = -1.303 + 0.185\ln(X) - 0.036(\ln(X))^2 \quad (7-56)$$

where:

X = Flow Rate (MGD) and

Y3 = Land Requirement (Acres).

### **7.3 BIOLOGICAL WASTEWATER TREATMENT TECHNOLOGY COSTS**

#### **7.3.1 Sequencing Batch Reactors**

A sequencing batch reactor (SBR) is a suspended growth system in which wastewater is mixed with existing biological floc in an aeration basin. SBR's are unique in that a single tank acts as an equalization tank, an aeration tank, and a clarifier.

The capital and O & M costs curves for the SBR systems were obtained from a vendor service. The average influent BOD<sub>5</sub>, ammonia as N, and nitrate-nitrite as N design concentrations used were 4,800 mg/l, 995 mg/l, and 46 mg/l, respectively. The average effluent BOD<sub>5</sub>, ammonia as N, and nitrate-nitrite as N concentrations used were 1,600 mg/l, 615 mg/l, and 1.0 mg/l, respectively. These concentrations were obtained from the sampling data from CWT QID 059. The system costs were calculated for a flow rate range of 0.001 to 1.0 MGD.

The capital costs for the SBR systems were estimated using the vendor quotes and represent equipment and installation costs. The equipment items include a tank system, sludge handling equipment, feed system and controls, pumps, piping, blowers, and valves. The SBR capital cost equation is:

$$\ln(Y1) = 15.707 + 0.512\ln(X) + 0.0022(\ln(X))^2 \quad (7-57)$$

where:

X = Flow Rate (MGD) and

Y1 = Capital Cost (1989 \$).

The O & M costs were determined by power, maintenance, labor, and taxes and insurance. Power was estimated using the vendor values for horsepower used. The labor requirement for a SBR system was four hours per day. The SBR O & M cost equation is:

$$\ln(Y2) = 13.139 + 0.562\ln(X) + 0.020(\ln(X))^2 \quad (7-58)$$

where:

X = Flow Rate (MGD) and

Y2 = O & M Cost (1989 \$).

To develop land requirements for SBR systems, overall system dimensions were provided by the vendor. The equation relating the flow of the system to the land requirement is:

$$\ln(Y3) = -2.971 + 0.097\ln(X) + 0.008(\ln(X))^2 \quad (7-59)$$

where:

X = Flow Rate (MGD) and

Y3 = Land Requirement (Acres).

## **7.4 ADVANCED WASTEWATER TREATMENT TECHNOLOGY COSTS**

### **7.4.1 Ultrafiltration**

Ultrafiltration (UF) systems are used by industry for the treatment of metal-finishing wastewater, textile industry effluent, and oily wastes. In the CWT industry, UF is applied for the treatment of oily wastewater.

The components of the UF system include: booster pumps; cartridge prefilters; control units; high pressure pump and motor assembly; membrane/pressure vessel assembly; and reject holding tanks. Capital equipment and operational costs were obtained from manufacturers' quotations. The capital cost equation was developed by adding installation, engineering, and contingency costs to the vendors' equipment cost. The system costs were calculated for a flow rate range of 0.000001 to 1.0 MGD. The UF capital cost equation is:

$$\ln(Y1) = 14.672 + 0.8789\ln(X) + 0.044(\ln(X))^2 \quad (7-60)$$

where:

X = Flow Rate (MGD) and

Y1 = Capital Cost (1989 \$).

The O & M costs were based on estimated electricity usage, maintenance, labor, taxes, and insurance. The electricity usage and costs were provided by the vendors. The labor requirement for the UF system was approximated at two hours per day. Concentrate disposal costs were based upon a concentrate generation rate of two percent of influent flow. The cost of concentrate disposal was quoted as \$0.50 per gallon from CWT QID 409. The UF O & M cost equation is:

$$\ln(Y2) = 15.043 + 1.164\ln(X) + 0.057(\ln(X))^2 \quad (7-61)$$

where:

X = Flow Rate (MGD) and

Y2 = O & M Cost (1989 \$).

Land requirements were calculated for UF systems using the system dimensions plus a 20-foot perimeter. The UF land requirement equation is:

$$\ln(Y3) = -1.632 + 0.42\ln(X) + 0.035(\ln(X))^2 \quad (7-62)$$

where:

X = Flow Rate (MGD) and

Y3 = Land Requirement (Acres).

#### **7.4.2 Reverse Osmosis**

Reverse osmosis (RO) is a high-pressure, fine membrane process for separating dissolved solids from water. A semi-permeable, microporous membrane and pressure are used to perform the separation. RO systems are typically used as end-of-pipe polishing processes, prior to final discharge of recovered wastewater.

The components of the RO system include a booster pump, cartridge prefilters, RO unit, and a reject holding tank. The capital cost equation was developed by adding installation, engineering, and contingency costs to the vendors' equipment cost. The capital and O & M costs were calculated for a flow rate range of 0.000001 to 1.0 MGD. The RO capital cost equation is:

$$\ln(Y1) = 15.381 + 0.919\ln(X) + 0.04(\ln(X))^2 \quad (7-63)$$

where:

X = Flow Rate (MGD) and

Y1 = Capital Cost (1989 \$).

The O & M costs were based on estimated electricity usage, maintenance, labor, taxes, and insurance. The electricity usage and costs were provided by the vendors. The labor requirement for the RO system was approximated at two hours per day. Concentrate disposal costs were based on a concentrate generation rate of 28 percent of influent flow (CWT QID 409). The cost of concentrate disposal was quoted at \$0.46 per gallon. The RO O & M cost equation is:

$$\ln(Y2) = 17.599 + 1.303\ln(X) + 0.048(\ln(X))^2 \quad (7-64)$$

where:

X = Flow Rate (MGD) and

Y2 = O & M Cost (1989 \$).

Land requirements were calculated for RO systems using the system dimensions plus a 20-foot perimeter. The RO land requirement equation is:

$$\ln(Y3) = -2.346 + 0.166\ln(X) + 0.012(\ln(X))^2 \quad (7-65)$$

where:

X = Flow Rate (MGD) and

Y3 = Land Requirement (Acres).

## **7.5 SLUDGE TREATMENT AND DISPOSAL COSTS**

### **7.5.1 Plate and Frame Pressure Filtration - Sludge Stream**

Pressure filtration systems are used for the removal of solids from waste streams. These systems typically follow chemical precipitation or clarification.

The plate and frame pressure filtration system costs were estimated for a sludge stream; this consists of the sludge which is collected in the clarification step following some chemical precipitation processes. The sludge stream consists of 80 percent liquid and 20 percent (200,000 mg/l) solids. The influent flow rate used for the sludge stream is 20 percent of the influent flow rate for the liquid wastewater stream. These influent parameters were taken from CWT QID 105.

The components of the plate and frame pressure filtration system include: filter plates; filter cloth; hydraulic pumps; pneumatic booster pumps; control panel; connector pipes; and support platform. Equipment and operational costs were obtained from manufacturers' recommendations. The capital cost equation was developed by adding installation, engineering, and contingency costs to the vendors' equipment costs. The

system costs were calculated for a flow rate range of 0.000001 to 1.0 MGD. The capital cost equation for Metals Option 1 sludge filtration is:

$$\ln(Y1) = 14.827 + 1.087\ln(X) + 0.050(\ln(X))^2 \quad (7-66)$$

where:

X = Flow Rate (MGD) of Liquid Stream and

Y1 = Capital Cost (1989 \$).

The O & M costs were based on estimated electricity usage, maintenance, labor, taxes and insurance, and filter cake disposal costs. The labor requirement for the plate and frame pressure filtration system was approximated at thirty minutes per cycle per filter press.

Filter cake disposal costs were derived from responses to the WTI Questionnaire. The disposal cost was estimated at \$0.74 per gallon of filter cake; this is based on the cost of contract hauling and disposal in a Subtitle C or Subtitle D landfill. A more detailed explanation of the filter cake disposal costs development is presented in Subsection 7.5.2. To determine the total O & M costs for a plate and frame filtration system, the filter cake disposal costs must be added to the other O & M costs.

The O & M cost equation for Metals Option 1 sludge filtration is:

$$\ln(Y2) = 12.239 + 0.388\ln(X) + 0.016(\ln(X))^2 \quad (7-67)$$

where:

X = Flow Rate (MGD) of Liquid Stream and

Y2 = O & M Cost (1989 \$).

A pressure filtration system upgrade was calculated to estimate the increase in O & M costs for facilities that already have a pressure filtration system in-place. These facilities would need to improve pollutant removals from their current performance levels to Metals Option 1 levels. To determine the percentage increase from current performance to Metals Option 1 levels, the ratio of the current performance to Metals

Option 1 levels versus the raw data to current performance levels was calculated. This increase was determined to be three percent, as follows:

$$\text{O \& M Upgrade Increase} = \frac{\text{Current - Metals Option 1}}{\text{Raw - Current}} = 0.03 = 3\% \quad (7-68)$$

Therefore, in order for the facilities to perform at Metals Option 1 levels, an O & M cost upgrade of three percent of the total O & M costs (except for taxes and insurance, which are a function of the capital cost) would be realized for each facility. The O & M upgrade cost equation for Metals Option 1 sludge filtration is:

$$\ln(Y2) = 8.499 + 0.331\ln(X) + 0.013(\ln(X))^2 \quad (7-69)$$

where:

X = Flow Rate (MGD) of Liquid Stream and

Y2 = O & M Cost (1989 \$).

Land requirements were calculated for the plate and frame pressure filtration systems using the system dimensions plus a 20-foot perimeter. The land requirement equation for Metals Option 1 sludge filtration is:

$$\ln(Y3) = -1.971 + 0.281\ln(X) + 0.018(\ln(X))^2 \quad (7-70)$$

where:

X = Flow Rate (MGD) of Liquid Stream and

Y3 = Land Requirements (Acres).

### **7.5.2 Filter Cake Disposal**

The liquid stream and sludge stream pressure filtration systems presented in Subsections 7.2.3 and 7.5.1, respectively, generate a filter cake residual. There is an annual O & M cost that is associated with the disposal of this residual. This cost must



be added to the pressure filtration equipment O & M costs to arrive at the total O & M costs for the pressure filtration operation.

To determine the cost of transporting filter cake to an off-site facility for disposal, an analysis of the WTI Questionnaire response data base was performed. Data from a subset of questionnaire respondents were pulled for analysis. This subset consisted of Metals Subcategory facilities that are direct and/or indirect dischargers, and would therefore be costed for CWT compliance. From these responses, the reported costs for both the Subtitle C and Subtitle D contract haul/disposal methods of filter cake disposal were tabulated. This information was edited to eliminate incomplete or combined data that could not be used.

From this data set, the median cost for both the Subtitle C and Subtitle D disposal options were determined. Then, the weighted average of these median costs was determined. The average was weighted to reflect the ratio of hazardous (67 percent) to nonhazardous (33 percent) waste receipts at these Metals Subcategory facilities. The final disposal cost is \$0.74 per gallon of filter cake.

The filter cake disposal costs were calculated for a flow rate range of 0.000001 to 1.0 MGD. The O & M cost equations for filter cake disposal for the Metals Options 1 and 2 plate and frame filtration full systems and system upgrades are presented as Equations 7-71 and 7-72, respectively.

$$Z = 0.109169 + 7,695,499.8(X) \quad (7-71)$$

$$Z = 0.101186 + 230,879.8(X) \quad (7-72)$$

where:

X = Flow Rate (MGD) of Liquid Stream and

Z = Filter Cake Disposal Cost (1989 \$).

## **7.6 ADDITIONAL COSTS**

### **7.6.1 Retrofit Costs**

Costs were assigned to the CWT Industry on both an option- and facility-specific basis. The option-specific approach costed a sequence of individual treatment technologies, corresponding to a particular regulatory option, for a subset of facilities defined as belonging to that regulatory subcategory. Within the costing of a specific regulatory option, treatment technology costs were assigned on a facility-specific basis depending upon the technologies determined to be currently in-place at the facility.

Once it was determined that a treatment technology cost should be assigned to a particular facility, there were two design scenarios which were considered. The first was the installation of a new individual treatment technology as a part of a new treatment train. The full capital costs presented in Subsections 7.2 through 7.5 of this document apply to this scenario. The second scenario was the installation of a new individual treatment technology which would have to be integrated into an existing in-place treatment train. It is in the case of this second scenario that retrofit costs were applied. These retrofit costs cover such items as piping and structural modifications which would be required in an existing piece of equipment to accommodate the installation of a new piece of equipment prior to or within an existing treatment train.

For all facilities which received retrofit costs, a retrofit factor of 20 percent was applied to the total capital cost of the newly-installed or upgraded treatment technology unit that would need to be integrated into an existing treatment train.

### **7.6.2 Monitoring Costs**

Monitoring costs will be realized by CWT facilities who discharge process wastewater directly to a receiving stream or indirectly to a POTW. Direct discharge effluent monitoring requirements are mandated in NPDES permits. Indirect discharge monitoring requirements are mandated by the operating authority of the POTW.

The method developed for the OCPSF Industry was used as the basis for the CWT monitoring cost estimation. The following generalizations have been used to estimate compliance monitoring costs:

- 1) Monitoring costs are based on the number of outfalls through which process wastewater is discharged. The cost for a single outfall is multiplied by the number of outfalls to arrive at the total costs for a facility.
- 2) Flow monitoring equipment costs are included in the capital costs for the specific treatment technologies.
- 3) Sample collection costs (labor and equipment) and sample shipping costs are not included.
- 4) The monitoring costs (based on frequency and analytical methods) are incremental to the monitoring currently being incurred by the CWT facility.

Respondents to the WTI Questionnaire reported their POTW discharge monitoring requirements. For direct discharger, NPDES permits were reviewed. This information shows that most facilities are currently required to monitor for several classical pollutant parameters (e.g. BOD<sub>5</sub>, TSS, pH, and cyanide). And, for the parameters that are not addressed, these analyses are relatively inexpensive. Therefore, costs for classical pollutant analyses are not included in the cost estimation.

Many facilities are required to monitor for commonly-regulated metals (e.g. lead, copper, and nickel); however, the CWT list of pollutants includes many more metals than any facility currently quantifies. Therefore, costs for metals monitoring are included in the cost estimation.

Very few facilities are required to monitor for organic compounds, so costs are included for these analyses. EPA method 1624 is used for the quantification of volatile organic compounds, and Method 1625 is used for the quantification of semivolatile organic compounds.

The frequency of monitoring currently required in the CWT Industry varies widely for any specific parameter from daily to semi-annually. An estimated weekly frequency was used for the cost estimation. This frequency includes a full scan as one of the analyses each month.

The OCPSF methodology assumes that larger dischargers would be required to monitor for more parameters within a pollutant group. As such, the analytical cost would increase based on the number of parameters to be quantified. The monitoring costs, adjusted to 1989 dollars, are presented in Table 7-4.

**Table 7-4. Monitoring Costs for the CWT Industry Cost Exercise**

Flow Rate Range (MGD)	Annual Monitoring Costs per Outfall (1989 \$)
$\leq 0.5$	40,680
0.5 - 4.99	61,725
5 - 9.99	68,100
$\geq 10$	134,525

### **7.6.3 RCRA Permit Modification Costs**

Respondents to the WTI Questionnaire whose RCRA Part B permits were modified were asked to report the following information pertaining to the cost of obtaining the modification:

- Legal fees;
- Administrative costs;
- Public relations costs;
- Other costs; and
- Total costs.

The purpose of the permit modification was also asked. Anticipated changes to a facility's RCRA permit as a result of the implementation of CWT regulations include the upgrade of existing equipment and/or the installation of new treatment technologies to achieve effluent limitations. These changes correlate with the purposes identified by the WTI Questionnaire respondents as "new tanks", "new units", "new technologies", and "other - modification of existing equipment". The applicable costs are summarized in Table 7-5.

**Table 7-5. RCRA Permit Modification Costs Reported in WTI Questionnaire**

Modification	QID	Year	Total Cost (reported \$)	Total Cost (1989 \$)
New Units	081	1990	26,000	25,357
	255	1990	7,000	6,827
New Technology	081	1990	82,000	79,793
	090	1990	6,300,000*	6,144,231*
Modify Existing Equipment	402	1991	14,080	13,440
Average	-	-	-	31,400

\* This cost includes equipment and installation costs; no cost breakdown is given. Therefore, this cost was not used in calculating the average cost.

#### **7.6.4 Land Costs**

An important factor in the calculation of treatment technology costs is the value of the land needed for the installation of the technology. Due to continuing development, the availability and therefore the cost of land can prove to be a significant part of the capital cost. To determine the amount of land required for costing purposes, the land requirements for each treatment technology were calculated for the range of system sizes. These land requirements were fitted to a curve so that a land requirement, in acres, could be calculated for every treatment system costed. The individual land requirements were then multiplied by the corresponding land cost estimates to obtain facility-specific cost estimates. Since land costs may vary widely across the country, a nationwide average figure would not be representative. Therefore, the average land costs for suburban sites in each state were obtained from the 1990 Guide to Industrial and Real Estate Office Markets survey.

According to the survey, the unimproved sites are the most desirable of the existing inventory and are zoned for industrial use; therefore, unimproved land costs

were used in this analysis. The survey categorizes the states into regions by geographical location: northeast, north central, south, and west. For states that have no land prices available in the survey, the regional average figures were used. In calculating the regional average costs for the western region, Hawaii was not included. This is because Hawaii's land cost is disproportionately high and its inclusion would have skewed the regional average.

The survey report data are also broken down by site size ranges; these are zero to 10 acres, 10 to 100 acres, and greater than 100 acres. The respondents to the WTI Questionnaire reported total facility areas ranging from less than one acre to 2,700 acres and undeveloped facility areas from zero to 1,775 acres. Since the CWT facilities fall into all three size ranges covered by the report data, the three size-specific land costs for each state were averaged to arrive at the final costs for the industry. As Table 7-6 indicates, that the least expensive state is Kansas with a land cost of \$7,042 per acre. The most expensive state is Hawaii with a land cost of \$1,089,000 per acre.

**Table 7-6. State Land Costs for the CWT Industry Cost Exercise**

State	Land Cost per Acre (1989 \$)	State	Land Cost per Acre (1989 \$)
Alabama	22,773	Nebraska	24,684
Alaska*	81,105	Nevada	36,300
Arizona	46,101	New Hampshire	52,998
Arkansas	15,899	New Jersey	89,443
California	300,927	New Mexico	26,929
Colorado	43,560	New York	110,013
Connecticut	54,232	North Carolina	33,880
Delaware	54,450	North Dakota*	20,488
Florida	63,273	Ohio	14,578
Georgia	72,600	Oklahoma	24,321
Hawaii	1,089,000	Oregon	50,820
Idaho*	81,105	Pennsylvania	32,307
Illinois	36,300	Rhode Island*	59,822
Indiana	21,078	South Carolina	21,296
Iowa	8,954	South Dakota*	20,488
Kansas	7,042	Tennessee	20,873
Kentucky	29,040	Texas	47,674
Louisiana	56,628	Utah*	81,105
Maine	19,602	Vermont*	59,822
Maryland	112,530	Virginia	39,930
Massachusetts	59,895	Washington	63,670
Michigan	13,649	West Virginia*	47,345
Minnesota	21,054	Wisconsin	17,424
Mississippi	13,068	Wyoming*	81,105
Missouri	39,930	Washington DC	174,240
Montana*	81,105		

\* No data available for state, used regional average.

## 7.7 REFERENCES

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## **SECTION 8**

### **DEVELOPMENT OF LIMITATIONS AND STANDARDS**

This section describes various waste treatment technologies and their costs, pollutants proposed for regulation, and pollutant reductions associated with the different treatment technologies obtained for the proposed effluent limitations guidelines and standards for the Centralized Waste Treatment Industry. The limitations and standards discussed in this section are Best Practicable Control Technology Currently Available (BPT), Best Conventional Pollutant Control Technology (BCT), Best Available Technology Economically Achievable (BAT), New Source Performance Standards (NSPS), Pretreatment Standards for Existing Sources (PSES), and Pretreatment Standards for New Sources (PSNS).

#### **8.1 ESTABLISHMENT OF BPT**

Generally, EPA bases BPT upon the average of the best current performance (in terms of treated effluent discharged) by facilities of various sizes, ages, and unit processes within an industry or subcategory. The factors considered in establishing the best practicable control technology currently available (BPT) include: (1) the total cost of applying the technology relative to the effluent reductions that result, (2) the age of process equipment and facilities involved, (3) the processes employed and required process changes, (4) the engineering aspects of the control technology, (5) non-water quality environmental impacts such as energy requirements, air pollution and solid waste generation, and (6) such other factors as the Administrator deems appropriate (section 304(b)(2)(B) of the Act). As noted, BPT technology represents the average of the best existing performances of facilities within the industry. When existing performance is uniformly inadequate, EPA may require a higher level of control than is currently in place in an industrial category if EPA determines that the technology can be practically applied. BPT may be transferred from a different subcategory or category. However, BPT

normally focuses on end-of-process treatment rather than process changes or internal controls, except when these technologies are common industry practice.

The cost/effluent reduction inquiry for BPT is a limited balancing one, committed to EPA's discretion, that does not require the Agency to quantify effluent reduction benefits in monetary terms. See, e.g., *American Iron and Steel Institute v. EPA*, 526 F. 2d 1027 (3rd Cir., 1975). In balancing costs against the effluent reduction benefits, EPA considers the volume and nature of discharges expected after application of BPT, the general environmental effects of pollutants, and the cost and economic impacts of the required level of pollution control. In developing guidelines, the Act does not require or permit consideration of water quality problems attributable to particular point sources, or water quality improvements in particular bodies of water. Therefore, EPA has not considered these factors in developing the proposed limitations. See *Weyerhaeuser Company v. Costle*, 590 F. 2d 1011 (D.C. Cir. 1978).

EPA concluded that the wastewater treatment performance of the facilities it surveyed was, with very limited exceptions, uniformly poor. Under these circumstances, for each subcategory, EPA has preliminarily concluded that only one treatment system meets the statutory test for best practicable, currently available technology. EPA has determined that the performance of facilities which mix different types of highly concentrated CWT wastes with non-CWT waste streams or with stormwater are not providing BPT treatment. The mass of pollutants being discharged is unacceptably high. Thus, comparison of EPA sampling data and CWT industry-supplied monitoring information establishes that, in the case of metal-bearing waste streams, virtually all the facilities are discharging large total quantities of heavy metals. As measured by total suspended solids (TSS) levels following treatment, TSS concentrations are substantially in excess of levels observed at facilities in other industry categories employing the same treatment technology -- 10 to 20 times greater than observed for other point source categories.

In the case of oil discharges, most facilities are achieving low removal of oils and grease relative to the performance required for other point source categories. Further,

facilities treating organic wastes, while successfully removing organic pollutants through biological treatment, fail to remove metals associated with these organic wastes.

The poor pollutant removal performance observed generally for discharging CWT facilities is not unexpected. As pointed out previously, these facilities are treating highly concentrated wastes that, in many cases, are process residuals and sludges from other point source categories. EPA's review of permit limitations for the direct dischargers show that, in most cases, the dischargers are subject to "best professional judgment" concentration limitations which were developed from guidelines for facilities treating and discharging much more dilute waste streams. EPA has concluded that treatment performance in the industry is widely inadequate and that the mass of pollutants being discharged is unacceptably high, given the demonstrated removal capability of treatment operation that the Agency reviewed.

#### **8.1.1 *Rationale for Metals Subcategory BPT Limitations***

In determining BPT, EPA evaluated metals precipitation as the principal treatment practice within the subcategory. Forty-seven of the 56 facilities in the Metals Subcategory use metals precipitation as a means for waste treatment. The precipitation techniques used by facilities varied in the treatment chemicals used and operation of the precipitation system, e.g., batch, continuous, or selective metals precipitation. In the process of selecting facilities for sampling, there was difficulty in gathering data from direct dischargers for establishing limitations and standards. Because BPT applies to direct dischargers, the data used to establish limitations and standards developed are normally collected from such facilities. Most facilities in the Metals Subcategory, however, are indirect dischargers and therefore do not monitor or optimize the performance of their treatment system for treatment of conventional pollutants. (Indirect dischargers generally are not required to control their discharges of conventional pollutants because the receiving POTWs are designed to achieve the conventional removals.) Therefore, when reviewing the analytical data collected, EPA concluded that the treatment performance

by indirect dischargers could not be characterized as the average of the best performance, because systems were obviously not operated so as to remove conventional pollutants. After evaluating various metals precipitation processes, EPA considered three regulatory options to reduce the discharge of pollutants by Centralized Waste Treatment facilities.

The three technology options considered for the Metals Subcategory BPT are:

- *Option 1 - Chemical precipitation, Solid-Liquid separation, and Sludge dewatering.* Under Option 1, BPT limitations would be based upon chemical precipitation with a lime/caustic solution followed by some form of separation and sludge dewatering to control the discharge of pollutants in wastewater. The data reviewed for this option showed that settling/clarification followed by pressure filtration of sludge yields removals equivalent to pressure filtration. In general, while the proposed BPT limitations would require the improvement of current treatment technologies in-place through increased quantities of treatment chemicals and additional monitoring of batch processes, this precipitation process is employed by many facilities. For metals streams which contain concentrated cyanide complexes, the proposed BPT limitations are based on alkaline chlorination at specific operating conditions prior to metals treatment. As previously noted, without treatment of cyanide waste streams prior to metals treatment, metals removals are significantly reduced.
- *Option 2 - Selective Metals Precipitation, Pressure Filtration, Secondary Precipitation, and Solid-Liquid Separation.* The second option evaluated for BPT for Centralized Waste Treatment facilities is based on the use of numerous treatment tanks and personnel to handle incoming waste streams, and the use of greater quantities of caustic in the treatment chemical mixture. (Caustic sludge is easier to recycle.) Option 2 is based on additional tanks and personnel to segregate incoming waste streams and to monitor the batch treatment processes to maximize the precipitation

of specific metals in order to generate a metal-rich filter cake. The metal-rich filter cake could possibly be sold to metal smelters to incorporate into metal products. Like Option 1, for metals streams which contain concentrated cyanide complexes, under Option 2, BPT limitations are based on alkaline chlorination at specific operating conditions prior to metals treatment.

- *Option 3 - Selective Metals Precipitation, Pressure Filtration, Secondary Precipitation, Solid-Liquid Separation, and Tertiary Precipitation.* The technology basis for Option 3 is the same as Option 2 except an additional precipitation step at the end of treatment is added. For metals streams which contain concentrated cyanide complexes, like Option 1 and 2, for Option 3, alkaline chlorination at specific operating conditions would be the basis for BPT limitations.

The Agency is proposing to adopt BPT effluent limitations based on Option 3 for the Metals Subcategory. These limitations were developed based on an engineering evaluation of the average of the best demonstrated methods to control the discharges of the regulated pollutants in this Subcategory. The proposed BPT limitations for the Metals Subcategory are presented in Table 8-1. Draft long-term averages for Options 1 and 2 are presented in the *Statistical Support Document for Proposed Effluent Limitations Guidelines and Standards for the Centralized Waste Treatment Industry* as well as the methodology for calculating the variability factors used to calculate limitations.

EPA's tentative decision to base BPT limitations on Option 3 treatment reflects primarily an evaluation of three factors: the degree of effluent reduction attainable, the total cost of the proposed treatment technologies in relation to the effluent reductions achieved, and potential non-water quality benefits. In assessing BPT, EPA considered the age, size, process, other engineering factors, and non-water quality impacts pertinent to the facilities treating wastes in this subcategory. No basis could be found for identifying different BPT limitations based on age, size, process or other engineering factors. Neither the age nor the size of the CWT facility will directly affect either the

**Table 8-1. BPT Effluent Limitations for the Metals Subcategory**

<b>Pollutant or Pollutant Parameter</b>	<b>Maximum for Any One Day</b>	<b>Monthly Average</b>
<b>Conventional Pollutants</b>		
Oil & Grease	45	11
TSS	55	18
<b>Priority and Non-Conventional Pollutants</b>		
Aluminum	0.72	0.16
Antimony	0.14	0.031
Arsenic	0.076	0.017
Barium	0.14	0.032
Cadmium	0.73	0.16
Chromium	0.77	0.17
Cobalt	0.73	0.16
Copper	1.0	0.23
Hexavalent Chromium	0.14	0.077
Iron	2.4	0.54
Lead	0.37	0.082
Magnesium	9.9	2.2
Manganese	0.18	0.039
Mercury	0.013	0.0030
Nickel	5.4	1.2
Silver	0.028	0.0063
Tin	0.20	0.044
Titanium	0.021	0.0047
Total Cyanide	4.4	1.2
Zinc	1.2	0.27
<b>In-Facility BPT Limitations for Cyanide Pretreatment</b>		
Total Cyanide	350	130

character or treatability of the CWT wastes or the cost of treatment. Further, the treatment process and engineering aspects of the technologies considered have a relatively insignificant effect because in most cases they represent fine tuning or add-ons to treatment technology already in use. These factors consequently did not weigh heavily in the development of these guidelines. For a service industry whose service is wastewater treatment, the most pertinent factors for establishing the limitations are costs of treatment, the level of effluent reductions obtainable, and non-water quality effects.

Generally, for purposes of defining BPT effluent limitations, EPA looks at the performance of the best operated treatment system and calculates limitations from some level of average performance of these "best" facilities. For example, in proposing BPT limitations for the pulp, paper and paper board category, EPA compared the average removal performance of the best 90 percent of paper mills and the performance level representing the average for the best 50 percent of the mills (58 FR 66078, 66105 (December 17, 1993)). For this industry, as previously explained, EPA concluded that treatment performance is, in virtually all cases, poor. Without separation of metal-bearing streams for selective precipitation, metal removal levels are uniformly inadequate across the industry. Consequently, BPT performance levels are based on data from the one well-operated system using selective metals precipitation that was sampled by EPA.

The demonstrated effluent reductions attainable through the Option 3 control technology represent the BPT performance attainable through the application of demonstrated treatment measures currently in operation in this industry. The Agency is proposing to adopt BPT limitations based on the removal performance of the Option 3 treatment system for the following reasons. First, these removals are demonstrated by a facility in this subcategory and can readily be applied to all facilities in the subcategory. The adoption of this level of control would represent a significant reduction in pollutants discharged into the environment

Second, the Agency assessed the total cost of water pollution controls likely to be incurred for Option 3 in relation to the effluent reduction benefits and determined these costs were reasonably achievable. While the absolute costs of selective metals

precipitation (Options 2 and 3) are significantly higher than Option 1, EPA concluded the costs were still reasonable. EPA's cost assessment shows that selective metals precipitation would not adversely affect profitability within this subcategory. EPA calculated that four facilities would experience decreased profitability while seven would show an increase in profitability. The expenses associated with selective metals precipitation would not cause any of the 12 direct dischargers currently to go from a profitable to unprofitable status. Addition of a further precipitation step (Option 3) did not change these results.

Third, adoption of these BPT limits could promote the non-water quality objectives of the CWA. Use of the Option 3 treatment regime -- which generates a metal-rich filter cake that may be recovered and smelted -- could reduce the quantity of waste which are being disposed of in landfills.

The Agency proposes to reject Option 1 because, as discussed above, EPA concluded that mixing disparate metal-bearing waste streams is not the best practicable treatment technology currently in operation for this subcategory of the industry. Consequently, effluent levels associated with this treatment option would not represent BPT performance levels. Option 2 was rejected, although similar to Option 3, because the greater removals obtained through addition of tertiary precipitation at Option 3 were obtained at a relatively insignificant increase in costs over Option 2.

In the process of selecting facilities for sampling, there was difficulty in gathering data from direct dischargers for establishing limitations and standards. Since BPT applies to direct dischargers, the limitations and standards developed are normally collected from such facilities. Most facilities in the Metals Subcategory are indirect dischargers and do not monitor or optimize the performance of their treatment system for treatment of conventional pollutants. Therefore, when reviewing the analytical data collected, EPA concluded that performance by indirect dischargers is not representative of the average of the best performance because these systems were not operated properly for the removal of conventional pollutants, thus, incidentally reducing metals removals.



### **8.1.2 Rationale for Oils Subcategory BPT Limitations**

In determining BPT for the Oily Subcategory, EPA evaluated a variety of different treatment methods used within the subcategory. Treatment varies depending on the type of oils accepted for treatment and other on-site operations. A majority of facilities, 29 out of 34, use chemical emulsion-breaking as a means to separate stable oil-water emulsions. The remaining facilities treat less stable oily wastes by gravity separation, dissolved air flotation (DAF), or in flocculation/clarification treatment system designed for a wide variety of waste streams.

Treatment of the wastewater resulting from emulsion-breaking is also accomplished by a variety of methods. Most of the facilities which use emulsion-breaking treat the resulting wastewater in a flocculation/clarification treatment system designed to treat a variety of waste streams. Only one facility was identified as treating the wastewater resulting from emulsion-breaking in a system specifically designed for the pollutants in an oily waste stream. After evaluating various treatment operations, EPA identified four regulatory options (identified from operations at the one facility which was specifically designed for the treatment of oily wastes) for consideration to reduce the discharge of pollutants by Centralized Waste Treatment facilities.

The four technology options considered for the Oils Subcategory BPT are:

- *Option 1 - Emulsion-Breaking.* Under Option 1, BPT limitations would be based on present performance of emulsion-breaking processes using acid and heat to separate oil-water emulsions. At present, most facilities have this technology in place unless unstable oil-water mixtures are accepted for treatment. Stable oil-water emulsions require some emulsion-breaking treatment because gravity separation or flotation alone is inadequate to breakdown the oil-water waste stream.
- *Option 2 - Ultrafiltration.* Under Option 2, BPT limitations are based on the use of ultrafiltration for treatment of less concentrated, unstable oily waste

receipts or for the additional treatment of wastewater from the emulsion-breaking process.

- *Option 3 - Ultrafiltration, Carbon Adsorption, and Reverse Osmosis.* The Option 3 BPT effluent limitations are based on the use of Carbon Adsorption and Reverse Osmosis in addition to the Option 2 technology. The reverse osmosis unit removes metals compounds found at significant levels for this subcategory. Inclusion of a carbon adsorption unit is necessary in order to protect the reverse osmosis unit by filtering out any large particles which may damage the reverse osmosis unit or decrease membrane performance.
- *Option 4 - Ultrafiltration, Carbon Adsorption, Reverse Osmosis, and Carbon Adsorption.* Option 4 is similar to Option 3 except for the additional carbon adsorption unit for final effluent polishing.

The Agency is proposing BPT effluent limitations for the Oily Waste Subcategory based on Option 3 as well as Option 2 treatment systems. The proposed BPT limitations for the Oils Subcategory are presented in Table 8-2. Draft long-term averages for Options 1 and 4 are presented in the *Statistical Support Document for Proposed Effluent Limitations Guidelines and Standards for the Centralized Waste Treatment Industry* as well as the methodology for calculating the variability factors used to calculate limitations. The EPA has preliminarily concluded that both options represent best practicable control technologies. The technologies are in-use in the industry and the data collected by the Agency show that the limitations are being achieved. In assessing BPT, EPA considered age, size, process, other engineering factors, and non-water quality impacts pertinent to the facilities treating wastes in this subcategory. No basis could be found for identifying different BPT limitations based on age, size, process or other engineering factors for the reasons previously discussed. For a service industry whose service is wastewater treatment, the pertinent factors here for establishing the limitations are costs of treatment, the level of effluent reductions obtainable, and non-water quality effects.

**Table 8-2. BPT Effluent Limitations for the Oils Subcategory (mg/l)**

Pollutant or Pollutant Parameter	Option 2		Option 3	
	Maximum for any One Day	Monthly Average	Maximum for any One Day	Monthly Average
<b>Conventional Pollutants</b>				
Oil & Grease	30,000	5,900	240	64
TSS	24	8.2	4.0	1.4
<b>Priority and Non-Conventional Pollutants</b>				
1,1,1-Trichloroethane	1.6	1.0	0.18	0.12
2-Propanone	41	22	130	44
4-Chloro-3-Methyl Phenol	5.2	4.4	0.96	0.54
Aluminum	2.3	0.57	0.085	0.038
Barium	0.10	0.026	0.0027	0.0012
Benzene	9.0	6.8	1.8	1.4
Butanone	3.7	2.0	13	4.3
Cadmium	1.5	0.37	0.0046	0.0020
Chromium	2.2	0.54	0.010	0.0045
Copper	2.0	0.50	0.016	0.0073
Ethyl Benzene	1.1	0.86	0.085	0.066
Iron	75	19	0.40	0.18
Lead	5.0	1.2	0.076	0.034
Manganese	5.4	1.3	0.043	0.019
Methylene Chloride	3.9	2.0	2.2	0.91
m-Xylene	1.6	1.2	0.074	0.058
Nickel	120	29	2.2	0.99

**Table 8-2. BPT Effluent Limitations for the Oils Subcategory (mg/l) (continued)**

Pollutant or Pollutant Parameter	Option 2		Option 3	
	Maximum for any One Day	Monthly Average	Maximum for any One Day	Monthly Average
<b>Priority and Non-Conventional Pollutants (continued)</b>				
n-Decane	0.18	0.096	0.19	0.067
n-Docosane	0.18	0.096	0.19	0.067
n-Eicosane	0.18	0.096	0.19	0.067
n-Hexacosane	0.18	0.096	0.19	0.067
n-Hexadecane	0.18	0.096	0.19	0.067
n-Octadecane	0.18	0.096	0.19	0.067
n-Tetradecane	0.18	0.096	0.19	0.067
o&p-Xylene	0.86	0.65	0.045	0.035
Tetrachloroethene	0.23	0.14	0.032	0.016
Tin	0.82	0.20	0.12	0.056
Toluene	17	13	1.8	1.4
Tripropyleneglycol Methyl Ether	280	150	160	57
Zinc	22	5.6	0.54	0.24

Among the options considered by the Agency, both Options 2 and 3 would provide for significant reductions in regulated pollutants discharged into the environment over current practice in the industry represented by Option 1. EPA is nonetheless, concerned about the cost of Option 3 because it is substantially more expensive than Option 2. However, EPA's economic assessment indicates, that under either Option 2 or 3, although one of four direct dischargers will experience some reduction in profitability, the other three facilities will see an increase. Even under Option 3, no facility in the subcategory would move from a profitable to unprofitable status. In these circumstances, EPA concluded that the costs of Option 3 may not be wholly disproportionate to the effluent reductions benefits achieved, particularly when other factors are taken into account.

As noted, the Agency is proposing Option 2 because it is a currently available and cost-effective treatment option. However, the BPT pollutant removal performance required for a number of specific pollutants (particularly oil and grease and metals) is less stringent than current BPT effluent limitations guidelines promulgated for other industries. EPA is concerned about the potential for encouraging off-site shipment of oily waste now being treated on-site if the limitations for this subcategory are significantly different from those other BPT effluent limitations currently in effect.

The Agency proposes to reject Option 1, because the technology does not provide for adequate control of the regulated pollutants. The Agency also proposes to reject Option 4 because less pollutant reductions occur in comparison to Option 3. Theoretically, Option 4 should provide for the maximum reduction of pollutants discharged due to the addition of carbon adsorption units, but specific pollutant concentrations increase across the carbon adsorption unit according to the analytical data collected.

Even though, as previously explained, BPT limitations are generally defined by the average effluent reduction performance of the best existing treatment systems, here, as was the case with the BPT metal-bearing wastes limitations, the options being proposed as the basis for BPT effluent limitations are based upon the treatment performance at a single facility. EPA concluded that existing performance at the other facilities is uniformly inadequate because many facilities that will be subject to the limitations for the Oily

Waste Subcategory now commingle the oily wastewater with other wastes prior to treatment. The Agency has determined that the practice of mixing waste streams before treatment results in inadequate removal of the regulated pollutants of concern for the Oils Subcategory. Oily wastewater contains significant levels of organic and metals compounds. If the oily wastewater is mixed with other CWT wastewater, these organic and metals compounds are often found at non-detectable levels prior to treatment because the oily wastewater is effectively diluted by the other wastewater to the point that the compounds are no longer detectable. The treatment system on which the Options 2 through 4 effluent limitations are based was designed specifically for the treatment of segregated oily wastewater.

#### **8.1.3 *Rationale for Organics Subcategory BPT Limitations***

Determining BPT for the Organics Subcategory was a difficult process. Most facilities in the Organics Subcategory have other non-CWT operations, such as organics manufacturing. The portion of CWT wastes and wastewater treated at the facility was minor in comparison to the overall facility flow. The CWT flows are a majority of the overall facility flow for only nine out of the 16 facilities in the subcategory. For organic waste streams, biological treatment is typically the predominant technology used. Due to the types of pollutants identified in the Organics Subcategory, most facilities in this subcategory use air stripping as a means for controlling volatile organics and multimedia or carbon adsorption for final effluent polishing. As discussed in Section 3, one facility was identified which developed a treatment system for recovering the organic constituents in the waste stream, but data from this facility could not be used for limitation development because it was not being operated so as to optimize removals at the time of the EPA sampling episode. Therefore, the EPA used the treatment technologies located at one facility to develop the two options for this subcategory.

The two technology options considered for the Organics Subcategory BPT are:

- *Option 1 - Equalization, Air-Stripping, Biological Treatment, and Multi-media Filtration.* BPT Option 1 effluent guidelines are based on the following treatment system: equalization, two air-strippers in series equipped with a carbon adsorption unit for control of air emissions, biological treatment in the form of a sequential batch reactor (which is operated on a batch basis), and finally multi-media filtration units for control of solids.
- *Option 2 - Equalization, Air-Stripping, Biological Treatment, Multi-media Filtration, and Carbon Adsorption.* Option 2 is the same as Option 1 except for the addition of carbon adsorption units.

The Agency is proposing to adopt BPT effluent limitations based on the Option 1 technology for the Organics Subcategory. The proposed BPT limitations for the Organics Subcategory are presented in Table 8-3. Draft long-term averages for Options 2 are presented in the *Statistical Support Document for Proposed Effluent Limitations Guidelines and Standards for the Centralized Waste Treatment Industry* as well as the methodology for calculating the variability factors used to calculate limitations. The demonstrated effluent reductions attainable through Option 1 control technology represent the best practicable performance attainable through the application of currently available treatment measures. EPA's decision to propose effluent limitations defined by the removal performance of the Option 1 treatment systems is based primarily on consideration of several factors: the effluent reductions attainable, the economic achievability of the option and non-water quality environmental benefits. Once again, the age and size of the facilities, processes and other engineering factors were not considered pertinent to establishment of BPT limitations for this subcategory.

Table 8-3. BPT Effluent Limitations for the Organics Subcategory (mg/l)

Pollutant or Pollutant Parameter	Maximum for Any One Day	Monthly Average
<b>Conventional Pollutants</b>		
BOD <sub>5</sub>	163	53
Oil & Grease	13	4.9
TSS	216	61
<b>Priority and Non-Conventional Pollutants</b>		
1,1,1,2-Tetrachloroethane	0.013	0.011
1,1,1-Trichloroethane	0.021	0.018
1,1,2-Trichloroethane	0.21	0.17
1,1-Dichloroethene	0.037	0.027
1,2,3-Trichloropropane	0.016	0.014
1,2-Dibromoethane	0.014	0.011
1,2-Dichloroethane	0.031	0.025
2,3-Dichloroaniline	0.17	0.14
Butanone	1.1	0.84
2-Propanone	1.6	1.3
4-Methyl-2-Pentanone	0.093	0.074
Acetophenone	0.048	0.022
Aluminum	1.3	0.75
Antimony	0.42	0.24
Barium	3.8	2.2
Benzene	0.014	0.011
Benzoic Acid	0.49	0.24
Carbon Disulfide	0.16	0.11
Chloroform	0.56	0.48



**Table 8-3. BPT Effluent Limitations for the Organics Subcategory (mg/l) (continued)**

Pollutant or Pollutant Parameter	Maximum for Any One Day	Monthly Average
<b>Priority and Non-Conventional Pollutants</b>		
Diethyl Ether	0.070	0.056
Hexanoic Acid	0.51	0.25
Lead	0.16	0.095
Methylene Chloride	1.1	0.97
Molybdenum	0.98	0.57
m-Xylene	0.014	0.011
o-Cresol	0.051	0.025
Phenol	0.79	0.38
Pyridine	0.71	0.24
p-Cresol	0.098	0.040
Tetrachloroethene	0.73	0.53
Tetrachloromethane	0.013	0.011
Toluene	0.014	0.011
trans-1,2-dichloroethene	0.15	0.11
Trichloroethene	1.2	0.86
Vinyl Chloride	0.071	0.052
Zinc	0.43	0.25

The Agency is proposing to adopt BPT limitations based on the removal performance of the Option 1 treatment system for the following reasons. First, the cost of achieving the pollutant discharge levels associated with the Option 1 treatment system is reasonable. The annualized costs for treatment are low. Further, EPA estimates that meeting the Option 1 BPT limitations, while adversely affecting the profitability of two of six direct dischargers would increase the profitability of the other four. No facility moves from profitable to unprofitable status. Second, the costs are not only low generally but low relative to the removals achieved. Third, significant non-water quality benefits may be expected from the installation of air stripping units equipped with carbon adsorption units which prevent volatilization of organic compounds.

According to the data collected, the Option 1 treatment system provides a greater effluent pollutant reduction level than the more expensive Option 2. Theoretically, Option 2 should provide for the maximum reduction of pollutants discharged due to the addition of carbon adsorption units, but specific pollutants of concern increased across the carbon adsorption unit according to the analytical data collected. Due to the poor performance of carbon adsorption in EPA's database for this industry, Option 2 is rejected. The poor performance may be a result of pH fluctuations in the carbon adsorption unit resulting in the solubilization of metals. Similar trends have been found for all of the data collected on carbon adsorption units in this industry.

The Agency used biological treatment performance data from the OCPSF regulation to establish direct discharge limitations for BOD<sub>5</sub> and TSS, because the facility from which Option 1 and 2 limitations were derived is an indirect discharger and the treatment system is not operated to optimize removal of conventional pollutants. EPA has concluded that the transfer of this data is appropriate given the absence of adequate treatment technology for these pollutants at the only otherwise well-operated BPT CWT facility. Given the treatment of similar wastes at both OCPSF and centralized waste treatment facilities, use of the data is warranted. Moreover, EPA has every reason to believe that the same treatment systems will perform similarly when treating the wastes in this subcategory.

Once again, the selected BPT option is based on the performance of a single facility. Many facilities that are treating wastes that will be subject to effluent limitations for the Organic-Bearing Waste Subcategory also operate other industrial processes that generate much larger amounts of wastewater than the quantity of off-site generated organic waste receipts. The off-site generated organic waste receipts are directly mixed with the wastewater from the other industrial processes for treatment. Therefore, identifying facilities to sample for limitations development was difficult because the waste receipts and treatment unit effectiveness could not be properly characterized for off-site generated waste. The treatment system for which Options 1 and 2 is based upon was one of the few facilities identified which treated organic waste receipts separately from other on-site industrial wastewater.

## **8.2 BCT**

EPA is proposing BCT equivalent to the BPT guidelines for the conventional pollutants covered under BPT. In developing BCT limits, EPA considered whether there are technologies that achieve greater removals of conventional pollutants than proposed for BPT, and whether those technologies are cost-reasonable according to the BCT Cost Test. In all three subcategories, EPA identified no technologies that can achieve greater removals of conventional pollutants than proposed for BPT that are also cost-reasonable under the BCT Cost Test, and accordingly EPA proposes BCT effluent limitations equal to the proposed BPT effluent limitations guidelines and standards.

## **8.3 BAT**

EPA is proposing BAT effluent limitations for all subcategories of the Centralized Waste Treatment Industry based upon the same technologies evaluated and proposed for BPT for each subcategory. The proposed BAT effluent limitations would control identified priority and non-conventional pollutants discharged from facilities.

EPA has not identified any more stringent treatment technology option which it considered to represent BPT level of control applicable to facilities in this industry for the metals, oils, and organics subcategories. EPA identified an add-on treatment technology -- carbon adsorption -- that should have further increased removals of pollutants of concern. However, as explained above, EPA's data show increases rather than decreases in concentrations of specific pollutants of concern.

#### **8.4 NSPS**

As previously noted, under section 306 of the Act, new industrial direct dischargers must comply with standards which reflect the greatest degree of effluent reduction achievable through application of the best available demonstrated control technologies. Congress envisioned that new treatment systems could meet tighter controls than existing sources because of the opportunity to incorporate the most efficient processes and treatment systems into plant design. Therefore, Congress directed EPA to consider the best demonstrated process changes, in-plant controls, operating methods and end-of-pipe treatment technologies that reduce pollution to the maximum extent feasible.

EPA is proposing NSPS that would control the same conventional, priority, and non-conventional pollutants proposed for control by the BPT effluent limitations. The technologies used to control pollutants at existing facilities are fully applicable to new facilities. Furthermore, EPA has not identified any technologies or combinations of technologies that are demonstrated for new sources that are different from those used to establish BPT/BCT/BAT for existing sources. Therefore, EPA is establishing NSPS subcategories similar to the subcategories for existing facilities and proposing NSPS limitations that are identical to those proposed for BPT/BCT/BAT.

## 8.5 PSES

Indirect dischargers in the Centralized Waste Treatment Industry, like the direct dischargers, accept for treatment wastes containing many priority and non-conventional pollutants. As in the case of direct dischargers, indirect dischargers may be expected to discharge many of these pollutants to POTWs at significant mass and concentration levels. EPA estimates that indirect dischargers annually discharge approximately 85.3 million pounds of pollutants.

Section 307(b) requires EPA to promulgate pretreatment standards to prevent pass-through of pollutants from POTWs to waters of the U.S. or to prevent pollutants from interfering with the operation of POTWs. EPA is establishing PSES for this industry to prevent pass-through of the same pollutants controlled by BAT from POTWs to waters of the U.S.

The Agency is proposing pretreatment standards for existing sources (PSES) based on the same technologies as proposed for BPT and BAT for 78 of the 87 priority and non-conventional pollutants regulated under BAT for Regulatory Option 1 (the combination of Metals Option 3, Oils Option 2, and Organics Option 1) and 81 of the 87 priority pollutants regulated under BAT for Regulatory Option 2 (the combination of Metals Option 3, Oils Option 3, and Organics Option 1). A discussion of the pollutants excluded from PSES are included in Section 5. These standards would apply to existing facilities in all subcategories of the Centralized Waste Treatment Industry that indirectly discharge wastewater to publicly-owned treatment works (POTWs). These limitations were developed based on the same technologies as proposed today for BPT/BAT, as applicable to each of the affected subcategories. PSES set at these points would prevent pass-through of pollutants, help control sludge contamination and reduce air emissions.

The Agency considered the age, size, processes, other engineering factors, and non-water quality environmental impacts pertinent to facilities in developing PSES. The Agency did not identify any basis for establishing different PSES limitations based on age, size, processes, or other engineering factors.

## **8.6 PSNS**

Section 307(c) of the Act requires EPA to promulgate pretreatment standards for new sources (PSNS) at the same time it promulgates new source performance standards (NSPS). New indirect discharging facilities, like new direct discharging facilities, have the opportunity to incorporate the best available demonstrated technologies, process changes, in-facility controls, and end-of-pipe treatment technologies.

EPA determined that a broad range of pollutants discharged by Centralized Waste Treatment Industry facilities pass-through POTWs. The same technologies discussed previously for BAT, NSPS, and PSES are available as the basis for PSNS.

EPA is proposing that pretreatment standards for new sources be set equal to NSPS for priority and non-conventional pollutants for all subcategories. The Agency is proposing to establish PSNS for the same priority and non-conventional pollutants as are being proposed for NSPS. EPA considered the cost of the proposed PSNS technology for new facilities. EPA concluded that such costs are not so great as to present a barrier to entry, as demonstrated by the fact that currently operating facilities are using these technologies.

## **8.7 COST OF TECHNOLOGY OPTIONS**

The Agency estimated the cost for Centralized Waste Treatment facilities to achieve each of the proposed effluent limitations and standards. All cost estimates in this section are expressed in 1993 dollars. The cost components reported in this section represent estimates of the investment cost of purchasing and installing equipment, the annual operating and maintenance costs associated with that equipment, additional costs for discharge monitoring, and costs for facilities to modify existing RCRA permits. The following sections present costs for BPT, BCT, BAT, and PSES.

### 8.7.1 Proposed BPT Costs

The Agency estimated the cost of implementing the proposed BPT effluent limitations guidelines and standards by calculating the engineering costs of meeting the required effluent limitations for each direct discharging CWT. This facility-specific engineering cost assessment for BPT began with a review of present waste treatment technologies. For facilities without a treatment technology in-place equivalent to the BPT technology, the EPA estimated the cost to upgrade its treatment technology, to use additional treatment chemicals to achieve the new discharge standards, and to employ additional personnel, where applicable, for the option. The only facilities given no cost for compliance were facilities with the treatment-in-place prescribed for that option. Details pertaining to the development of the technology costs are included in Section 7. The capital expenditures for the process change component of proposed BPT are estimated to be \$17.7 million with annual O&M costs of \$14.3 million for Regulatory Option 1 (the combination of Metals Option 3, Oils Option 2, and Organics Option 1) and \$20.6 million with annual O&M costs of \$21.7 million for Regulatory Option 2 (the combination of Metals Option 3, Oils Option 3, and Organics Option 1). Table 8-4 summarizes, by subcategory, the capital expenditures and annual O&M costs for implementing proposed BPT.

**Table 8-4. Cost of Implementing Proposed BPT Regulations [in millions of 1993 dollars]**

Subcategory	Number of Facilities <sup>1</sup>	Capital Costs	Annual O&M Costs
Metals Treatment and Recovery	12	15.4	10.5
Oils Treatment and Recovery - Regulatory Option 1	4	1.02	0.779
Oils Treatment and Recovery - Regulatory Option 2	4	3.84	8.15
Organics Treatment	6	1.32	3.06
Regulatory Option 1	16	17.7	14.3
Regulatory Option 2	16	20.6	21.7

<sup>1</sup>Because some direct dischargers include operations in more than one subcategory, the sum of the facilities with operations in any one subcategory exceeds the total number of facilities.

### 8.7.2 Proposed BCT/BAT Costs

The Agency estimated that there would be no cost of compliance for implementing proposed BCT/BAT, because the technology is identical to BPT and the costs are included with proposed BPT.

### 8.7.3 Proposed PSES Costs

The Agency estimated the cost for implementing proposed PSES with the same assumptions and methodology used to estimate cost of implementing BPT. The capital expenditures for the process change component of PSES are estimated to be \$43.8 million with annual O&M costs of \$26.8 million for Regulatory Option 1 (the combination of Metals Option 3, Oils Option 2, and Organics Option 1) and \$52.6 million with annual O&M costs of \$45.9 million for Regulatory Option 2 (the combination of Metals Option 3, Oils Option 3, and Organics Option 1). Table 8-5 summarizes, by subcategory, the capital expenditures and annual O&M costs for implementing proposed PSES.

**Table 8-5. Cost of Implementing Proposed PSES Regulations [in millions of 1993 dollars]**

<b>Subcategory</b>	<b>Number of Facilities</b>	<b>Capital Costs</b>	<b>Annual O&amp;M Costs</b>
Metals Treatment and Recovery	44	27.598	22.267
Oils Treatment and Recovery - Regulatory Option 1	31	4.084	2.294
Oils Treatment and Recovery - Regulatory Option 2	31	12.607	20.894
Organics Treatment	16	10.736	1.365
Regulatory Option 1	56	43.8	26.8
Regulatory Option 2	56	52.6	45.9

<sup>1</sup>Because some indirect dischargers include operations in more than one subcategory, the sum of the facilities with operations in any one subcategory exceeds the total number of facilities.



## **8.8 POLLUTANT REDUCTIONS**

### **8.8.1 Conventional Pollutant Reductions**

EPA has calculated how much adoption of the proposed BPT/BCT limitations would reduce the total quantity of conventional pollutants that are discharged. To do this, for each subcategory, the Agency developed an estimate of the long-term average loading (LTA) of BOD<sub>5</sub>, TSS, and Oil and Grease that would be discharged after the implementation of BPT. Next, these BPT/BCT LTAs for BOD<sub>5</sub>, TSS, and Oil and Grease were multiplied by 1989 wastewater flows for each direct discharging facility in the subcategory to calculate BPT/BCT mass discharge loadings for BOD<sub>5</sub>, TSS, and Oil and Grease for each facility. The BPT/BCT mass discharge loadings were subtracted from the estimated current loadings to calculate the pollutant reductions for each facility. Each subcategory's BPT/BCT pollutant reduction was summed to estimate the total facility's pollutant reduction for those facilities treating wastes in multiple subcategories. Subcategory reductions, obviously, were obtained by summing individual subcategory results. The Agency estimates that the proposed regulations will reduce BOD<sub>5</sub> discharges by approximately 34.5 million pounds per year for Regulatory Option 1 (the combination of Metals Option 3, Oils Option 2, and Organics Option 1) and 36.9 million pounds per year for Regulatory Option 2 (the combination of Metals Option 3, Oils Option 3, and Organics Option 1); TSS discharges by approximately 30.3 million pounds per year for both Regulatory Options; and Oil and Grease discharges by approximately 52.4 million pounds per year for Regulatory Option 1 (the combination of Metals Option 3, Oils Option 2, and Organics Option 1) and 56.9 million pounds per year for Regulatory Option 2 (the combination of Metals Option 3, Oils Option 3, and Organics Option 1).

## **8.8.2 *Priority and Nonconventional Pollutant Reductions***

### **8.8.2.1 *Methodology***

The proposed BPT, BCT, BAT, and PSES, if promulgated, will also reduce discharges of priority and non-conventional pollutants. Applying the same methodology used to estimate conventional pollutant reductions attributable to application of BPT/BCT control technology, EPA has also estimated priority and non-conventional pollutant reductions for each facility by subcategory. Because EPA has proposed BAT limitations equivalent to BPT, there are obviously no further pollutant reductions associated with BAT limitations.

Current loadings were estimated using data collected by the Agency in the field sampling program and from the questionnaire data supplied by the industry. For many facilities, data were not available for all pollutants of concern or without the addition of other non-CWT wastewater. Therefore, methodologies were developed to estimate current performance for each subcategory. Performance of on-site treatment technologies was assessed with wastewater permit information and monitoring data supplied in the 1991 Waste Treatment Industry Questionnaire and the Detailed Monitoring Questionnaire.

### **8.8.2.2 *Direct Facility Discharges (BPT/BAT)***

The estimated reductions in pollutants directly discharged in treated final effluent resulting from implementation of proposed BPT/BAT are listed in Table 8-6. Pollutant reductions are presented for Regulatory Option 1 (the combination of Metals Option 3, Oils Option 2, and Organics Option 1) and Regulatory Option 2 (the combination of Metals Option 3, Oils Option 3, and Organics Option 1). The Agency estimates that proposed BPT/BAT regulations will reduce direct facility discharges of priority, and non-

conventional pollutants by 56.1 million pounds per year for Regulatory Option 1 and 58.2 million pounds per year for Regulatory Option 2.

**Table 8-6.** Reduction in Direct Discharge of Priority and Nonconventional Pollutants After Implementation of Proposed BPT/BAT Regulations  
(units = lbs/year)

Subcategory	Metal Compounds	Organic Compounds
Metals Treatment and Recovery	871,832	245,525
Oils Treatment and Recovery - Regulatory Option 1	294,543	556,627
Oils Treatment and Recovery - Regulatory Option 2	319,847	610,937
Organics Treatment	3,065,679	0 <sup>1</sup>
Regulatory Option 1	4,232,054	802,153
Regulatory Option 2	4,257,358	856,462

<sup>1</sup>The organic compounds pollutant reduction for the Organics Subcategory was estimated to be 0, because all facilities had the treatment-in-place for removal of organic compounds.

#### 8.8.2.3 PSES Effluent Discharges to POTWs

The estimated reductions in pollutants indirectly discharged to POTWs resulting from implementation of proposed PSES are listed in Table 8-7. Pollutant reductions are presented for Regulatory Option 1 (the combination of Metals Option 3, Oils Option 2, and Organics Option 1) and Regulatory Option 2 (the combination of Metals Option 3, Oils Option 3, and Organics Option 1). The Agency estimates that proposed PSES regulations will reduce indirect facility discharge to POTWs by 76.8 million pounds per year for Regulatory Option 1 and for Regulatory Option 2 81.9 million pounds per year.

**Table 8-7.** Reduction in Indirect Discharge of Priority and Nonconventional Pollutants  
After Implementation of Proposed PSES Regulations  
(units = lbs/year)

<b>Subcategory</b>	<b>Metal Compounds</b>	<b>Organic Compounds</b>
Metals Treatment and Recovery	428,040	120,545
Oils Treatment and Recovery - Regulatory Option 1	709,834	1,341,439
Oils Treatment and Recovery - Regulatory Option 2	771,668	1,474,708
Organics Treatment	415,812	3,521,560
Regulatory Option 1 (with Oils Option 2)	1,553,686	4,983,544
Regulatory Option 2 (with Oils Option 3)	1,615,520	5,116,813

## **SECTION 9**

### **NON-WATER QUALITY IMPACTS**

During wastewater treatment, the pollutants of concern are either removed from the waste stream or destroyed. If the pollutants are removed, they are transferred from the water to another medium as a treatment residual. Subsequent disposition of these wastewater treatment residuals results in non-water quality impacts. The removal of organic pollutants from the wastewater also prevents them from being released into the atmosphere, which affects air quality.

Wastewater treatment also results in other, non-water, non-residual, impacts. These impacts are the consumption of energy used to power the wastewater treatment equipment, and the use of additional personnel to provide the wastewater treatment equipment operating labor.

Sections 304(b) and 306 of the Clean Water Act require EPA to consider the non-water quality environmental impacts and energy requirements of certain regulations. Pursuant to these requirements, EPA has considered the effect of the CWT BPT, BCT, BAT, NSPS, PSES, and PSNS regulations on air pollution, solid waste generation, and energy consumption. Additionally, EPA has considered the positive effect of employment gains for the industry resulting from the increased operating labor requirements of these regulations.

#### **9.1 AIR POLLUTION**

CWT facilities treat waste streams which contain significant concentrations of volatile organic compounds (VOCs). These waste streams usually pass through collection and treatment units that are open to the atmosphere. This exposure may result in the volatilization of VOCs from the wastewater.

No negative air quality impacts are anticipated as a result of the CWT regulations. Rather, the implementation of technologies for compliance with the regulations should

reduce the emissions of VOCs into the atmosphere. In the Organics Subcategory treatment trains, air stripping and granular activated carbon (GAC) adsorption treatment results in the removal of VOCs from the wastewater. In the Oils Subcategory treatment trains, the ultrafiltration, reverse osmosis, and GAC treatment units also provide VOC removals. These VOCs, instead of being released into the air, are transferred to a treatment residual. Taken here as a positive impact, removal of these VOCs results in a negative impact in terms of solid and aqueous treatment residuals generation. Table 9-1 presents the estimated reductions in VOC emissions resulting from compliance with the CWT regulations. Solid and aqueous impacts are discussed later.

**Table 9-1. Air Pollution Reductions for the CWT Industry**

CWT Subcategory	Option	VOCs Removed (million lbs/year)		
		Indirects	Directs	Total
Oils	2	63.7783	24.2875	88.0658
	3	82.8056	33.1970	116.0028
	4	85.1056	34.3239	119.4295
Organics	1	1,302.6800	708.3285	2,011.0085
	2	1,303.7248	709.0126	2,012.7374

## 9.2 **SOLID AND OTHER AQUEOUS WASTE**

Solid and other aqueous waste would be generated by several of the wastewater treatment technologies expected to be implemented to comply with the CWT regulations. The costs for disposal of these other waste residuals were included in the compliance cost estimates prepared for the regulatory options.

The solid and other aqueous waste treatment residuals are filter cake, reverse osmosis and ultrafiltration concentrate, spent activated carbon, and deactivated air

stripper oxidizer catalyst. These residuals are described and quantified in the following discussions.

### **9.2.1 *Filter Cake***

In the CWT Metals Subcategory treatment trains, hydroxide precipitation of metals generates a sludge residual. This sludge is dewatered, and the resultant filter cake is disposed or recycled. At one CWT facility that EPA sampled during this project, the use of selective metals precipitation allows for the reclamation of the metal-bearing filter cake. Therefore, the total quantities of metals treatment filter cake estimated for CWT compliance may not necessarily require disposal. However, in the CWT economic evaluation, contract hauling for off-site disposal in a Subtitle C or D landfill was the method costed. In the Organics Subcategory treatment train, the sequencing batch reactor (SBR) produces a biological treatment sludge which is also dewatered and disposed off-site.

It is estimated that compliance with Metals Options 1, 2, or 3 and Organics Options 1 or 2 would result in the disposal of 3.9 million gallons, or 39 million pounds, of hazardous and nonhazardous filter cake. The itemized estimated filter cake generation for the CWT Industry is presented in Table 9-2.

**Table 9-2. Filter Cake Generation for the CWT Industry**

CWT Subcategory	Option	Filter Cake Generated (million gal/year)					
		Hazardous			Nonhazardous		
		Indirect	Direct	Total	Indirect	Direct	Total
Organics	1	0.1870	0	0.1870	0.3798	0	0.3798
	2	0.1870	0	0.1870	0.3798	0	0.3798
Metals	1	0.9905	1.2439	2.2344	0.4879	0.6126	1.1005
	2	0.9905	1.2439	2.2344	0.4879	0.6126	1.1005
	3	0.9905	1.2439	2.2344	0.4879	0.6126	1.1005

**9.2.2 Reverse Osmosis Concentrate**

In the Oils Subcategory treatment trains, reverse osmosis (RO) treatment of oily streams results in the generation of a concentrated residual stream. At the CWT facility which uses this technology, the concentrated residual is either recycled via fuel-blending or disposed. Therefore, the total quantities of RO concentrate estimated for CWT compliance may not necessarily require disposal. However, in the CWT economic evaluation, contract hauling for off-site disposal was costed. The estimated RO concentrate generation for the CWT Industry is presented in Table 9-3.

**Table 9-3. Reverse Osmosis Concentrate Generation for the CWT Industry**

CWT Oils Subcategory Option	RO Concentrate Generated (MGal/year)		
	Indirects	Directs	Total
2	0	0	0
3	42.2458	15.9214	58.1672
4	42.2458	15.9214	58.1672



### 9.2.3 Ultrafiltration Concentrate

In the Oils Subcategory treatment trains, ultrafiltration (UF) treatment of oily streams results in the generation of a concentrated residual stream. At the CWT facility which uses this technology, the concentrated residual is either recycled via fuel-blending or disposed. Therefore, the total quantities of UF concentrate estimated for CWT compliance may not necessarily require disposal. However, in the CWT economic evaluation, contract hauling for off-site disposal was costed. The estimated UF concentrate generation for the CWT Industry is presented in Table 9-4.

**Table 9-4.** Ultrafiltration Concentrate Generation for the CWT Industry

CWT Oils Subcategory Option	UF Concentrate Generated (MGal/year)		
	Indirects	Directs	Total
2	2.9864	1.1372	4.1236
3	2.9864	1.1372	4.1236
4	2.9864	1.1372	4.1236

### 9.2.4 Spent Carbon

In the Oils and Organics Subcategories treatment trains, granular activated carbon (GAC) adsorption treatment of waste streams results in the generation of exhausted, or spent activated carbon. In the CWT economic evaluation, removal of the spent carbon for regeneration by a vendor was costed. The estimated activated carbon usage for the CWT Industry is presented in Table 9-5.

**Table 9-5. Activated Carbon Requirements for the CWT Industry**

CWT Subcategory	Option	Carbon Usage (million lbs/year)		
		Indirects	Directs	Total
Oils	2	0	0	0
	3	1.0794	0.5289	1.6083
	4	2.1624	4.4126	6.5750
Organics	1	0	0	0
	2	5.4402	3.5618	9.0020

### 9.2.5 Air Stripper Oxidizer Catalyst

In the Organics Subcategory treatment train, air stripping treatment of waste streams results in the generation of a contaminated off-gas, which requires the application of an air pollution control device. A catalytic oxidizer was costed for the CWT economic evaluation. Over time, its catalyst becomes deactivated; the replacement of the spent catalyst by a vendor was costed. The estimated air stripper catalyst usage for the CWT Industry is presented in Table 9-6.

**Table 9-6. Air Stripper Oxidizer Catalyst Requirements for the CWT Industry**

CWT Organics Subcategory Option	Catalyst Usage (lbs/year)		
	Indirects	Directs	Total
1	109.1	59.4	168.5
2	109.1	59.4	168.5

### 9.3 ENERGY REQUIREMENTS

In all of the CWT Subcategories, operation of wastewater treatment equipment results in the consumption of energy. This energy is used to power pumps, mixers, and other equipment components, to power lighting and controls, and to generate heat. The itemized estimated energy usage for the CWT Industry is presented in Table 9-7. As can be seen in this table, the proposed CWT Regulatory Option 1 (the combination of Oils Option 2, Organics Option 1, Cyanide Waste Pretreatment, and Metals Option 3) would require the consumption of 17.71 million kilowatt-hours per year of electricity. This is the equivalent of 9,925 barrels per year of #2 fuel oil. The proposed CWT Regulatory Option 2 (the combination of Oils Option 3, Organics Option 1, Cyanide Waste Pretreatment, and Metals Option 3) would require the consumption of 21.95 million kilowatt-hours per year of electricity, or 12,300 barrels per year of #2 fuel oil.

**Table 9-7.** Energy Requirements for the CWT Industry

CWT Subcategory	Option	Energy Usage (kwhr/year)		
		Indirects	Directs	Total
Oils	2	5,799,279	3,566,654	9,365,933
	3	8,872,953	4,735,779	13,608,732
	4	8,918,041	4,763,509	13,681,550
Organics	1	619,642	294,821	914,463
	2	639,494	307,819	947,313
Cyanide Waste Pretreatment	2	219,603	55,683	275,286
Metals	1	99,790	137,339	237,129
	2	3,553,280	2,649,986	6,203,266
	3	4,117,529	3,035,628	7,153,157

## 9.4 LABOR REQUIREMENTS

The installation of new wastewater treatment equipment for compliance with the CWT regulations would result in increased operating labor requirements for CWT facilities. It is estimated that compliance with the CWT regulations would result in industry-wide employment gains; the estimated labor needs are presented in Table 9-8.

**Table 9-8.** Labor Requirements for the CWT Industry

CWT Subcategory	Option	Operating Labor Requirements			
		Indirect Dischargers		Direct Dischargers	
		(hours/yr)	(men/yr)	(hours/yr)	(men/yr)
Oils	2	14,560	7.3	2,080	1.0
	3	58,630	29.3	8,540	4.3
	4	91,480	45.8	12,920	6.5
Organics	1	48,234	24.1	16,266	8.1
	2	60,279	30.1	22,836	11.4
Cyanide Waste Pretreatment	2	17,520	8.6	2,190	1.1
Metals	1	22,456	11.2	15,242	7.6
	2	1,062,640	531.3	223,580	111.8
	3	1,089,940	545.0	229,820	114.9

## **SECTION 10 IMPLEMENTATION**

Implementation of a regulation is the final step in the regulatory process. If a regulation is not effectively implemented, the removals and environmental benefits estimated for the regulation may not be achieved.

In discussions with permit writers and pretreatment authorities, many stated that close communication with CWT facilities was important for effective implementation of discharge permits. Due to the difficulty in treating the concentrated waste streams identified in the CWT Industry, many facilities also maintain close communication with the waste generator. Many CWT facilities work with generators to ensure the waste received for treatment is, in fact, substantially similar to that reported in the original paperwork for accepting the waste for treatment. CWT facilities also work with generators to reduce the mixing of various waste streams. The facility on which the proposed Metals Subcategory limitations are based asked waste generators not to mix wastes from various processes. This assisted the process of selective metals precipitation. Therefore, close communication among permit writers/pretreatment authorities, waste generators, and CWT facilities is an important aspect in effective implementation of the effluent guidelines limitations and standards.

### **10.1 *APPLICABLE WASTE STREAMS***

Effective implementation of the regulation depends on accurate determination of which waste streams are covered by the each subcategory of the regulation and careful management of individual waste streams by the generators of the waste and the CWT facility. Section 4 describes the sources of wastewater for the CWT Industry including waste receipts; tanker truck, trailer/roll-off bins and drum wash water; solubilization water; and contaminated stormwater. One of the most difficult wastewater sources to identify is contaminated stormwater. Many facilities discharge stormwater, but not necessarily

contaminated stormwater. Contaminated stormwater is defined as any wastewater which comes in direct contact with waste receipts and waste handling or treatment areas.

During site visits at CWT facilities, EPA identified many circumstances in which uncontaminated stormwater is added to CWT wastewater for treatment or after treatment but prior to effluent discharge monitoring. In most cases, the addition of stormwater probably resulted in dilution of the waste stream. In some cases, stormwater, contaminated or uncontaminated, was used as solubilization water for wastes in the solid phase to render the waste treatable in order to reduce water costs.

## **10.2 DETERMINATION OF SUBCATEGORIES**

Since 30 percent of facilities receive wastes which may be classified in more than one subcategory, one of the most important aspects of implementation is the determination of which subcategory's limitations are applicable to a facility's operation. EPA recommends that permit writers and pretreatment authorities work with CWT facilities to assess the process for which wastes are accepted for treatment. In Section 3, a process that many CWT facilities used for waste acceptance is outlined. This process ensures that CWT facilities are aware of the types of waste accepted for treatment and the types of pollutants which are contained in the waste.

After characterizing wastes accepted for treatment, the pollutant concentrations listed in Table 10-1 may be used as a guide for determining the subcategory of wastes accepted for treatment. It is important to note that various pollutants were detected in all three subcategories. Organic pollutants were found in the Metals and Oils Subcategories and metal pollutants were detected in the Organics Subcategory. Waste stream subcategories are determined by the concentration levels reported. In developing the regulation, EPA did not find any single waste receipt which could be classified in multiple subcategories. This most probably would occur if waste streams were mixed by the waste generator.

**Table 10-1. Pollutant Concentrations for Determination of Subcategory**

Metals Subcategory	Oils Subcategory	Organics Subcategory																																		
<p>If any of the following metals are found at a concentration greater than the values listed below:</p> <table><tr><td>Aluminum</td><td>1993 mg/l</td></tr><tr><td>Antimony</td><td>1.6 mg/l</td></tr><tr><td>Arsenic</td><td>0.7 mg/l</td></tr><tr><td>Barium</td><td>7.1 mg/l</td></tr><tr><td>Cadmium</td><td>0.5 mg/l</td></tr><tr><td>Chromium</td><td>7.2 mg/l</td></tr><tr><td>Cobalt</td><td>0.9 mg/l</td></tr><tr><td>Copper</td><td>80.0 mg/l</td></tr><tr><td>Lead</td><td>22.0 mg/l</td></tr><tr><td>Magnesium</td><td>250 mg/l</td></tr><tr><td>Manganese</td><td>20.4 mg/l</td></tr><tr><td>Mercury</td><td>0.007 mg/l</td></tr><tr><td>Molybdenum</td><td>13 mg/l</td></tr><tr><td>Nickel</td><td>62 mg/l</td></tr><tr><td>Tin</td><td>6.3 mg/l</td></tr><tr><td>Titanium</td><td>21 mg/l</td></tr><tr><td>Zinc</td><td>94.5 mg/l</td></tr></table> <p>If Total Cyanide is greater than 68 mg/l, in-facility monitoring after CN pretreatment is required.</p>	Aluminum	1993 mg/l	Antimony	1.6 mg/l	Arsenic	0.7 mg/l	Barium	7.1 mg/l	Cadmium	0.5 mg/l	Chromium	7.2 mg/l	Cobalt	0.9 mg/l	Copper	80.0 mg/l	Lead	22.0 mg/l	Magnesium	250 mg/l	Manganese	20.4 mg/l	Mercury	0.007 mg/l	Molybdenum	13 mg/l	Nickel	62 mg/l	Tin	6.3 mg/l	Titanium	21 mg/l	Zinc	94.5 mg/l	<p>If the Oil &amp; Grease concentration is greater than 700 mg/l.</p>	<p>If concentrations detected are less than the cut-offs for the Metals and Oils Subcategory.</p>
Aluminum	1993 mg/l																																			
Antimony	1.6 mg/l																																			
Arsenic	0.7 mg/l																																			
Barium	7.1 mg/l																																			
Cadmium	0.5 mg/l																																			
Chromium	7.2 mg/l																																			
Cobalt	0.9 mg/l																																			
Copper	80.0 mg/l																																			
Lead	22.0 mg/l																																			
Magnesium	250 mg/l																																			
Manganese	20.4 mg/l																																			
Mercury	0.007 mg/l																																			
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Tin	6.3 mg/l																																			
Titanium	21 mg/l																																			
Zinc	94.5 mg/l																																			

Permit writers and pretreatment authorities should also review the types of operations at a facility. Facilities which operate Oils Recovery and Metals Recovery are included in the Oils Subcategory and Metals Subcategory, respectively. Oils recovery processes are typically chemical emulsion breaking processes where the addition of acid or heat are used to break stable oil-water emulsions. During the EPA sampling program,

stable oil-water emulsions were not sampled prior to treatment because approved analytical methods were not applicable for the waste type. Any wastewater generated from an Oils Recovery process is classified as Oils Subcategory wastewater.

### **10.3 ESTABLISHING LIMITATIONS AND STANDARDS FOR FACILITY DISCHARGES**

#### **10.3.1 Facilities with One Operation**

The simplest case for establishing discharge limitations and standards is for facilities classified in one CWT subcategory. If all water discharged is classified as CWT wastewater, the limitations for the subcategory of concern are applied at the outfall or discharge point. Permit writers or pretreatment authorities should review the facility wastewater sources to determine if any portion of the wastewater discharge results from the treatment or addition of non-CWT wastewater (i.e., stormwater or other industrial wastewater). The permit writer or pretreatment authority should determine the effluent discharge limitation for each pollutant by flow-proportioning CWT limitations as illustrated in Equation 10-1.

$$X_{\text{LIMIT}} = \frac{X_{\text{CWT}} * \text{FLOW}_{\text{CWT}} + X_{\text{NON-CWT}} * \text{FLOW}_{\text{NON-CWT}}}{\text{FLOW}_{\text{TOTAL}}} \quad (40-1)$$

where:

$X_{\text{LIMIT}}$  = Permit Discharge Concentration,

$X_{\text{CWT}}$  = CWT Limitation,

$\text{FLOW}_{\text{CWT}}$  = CWT Flow,

$X_{\text{NON-CWT}}$  = Limitation for Non-CWT Waste Stream, and

$\text{FLOW}_{\text{Non-CWT}}$  = Non-CWT Flow.



If the waste stream is added after treatment of the CWT waste stream occurs, the permit writer or pretreatment authority may establish the discharge limitations prior to the addition of the non-CWT waste stream.

### 10.3.2 *Facilities with Operations Classified in Multiple Subcategories*

After facilities have been classified in multiple subcategories, permits may be established based on site specific configurations. Facilities which have separate treatment systems for each of the waste streams may monitor for compliance with the limitations after each of the separate treatment systems or may monitor for compliance after mixing of the waste streams for discharge. When facilities mix the wastewater from each separate treatment system, Equation 10-2 may be used to determine the discharge limitations for each pollutant. CWT facilities that mix the wastewater prior to discharge but after treatment must demonstrate that limitations are being achieved through treatment not dilution. Therefore, if any pollutants are not detected at the discharge point, analysis of the waste streams prior to mixing is required to ensure compliance with the limitations and standards.

$$X_{LIMIT} = \frac{X_{METAL} * FLOW_{METAL} + X_{OILS} * FLOW_{OILS} + X_{ORGANICS} * FLOW_{ORGANICS}}{FLOW_{TOTAL}} \quad (50-1)$$

where:

$X_{LIMIT}$  = Permit Discharge Concentration,

$X_{METALS}$  = Metals Subcategory Limitation,

$FLOW_{METALS}$  = Metals Subcategory Flow,

$X_{OILS}$  = Oils Subcategory Limitation,

$FLOW_{OILS}$  = Oils Subcategory Flow,

$X_{\text{ORGANICS}}$  = Organics Subcategory Limitation, and

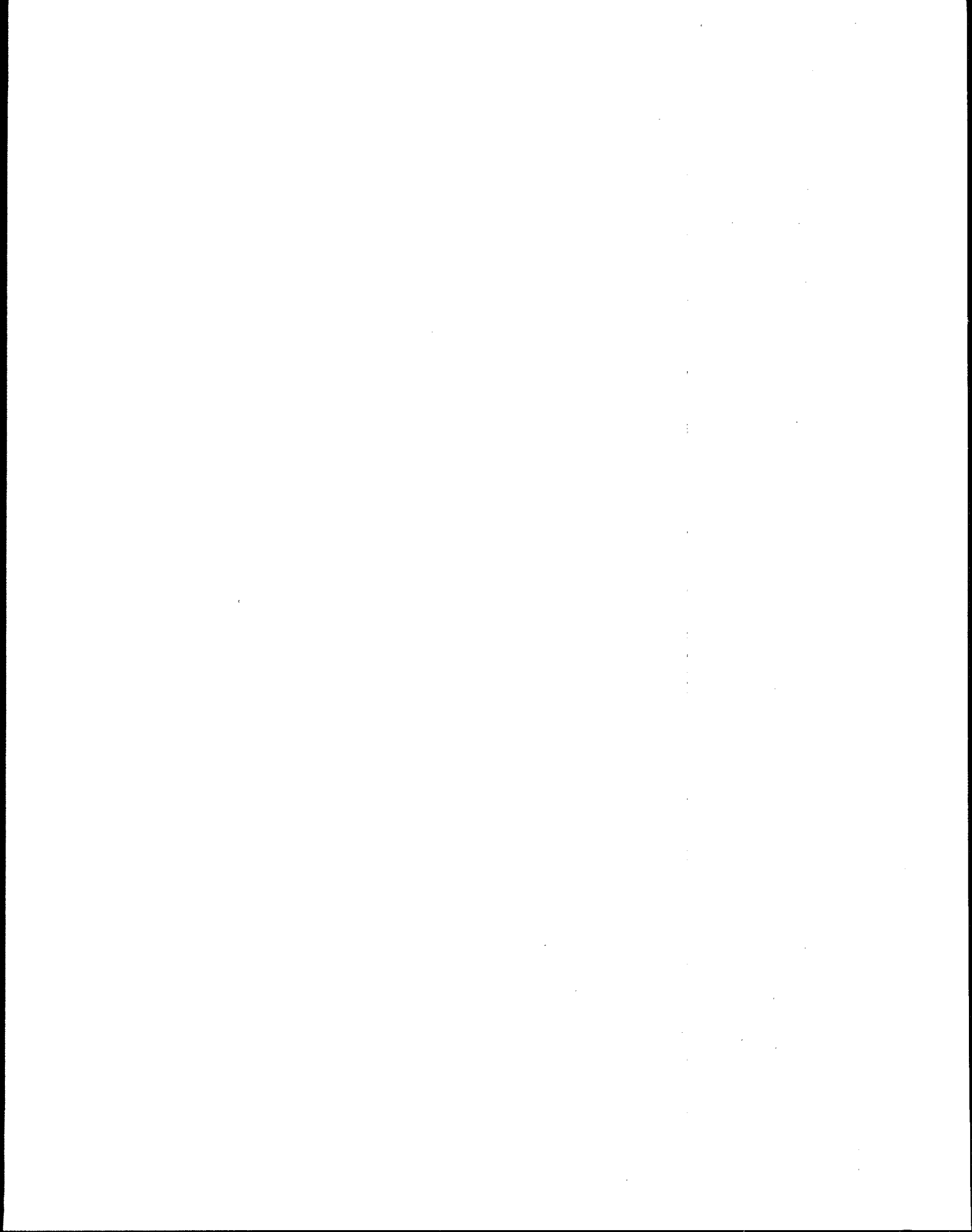
$\text{FLOW}_{\text{ORGANICS}}$  = Organics Subcategory Flow.

Facilities which mix waste prior to complete treatment of the wastewater may also use Equation 10-2 to determine the discharge limitations for each pollutant, but monitoring for compliance is more difficult. The CWT facility must demonstrate to the permit writer or pretreatment authority that the treatment system can achieve the effluent limitations through treatment, not dilution.

The first step in determining if a treatment system can achieve the limitations is analyzing the waste stream prior to addition with other wastes. If pollutants of concern for the waste type are detected after mixing of waste streams and the effluent discharge limitations are met, the CWT facility has demonstrated compliance. If pollutants of concern for the waste type are not detected after mixing with other wastes, the CWT facility must demonstrate to the permit writer or pretreatment authority that the treatment system can achieve the effluent limitations and standards. CWT facilities may demonstrate that treatment systems can achieve the effluent limitations and standards in various ways. If the treatment facility has any treatability studies for the design of the treatment system which contain data on pollutant concentrations, this information may be used. Facilities may also submit data from text books which discuss the types of pollutants which are removed from the treatment technologies in place. For example, a facility classified in both the Metals and Organics subcategories may have biological treatment as the on-site treatment technology. Various text books on the design of biological treatment systems discuss the pollutants removed and the possible treatment levels, but metal pollutants are not typically treated in biological treatment systems to any appreciable level. Therefore, the facility, in the above case, would be required to add treatment for the metals portion of the waste stream to demonstrate compliance with the effluent limitations and standards.

EPA identified many circumstances where additional treatment may be necessary to demonstrate compliance. Many facilities accept metal-bearing and oily wastes. The

wastewater from Oils Recovery is typically mixed with the metal-bearing waste stream for treatment in a metal precipitation process. The metals precipitation process may treat the metal compounds detected in both waste streams, but will not treat the organic constituents present in the oily waste stream. In many instances, the oily wastewater flow is relatively small in comparison to the metal-bearing waste stream and mixing of the waste streams results in pollutants of concern not being detected. Therefore, when establishing the permit for such an operation, a facility would be required to demonstrate compliance with the effluent limitations by submitting treatability data or technical references to the permit writer or pretreatment authority illustrating that the effluent limitations are achievable in the on-site treatment system. If the facility is unable to demonstrate compliance for the on-site treatment system, additional treatment would be necessary to effectively treat the pollutants which are not treated in the present treatment system.



## INDEX

### Activated Sludge

- Technology Description (6-51)

- Treatment Performance (6-52)

### Air Pollution Control Scrubber Blow-down (4-3)

### Air Pollution Reduction Impacts (9-1)

### Air Stripping

- Costs (7-21)

- Land Requirements (7-22)

- Oxidizer Catalyst Replacement Impacts (9-5)

- Technology Description (6-17)

- Treatment Performance (6-20)

### Applicable Waste Streams (10-1)

### Aqueous Waste Disposal Impacts (9-2)

### BAT (1-3, 8-19)

- Costs (8-24)

### BCT (1-2, 8-19)

- Costs (8-24)

### Belt Pressure Filtration

- Technology Description (6-68)

- Treatment Performance (6-70)

### Biotowers

- Technology Description (6-49)

- Treatment Performance (6-51)

### BOD (4-7)

- Influent Concentration (4-8)

### BPT (1-1)

- Costs (8-23)

- Establishment (8-1)

- Limitations - Metals Subcategory (8-6)

- Limitations - Oils Subcategory (8-11)

- Limitations - Organics Subcategory (8-16)

- Metals Subcategory - Rationale (8-3)

- Oils Subcategory - Rationale (8-9)

- Organics Subcategory - Rationale (8-14)

BPT (continued)

- Technology Options - Metals Subcategory (8-4)
- Technology Options - Oils Subcategory (8-9)
- Technology Options - Organics Subcategory (8-14)

Carbon Adsorption

- Costs (7-24)
- Land Requirements (7-25)
- Spent Carbon Replacement Impacts (9-5)
- Technology Description (6-24)
- Treatment Performance (6-26)

Chemical Precipitation

- Costs (7-4)
- Land Requirements (7-8)
- Technology Description (6-2)
- Treatment Performance (6-5)

Chromium Reduction

- Costs (7-28)
- Land Requirements (7-30)
- Technology Description (6-33)
- Treatment Performance (6-36)

Clarification

- Costs (7-14)
- Land Requirements (7-16)
- Technology Description (6-10)
- Treatment Performance (6-10)

Cost Factors

- Capital (7-2)
- O & M (7-3)

Costs

- BCT/BAT (8-24)
- BPT (8-23)
- Capital, Explanation of (7-2)
- Filter Cake Disposal (7-36)
- Implementation (Es-4)

- Costs (continued)
  - Land (7-41)
  - Monitoring (7-38)
  - O & M, Explanation of (7-2)
  - PSES (8-24)
  - RCRA Permit Modification (7-40)
  - Retrofit (7-38)
  - Technology Options (8-22)
- Current Performance (4-13)
  - Metals Subcategory (4-13, 4-16)
  - Oils Subcategory (4-18)
  - Organics Subcategory (4-21)
- CWT Industry
  - General Information (3-2)
  - Location (3-2)
  - Number of Facilities (3-2)
  - Other Industrial Operations (3-3)
- Cyanide Destruction
  - Costs (7-26)
  - Land Requirements (7-27)
  - Technology Description (6-30)
  - Treatment Performance (6-33)
- Discharge Information
  - Comparison of Total Facility Discharge (4-4)
  - Distribution of Facilities (3-8)
  - Options Used (3-8)
  - Pollutants (4-13)
  - Quantity Discharged (3-9)
  - Quantity Discharged in 1989 (3-9)
- Dissolved Air Flotation
  - Technology Description (6-42)
  - Treatment Performance (6-45)
- Electrolytic Recovery
  - Technology Description (6-36)
  - Treatment Performance (6-37)

Emulsion Breaking

Technology Description (6-14)

Treatment Performance (6-16)

Energy Requirements Impacts (9-6)

Equalization

Costs (7-20)

Land Requirements (7-21)

Technology Description (6-16)

Treatment Performance (6-17)

Equipment Washes (4-3)

Facility Statistics

Wastes Receipts (3-3)

Filter Cake Disposal

Costs (7-36)

Impacts (9-3)

Gravity Separation

Technology Description (6-41)

Treatment Performance (6-42)

Impacts

Air Pollution Reductions (9-1)

Air Stripper Oxidizer Catalyst Replacement (9-5)

Energy Requirements (9-6)

Filter Cake Disposal (9-3)

Labor Requirements (9-7)

Non-water Quality (9-1)

Reverse Osmosis Concentrate Disposal (9-3)

Solid and Other Aqueous Waste Disposal (9-2)

Spent Carbon Replacement (9-5)

Ultrafiltration Concentrate Disposal (9-4)

Implementation (10-1)

Applicable Waste Streams (10-1)

Determination of Subcategories (10-2)

Establishment of Limitations (10-4)



- Influent Concentrations
  - Metal Pollutants (4-10)
  - Organic Pollutants (4-11)
  - Pollutant Parameters (4-8)
- Ion Exchange
  - Technology Description (6-37)
  - Treatment Performance (6-41)
- Laboratory-derived Wastewater (4-3)
- Labor Requirements Impacts (9-7)
- Lancy Filtration
  - Technology Description (6-59)
  - Treatment Performance (6-60)
- Land Costs (7-41)
- Limitations
  - Cyanide Pretreatment (8-6)
  - Metals Subcategory (8-6)
  - Oils Subcategory (8-11)
  - Organics Subcategory (8-16)
  - Technology Basis (Es-2)
- Liquid Carbon Dioxide Extraction
  - Technology Description (6-62)
  - Treatment Performance (6-64)
- Metals Subcategory
  - BPT - Rationale (8-3)
  - Current Performance (4-13, 4-16)
  - Influent Concentrations (4-8, 4-10, 4-11)
  - Pollutants Selected for Regulation (5-3)
  - Technology Options (8-4)
- Monitoring Costs (7-38)
- Multi-media Filtration
  - Costs (7-23)
  - Land Requirements (7-24)
  - Technology Description (6-21)
  - Treatment Performance (6-22)
- Non-water Quality Impacts (9-1)
- NSPS (1-3, 8-20)

Oil and Grease (4-7)

Influent Concentration (4-8)

Oils Subcategory

BPT - Rationale (8-9)

Current Performance (4-18)

Influent Concentrations (4-8, 4-10, 4-11)

Pollutants Selected for Regulation (5-3)

Technology Options (8-9)

Organics Subcategory

BPT - Rationale (8-14)

Current Performance (4-21)

Influent Concentrations (4-8, 4-10, 4-11)

Pollutants Selected for Regulation (5-3)

Technology Options (8-14)

Pass-through Analysis

50 Potw Study Data Base (5-8)

Approach (5-7)

Data Editing (5-9)

Final Potw Removals (5-12)

Results (5-14)

Results - Metals Subcategory (5-16)

Results - Oils Subcategory (5-17)

Results - Organics Subcategory (5-18)

RREL Treatability Data Base (5-9)

Volatile Override (5-15)

pH (4-7)

Pipeline Exclusion (3-3)

Plate and Frame Pressure Filtration - Liquid Stream

Costs (7-16), (7-19)

Land Requirements (7-18), (7-19)

Technology Description (6-12)

Treatment Performance (6-14)

Plate and Frame Pressure Filtration - Sludge Stream

Costs (7-34)

Land Requirements (7-36)

Technology Description (6-66)

Plate and Frame Pressure Filtration - Sludge Stream (continued)

Treatment Performance (6-68)

Pollutant Reductions (8-25)

BPT (8-26)

Conventional Pollutants (8-25)

Direct Discharges (8-26)

Indirect Discharges (8-27)

Methodology (8-26)

PSES (8-27)

Pollutants Excluded from Regulation

Due to Ineffective Treatment (5-6)

Due to Isolated Detection (5-4)

Due to Low Concentrations (5-4)

Due to No Analysis at Technology Option (5-5)

Pollutants Selected for Regulation (5-3)

For Pretreatment Standards (5-6)

Priority and Non-conventional Pollutants (4-9)

Procedures for Receipt of Waste (3-6)

PSES (1-4, 8-21)

Costs (8-24)

PSNS (1-4, 8-22)

Quantity of Waste (3-6)

Questionnaires

Pre-test (2-3)

1991 Waste Treatment Industry Questionnaire (2-1, 2-2)

Development (2-1)

Distribution (2-4)

DMQ (2-1, 2-2)

RCRA Codes (3-4)

RCRA Permit Modification Costs (7-40)

Retrofit Costs (7-38)

Reverse Osmosis

Concentrate Disposal Impacts (9-3)

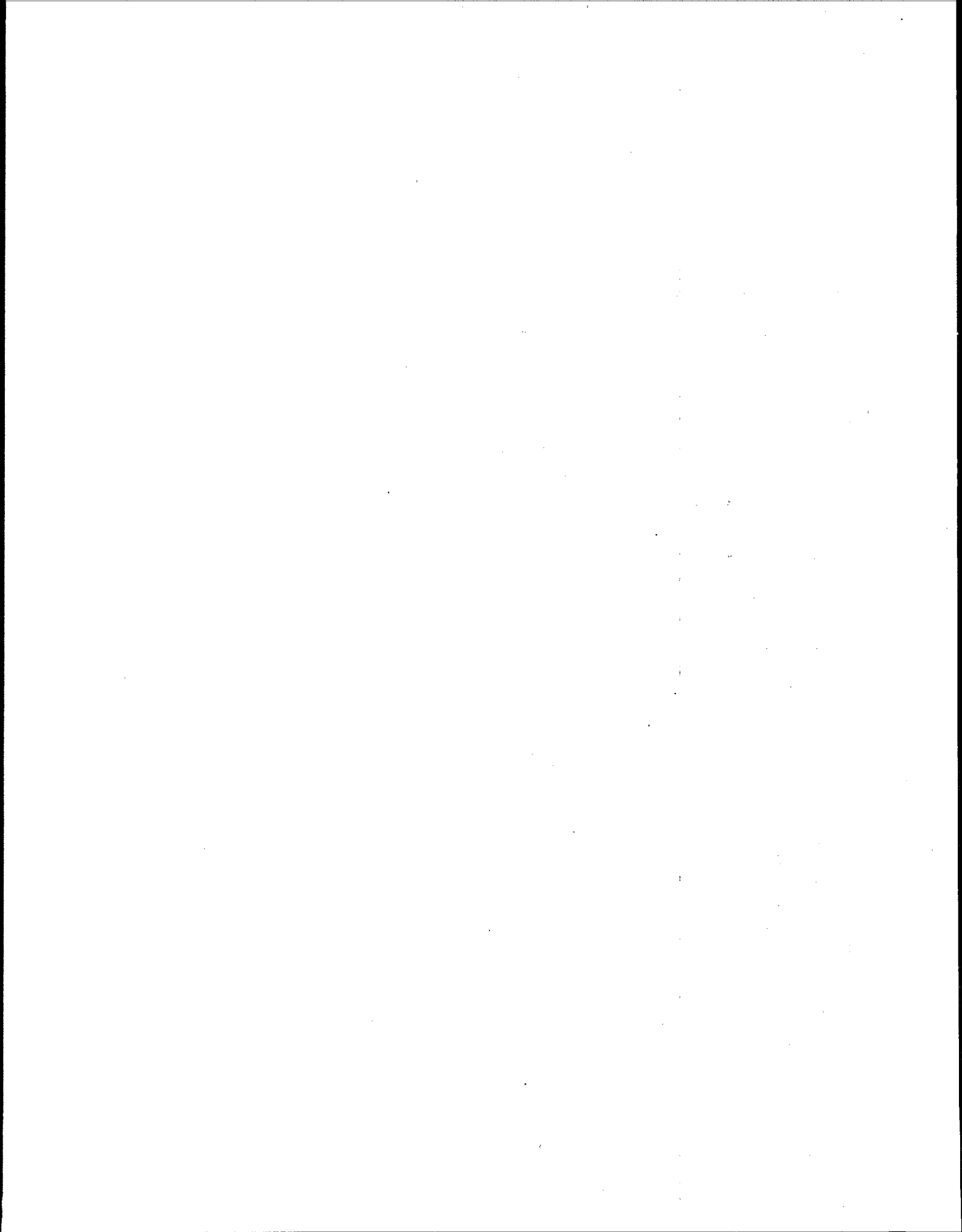
Costs (7-33)

Land Requirements (7-34)

Technology Description (6-56)

- Reverse Osmosis (continued)
  - Treatment Performance (6-57)
- Sampling Program (2-5)
  - 1989-1993 (2-6)
  - 1994 (2-9)
  - Facility Selection Criteria (2-6)
  - Metal-bearing Waste (2-7)
  - Oily Wastes (2-7, 2-9)
  - Organic Wastes (2-8)
  - Pre-1989 (2-5)
  - Sampling Episodes Procedures (2-8)
- Secondary Precipitation
  - Costs (7-10)
  - Land Requirements (7-12)
  - Treatment Performance (6-5)
- Section 304(m) (1-5)
- Selective Metals Precipitation
  - Costs (7-8)
  - Land Requirements (7-10)
  - Technology Description (6-3)
  - Treatment Performance (6-5)
- Sequencing Batch Reactors
  - Costs (7-30)
  - Land Requirements (7-31)
  - Technology Description (6-47)
  - Treatment Performance (6-47)
- Sic Code (3-3)
- Solid Waste Disposal Impacts (9-2)
- Solubilization Water (4-2)
- Stormwater
  - Contaminated (4-3)
  - Quantity Discharged (4-3)
- Subcategories
  - Determination of (10-2)
  - Metal-bearing Waste Treatment (3-13)
  - Oily Waste Treatment (3-13)

- Subcategories (continued)
  - Organic Waste Treatment (3-14)
- Subcategorization (3-10)
  - Development of Scheme (3-11)
  - Proposed Scheme (3-12)
- Tanker Truck/drum/roll-off Box Washes (4-2)
- Tertiary Precipitation
  - Costs (7-12)
  - Land Requirements (7-14)
  - Treatment Performance (6-5)
- Treatment Residuals (3-9)
- TSS (4-7)
  - Influent Concentration (4-8)
- Ultrafiltration
  - Concentrate Disposal Impacts (9-4)
  - Costs (7-31)
  - Land Requirements (7-32)
  - Technology Description (6-54)
  - Treatment Performance (6-56)
- Vacuum Filtration
  - Technology Description (6-70)
  - Treatment Performance (6-72)
- Waste Form Codes (3-5)
- Waste Oil Emulsion-breaking Wastewater (4-2, 4-3)
- Waste Receipts (3-3, 4-2)
  - Acceptance Procedures (3-6)
  - Quantity (3-6)
- Wastewater
  - By Subcategory (4-6)
  - Characterization (4-6)
  - Sources (4-1)



## Appendix A. RCRA and Waste Form Codes Reported by Facilities in 1989

### RCRA Codes

D001	Ignitable Waste
D002	Corrosive Waste
D003	Reactive Waste
D004	Arsenic
D005	Barium
D006	Cadmium
D007	Chromium
D008	Lead
D009	Mercury
D010	Selenium
D011	Silver
D012	Endrin(1,2,3,4,10,10-hexachloro-1,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4-endo-5,8-dimeth-ano-naphthalene)
D017	2,4,5-TP Silvex (2,4,5-trichlorophenixypropionic acid)
D035	Methyl ethyl ketone
F001	The following spent halogenated solvents used in degreasing: tetrachloroethylene; trichloroethane; carbon tetrachloride and chlorinated fluorocarbons and all spent solvent mixtures/blends used in degreasing containing, before use, a total of 10 percent or more (by volume) of one or more of the above halogenated solvents or those solvents listed in F002, F004, and F005; and still bottoms from the recovery of these spent solvents and spent solvent mixtures
F002	The following spent halogenated solvents: tetrachloroethylene; 1,1,1-trichloroethane; chlorobenzene; 1,1,2-trichloro-1,2,2-trifluoroethane; ortho-dichlorobenzene; trichloroethane; all spent solvent mixtures/blends containing, before use, a total of 10 percent or more (by volume) of one or more of the above halogenated solvents or those solvents listed in F001, F004, and F005; and still bottoms from the recovery of these spent solvents and spent solvent mixtures
F003	The following spent nonhalogenated solvents: xylene, acetone, ethyl acetate, ethyl benzene, ethyl ether, methyl isobutyl ketone, n-butyl alcohol, cyclohexanone, and methanol; all spent solvent mixtures/blends containing, before use, one or more of the above nonhalogenated solvents, and a total of 10 percent or more (by volume) of one or more of those solvents listed in F001, 002, F004, and F005; and still bottoms from the recovery of these spent solvents and spent solvent mixtures.

**Appendix A. RCRA and Waste Form Codes Reported by Facilities in 1989 (continued)**

**RCRA Codes (continued)**

F004	The following spent nonhalogenated solvents: cresols, cresylic acid, and nitrobenzene; and the still bottoms from the recovery of these solvents; all spent solvent mixtures/blends containing before use a total of 10 percent or more (by volume) of one or more of the above nonhalogenated solvents or those solvents listed in F001, F002, and F005; and still bottoms from the recovery of these spent solvents and spent solvent mixtures
F005	The following spent nonhalogenated solvents: toluene, methyl ethyl ketone, carbon disulfide, isobutanol, pyridine, benzene, 2-ethoxyethanol, and 2-nitropropane; all spent solvent mixtures/blends containing, before use, a total of 10 percent or more (by volume) of one or more of the above nonhalogenated solvents or those solvents listed in F001, F002, or F004; and still bottoms from the recovery of these spent solvents and spent solvents mixtures
F006	Wastewater treatment sludges from electroplating operations except from the following processes: (1) sulfuric acid anodizing of aluminum; (2) tin plating on carbon steel; (3) zinc plating (segregated basis) on carbon steel; (4) aluminum or zinc-aluminum plating on carbon steel; (5) cleaning/stripping associated with tin, zinc, and aluminum plating on carbon steel; and (6) chemical etching and milling of aluminum
F007	Spent cyanide plating bath solutions from electroplating operations
F008	Plating bath residues from the bottom of plating baths from electroplating operations in which cyanides are used in the process
F009	Spent stripping and cleaning bath solutions from electroplating operations in which cyanides are used in the process
F010	Quenching bath residues from oil baths from metal heat treating operations in which cyanides are used in the process
F011	Spent cyanide solutions from slat bath pot cleaning from metal heat treating operations
F012	Quenching waste water treatment sludges from metal heat treating operations in which cyanides are used in the process
F019	Wastewater treatment sludges from the chemical conversion coating of aluminum
F039	Multi-source leachate
K001	Bottom sediment sludge from the treatment of wastewater from wood preserving processes that use creosote and/or pentachlorophenol
K011	Bottom stream from the wastewater stripper in the production of acrylonitrile
K013	Bottom stream from the acetonitrile column in the production of acrylonitrile



**Appendix A. RCRA and Waste Form Codes Reported by Facilities in 1989 (continued)**

**RCRA Codes (continued)**

K014	Bottoms from the acetonitrile purification column in the production of acrylonitrile
K015	Still bottoms from the distillation of benzyl chloride
K016	Heavy ends or distillation residues from the production of carbon tetrachloride
K031	By-product salts generated in the production of MSMA and cacodylic acid
K035	Wastewater treatment sludges generated in the production of creosote
K044	Wastewater treatment sludges from the manufacturing and processing of explosives
K045	Spent carbon from the treatment of wastewater containing explosives
K048	Dissolved air flotation (DAF) float from the petroleum refining industry
K049	Slop oil emulsion solids from the petroleum refining industry
K050	Heat exchanger bundle cleaning sludge from the petroleum refining industry
K051	API separator sludge from the petroleum refining industry
K052	Tank bottoms (leaded) from the petroleum refining industry
K061	Emission control dust/sludge from the primary production of steel in electric furnaces
K064	Acid plant blowdown slurry/sludge resulting from the thickening of blowdown slurry from primary copper production
K086	Solvent washes and sludges, caustic washes and sludges, or water washes and sludges from cleaning tubs and equipment used in the formulation of ink from pigments, driers, soaps, and stabilizers containing chromium and lead
K093	Distillation light ends from the production of phthalic anhydride from ortho-xylene
K094	Distillation bottoms from the production of phthalic anhydride from ortho-xylene
K098	Untreated process wastewater from the production of toxaphene
K103	Process residues from aniline extraction from the production of aniline
K104	Combined wastewater streams generated from nitrobenzene/aniline production
P011	Arsenic pentoxide (t)
P012	Arsenic (III) oxide (t) Arsenic trioxide (t)
P013	Barium cyanide
P020	Dinoseb, Phenol, 2,4-dinitro-6-(1-methylpropyl)-
P022	Carbon bisulfide (t)

# Appendix A. RCRA and Waste Form Codes Reported by Facilities in 1989 (continued)

## RCRA Codes (continued)

	Carbon disulfide (t)
P028	Benzene, (chloromethyl)- Benzyl chloride
P029	Copper cyanides
P030	Cyanides (soluble cyanide salts), not elsewhere specified (t)
P040	0,0-diethyl 0-pyrazinyl phosphorothioate Phosphorothioic acid, 0,0-diethyl 0-pyrazinyl ester
P044	Dimethoate (t) Phosphorodithioic acid, 0,0-dimethyl S-[2-(methylamino)-2-oxoethyl]ester (t)
P048	2,4-dinitrophenol Phenol,2,4-dinitro-
P050	Endosulfan 5-norbornene-2,3-dimethanol, 1,4,5,6,7,7-hexachloro,cyclic sulfite
P063	Hydrocyanic acid Hydrogen cyanide
P064	Methyl isocyanate Isocyanic acid, methyl ester
P069	2-methylactonitrile Propanenitrile,2-hydroxy-2-methyl-
P071	0,0-dimethyl 0-p-nitrophenyl phosphorothioate Methyl parathion
P074	Nickel (II) cyanide Nickel cyanide
P078	Nitrogen (IV) oxide Nitrogen dioxide
P087	Osmium tetroxide Osmium oxide
P089	Parathion (t) Phosphorothiotic acid,0,0-diethyl 0-(p-nitrophenyl) ester (t)
P098	Potassium cyanide
P104	Silver cyanide
P106	Sodium cyanide
P121	Zinc cyanide
P123	Toxaphene Camphene,octachloro-
U002	2-propanone (i) Acetone (i)
U003	Ethanenitrile (i,t)

**Appendix A. RCRA and Waste Form Codes Reported by Facilities in 1989 (continued)**

**RCRA Codes (continued)**

	Acetonitrile (i,t)
U008	2-propenoic acid (i)
	Acrylic acid (i)
U009	2-propenenitrile
	Acrylonitrile
U012	Benzenamine (i,t)
	Aniline (i,t)
U019	Benzene (i,t)
U020	Benzenesulfonyl chloride (c,r)
	Benzenesulfonic acid chloride (c,r)
U031	1-butanol (i)
	N-butyl alcohol (i)
U044	Methane, trichloro-
	Chloroform
U045	Methane, chloro-(i,t)
	Methyl chloride (i,t)
U052	Cresylic acid
	Cresols
U057	Cyclohexanone (i)
U069	Dibutyl phthalate
	1,2-benzenedicarboxylic acid, dibutyl ester
U080	Methane, dichloro-
	Methylene chloride
U092	Methanamine, N-methyl-(i)
	Dimethylamine (i)
U098	Hydrazine, 1,1-dimethyl-
	1,1-dimethylhydrazine
U105	2,4-dinitrotoluene
	Benzene, 1-methyl-2,4-dinitro-
U106	2,6-dinitrotoluene
	Benzene, 1-methyl-2,6-dinitro
U107	Di-n-octyl phthalate
	1-2-benzenedicarboxylic acid, di-n-octyl ester
U113	2-propenoic acid, ethyl ester (i)
	Ethyl acrylate (i)
U118	2-propenoic acid, 2-methyl-, ethyl ester
	Ethyl methacrylate
U122	Formaldehyde
	Methylene oxide
U125	Furfural (i)

**Appendix A. RCRA and Waste Form Codes Reported by Facilities in 1989 (continued)**

**RCRA Codes (continued)**

	2-furancarboxaldehyde (i)
U134	Hydrogen fluoride (c,t)
	Hydrofluoric acid (c,t)
U135	Sulfur hydride
	Hydrogen sulfide
U139	Ferric dextran
	Iron dextran
U140	1-propanol, 2-methyl- (i,t)
	Isobutyl alcohol (i,t)
U150	Melphalan
	Alanine, 3-[p-bis(2-chloroethyl)amino] phenyl-,L-
U151	Mercury
U154	Methanol (i)
	Methyl alcohol (i)
U159	Methyl ethyl ketone (i,t)
	2-butanone (i,t)
U161	4-methyl-2-pentanone (i)
	Methyl isobutyl ketone (i)
U162	2-propenoic acid,2-methyl-,methyl ester (i,t)
	Methyl methacrylate (i,t)
U188	Phenol
	Benzene, hydroxy-
U190	Phthalic anhydride
	1,2-benzenedicarboxylic acid anhydride
U205	Selenium disulfide (r,t)
	Sulfur selenide (r,t)
U210	Tetrachloroethylene
	Ethene,1,1,2,2-tetrachloro
U213	Tetrahydrofuran (i)
	Furan, tetrahydro- (i)
U220	Toluene
	Benzene, methyl-
U226	1,1,1-trichloroethane
	Methylchloroform
U228	Trichloroethylene
	Trichloroethene
U239	Xylene (i)
	Benzene, dimethyl- (i,t)

## Appendix A. RCRA and Waste Form Codes Reported by Facilities in 1989 (continued)

### Waste Form Codes

B001	Lab packs of old chemicals only
B101	Aqueous waste with low solvent
B102	Aqueous waste with low other toxic organics
B103	Spent acid with metals
B104	Spent acid without metals
B105	Acidic aqueous waste
B106	Caustic solution with metals but no cyanides
B107	Caustic solution with metals and cyanides
B108	Caustic solution with cyanides but no metals
B109	Spent caustic
B110	Caustic aqueous waste
B111	Aqueous waste with reactive sulfides
B112	Aqueous waste with other reactives (e.g., explosives)
B113	Other aqueous waste with high dissolved solids
B114	Other aqueous waste with low dissolved solids
B115	Scrubber water
B116	Leachate
B117	Waste liquid mercury
B119	Other inorganic liquids
B201	Concentrated solvent-water solution
B202	Halogenated (e.g., chlorinated) solvent
B203	Nonhalogenated solvent
B204	Halogenated/Nonhalogenated solvent mixture
B205	Oil-water emulsion or mixture
B206	Waste oil
B207	Concentrated aqueous solution of other organics
B208	Concentrated phenolics
B209	Organic paint, ink, lacquer, or varnish
B210	Adhesive or epoxies
B211	Paint thinner or petroleum distillates
B219	Other organic liquids
B305	"Dry" lime or metal hydroxide solids chemically "fixed"
B306	"Dry" lime or metal hydroxide solids not "fixed"
B307	Metal scale, filings, or scrap
B308	Empty or crushed metal drums or containers
B309	Batteries or Battery parts, casings, cores
B310	Spent solid filters or adsorbents
B312	Metal-cyanides salts/chemicals
B313	Reactive cyanides salts/chemicals
B315	Other reactive salts/chemicals

## **Appendix A. RCRA and Waste Form Codes Reported by Facilities in 1989 (continued)**

### **Waste Form Codes (continued)**

B316	Other metal salts/chemicals
B319	Other waste inorganic solids
B501	Lime sludge without metals
B502	Lime sludge with metals/metal hydroxide sludge
B504	Other wastewater treatment sludge
B505	Untreated plating sludge without cyanides
B506	Untreated plating sludge with cyanides
B507	Other sludges with cyanides
B508	Sludge with reactive sulfides
B510	Degreasing sludge with metal scale or filings
B511	Air pollution control device sludge (e.g., fly ash, wet scrubber sludge)
B513	Sediment or lagoon dragout contaminated with inorganics only
B515	Asbestos slurry or sludge
B519	Other inorganic sludges
B601	Still bottoms of halogenated (e.g., chlorinated) solvents or other organic liquids
B603	Oily sludge
B604	Organic paint or ink sludge
B605	Reactive or polymerized organics
B607	Biological treatment sludge
B608	Sewage or other untreated biological sludge
B609	Other organic sludges

## Appendix B. Initial Pollutants Included in Sampling Program

### Conventional/Non-Conventional

Amenable Cyanide	pH
Ammonia as N	Sulfide, Total
BOD	TOC
COD	TOX
Total Cyanide	TSS
d-COD	Hexavalent Chromium
Fluoride	Total Phenols
Nitrate-nitrite as N	Total Phosphorus
Oil + Grease	

### Dioxins/Furans

Octachlorodibenzo-p-dioxin	1,2,3,4,7,8-hexachlorodibenzo-p-dioxin
Octochlorodibenzo-furan	1,2,3,4,7,8-hexachlorodibenzofuran
Total Heptachlorodibenzo-p-dioxin	1,2,3,4,7,8,9-heptachlorodibenzofuran
Total Heptachlorodibenzofurans	1,2,3,6,7,8-hexachlorodibenzo-p-dioxin
Total Hexachlorodibenzo-p-dioxins	1,2,3,6,7,8-heptachlordibenzofuran
Total Hexachlorodibenzo-furans	1,2,3,7,8-pentachlorodibenzo-p-dioxin
Total Pentachlorodibenzo-p-dioxins	1,2,3,7,8-pentachlorodibenzofuran
Total Pentachlorodibenzofurans	1,2,3,7,8,9-hexachlorodibenzo-p-dioxin
Total Tetrachlorodibenzo-p-dioxins	1,2,3,7,8,9-hexachlorodibenzofuran
Total Tetrachlorodibenzo-furans	2,3,4,6,7,8-hexachlorodibenzofuran
1,2,3,4,6,7,8-heptachloro- benzo-p-dioxin	2,3,4,7,8-pentachlorodibenzofuran
1,2,3,4,6,7,8-heptachloro-dibenzofuran	2,3,7,8-tetrachlorodibenzo-p-dioxin
	2,3,7,8-tetrachlorodibenzofuran

### Alcohol/Formaldehydes

Ethanol	3,4-dichlorophenol
Formaldehyde	3,4,5-trichlorocatechol
Methanol	3,4,6-trichloroguaiacol
Pentachlorophenol	3,5-dichlorocatecol
Tetrachlorocatechol	3,5-dichlorophenol
Tetrachloroguaiacol	3,6-dichlorocatechol
Trichlorosyringol	4-chlorophenol
2-syringealdehyde	4,5-dichlorocatechol
2,3,4,6-tetrachlorophenol	4,5-dichloroguaiacol
2,3,6-trichlorophenol	4,5,6-trichloroguaiacol
2,4-dichlorophenol	4,6-dichloroguaiacol
2,4,5-trichlorophenol	5-chloroguaiacol
2,4,6-trichlorophenol	5,6-dichlorovanillin
2,6-dichlorophenol	6-chlorovanillin

## Appendix B. Initial Pollutants Included in Sampling Program (continued)

### Metals

Aluminum  
Antimony  
Arsenic  
Barium  
Beryllium  
Bismuth  
Boron  
Cadmium  
Calcium  
Cerium  
Chromium  
Cobalt  
Copper  
Dysprosium  
Erbium  
Europium  
Gadolinium  
Gallium  
Germanium  
Gold  
Hafnium  
Holmium  
Indium  
Iodine  
Iridium  
Iron  
Lanthanum  
Lead  
Lithium  
Lutetium  
Magnesium  
Manganese  
Mercury  
Molybdenum  
Neodymium

### Organics

Acenaphthene  
Acenaphthylene  
Acetophenone  
Acrylonitrile

Nickel  
Niobium  
Osmium  
Palladium  
Phosphorus  
Platinum  
Potassium  
Praseodymium  
Rhenium  
Rhodium  
Ruthenium  
Samarium  
Scandium  
Selenium  
Silicon  
Silver  
Sodium  
Strontium  
Sulfur  
Tantalum  
Tellurium  
Terbium  
Thallium  
Thorium  
Thulium  
Tin  
Titanium  
Tungsten  
Uranium  
Vanadium  
Ytterbium  
Yttrium  
Zinc  
Zirconium

Alpha-terpineol  
Aniline  
2,4,5-trimethylaniline  
Anthracene



## Appendix B. Initial Pollutants Included in Sampling Program (continued)

### Organics (continued)

Aramite	Dibromomethane
Benzanthrone	Diethyl Ether
Benzene	Diethyl Phthalate
Benzenethiol	Dimethyl Phthalate
Benzidine	Dimethyl Sulfone
Benzo(a)anthracene	Diphenyl Ether
Benzo(a)pyrene	Diphenylamine
Benzo(b)fluoranthene	Diphenyldisulfide
Benzo(ghi)perylene	Pentachloroethane
Benzo(k)fluoranthene	Ethyl Cyanide
Benzoic Acid	Ethyl Emthacrylate
Benzonitrile,3,5-dibromo-4-hydroxy	Ethyl Methanesulfonate
Benzyl Alcohol	Ethyl Benzene
Beta-naphthylamine	Ethylene Thiourea
Biphenyl	Fluoranthene
Biphenyl,4-nitro	Fluorene
Bis(2-chloroethoxy)methane	Hexachlorobenzene
Bis(2-chloroethyl)ether	Hexachlorobutadiene
Bis(2chloroisopropyl)ether	Hexachlorocyclopentadiene
Bis(2-ethylhexyl)phthalate	Hexachloroethane
Bromodichloromethane	Hexachloropropene
Bromomethane	Hexanoic Acid
Butanone	Indeno(1,2,3-cd)pyrene
Butyl Benzyl Phthalate	Iodomethane
Carbazole	Isobutyl Alcohol
Carbon Disulfide	Isophorone
Chloroacetonitrile	Isosafrole
Chlorobenzene	Longifolene
Chloroethane	m-Xylene
Chloroform	Malachitegreen
Chloromethane	Mestranol
Chrysene	Methapyrilene
cis-1,3-dichloropropene	Methyl Methacrylate
Crotonaldehyde	Methyl Methane Sulfonate
Crotoxyphos	Methylene Chloride
Di-n-butyl Phthalate	n-Decane
Di-n-octyl Phthalate	n-Docosane
Di-n-propylnitrosamine	n-Dodecane
Dibenzo(a,h)anthracene	n-Eicosane
Dibenzofuran	n-Hexacosane
Dibenzothiophene	n-Hexadecane
Dibromochloromethane	

## Appendix B. Initial Pollutants Included in Sampling Program (continued)

### Organics (continued)

n-Nitrosodi-n-butylamine	Styrene
n-Nitrosodiethylamine	Tetrachloroethene
n-Nitrosodimethylamine	Tetrachloromethane
n-Nitrosodiphenylamine	Thianaphthene
n-Nitrosomethylethylamine	Thioacetamide
n-Nitrosomethylphenylamine	Thioxanthe-9-one
n-Nitrosomorpholine	Toluene
n-Nitrosopiperidine	Toluene,2,4-diamino
n-Octacosane	trans-1,2-dichloroethene
n-Octadecane	trans-1,3-dichloropropene
n-Tetracosane	trans-1,4-dichloro-2-butene
n-Tetradecane	Tribromomethane
n-Triacontane	Trichloroethene
n,n-Dimethylformamide	Trichlorofluoromethane
Naphthalene	Triphenylene
Nitrobenzene	Tripropyleneglycol Methyl Ether
o+p-Xylene	Vinyl Acetate
o-Anisidine	Vinyl Chloride
o-Cresol	1-Bromo-2-chlorobenzene
o-Toluidine	1-Bromo-3-chlorobenzene
o-Toluidine,5-chloro-	1-Chloro-3-nitrobenzene
p-Chloroaniline	1-Methyl Fluorene
p-Cresol	1-Methylphenanthrene
p-Cymene	1-Naphthylamine
p-Dimethylaminoazobenzo	1-Phenyl Naphthalene
p-Nitroaniline	1,1-Dichloroethane
Pentachlorobenzene	1,1-Dichloroethene
Pentachlorophenol	1,1,1-Trichloroethane
Pentamethylbenzene	1,1,1,2-Tetrachloroethane
Perylene	1,1,2-Trichloroethane
Phenacetin	1,1,2,2-Tetrachloroethane
Phenanthrene	1,2-Dibromo-3-chloropropane
Phenol	1,2-Dibromoethane
Phenol,2-methyl-4,6-dinitro	1,2-Dichlorobenzene
Phenol Thiazine	1,2-Dichloroethane
Pronamide	1,2-Dichloropropane
Pyrene	1,2-Diphenyl Hydrazine
Pyridine	1,2,3-Trichlorobenzene
Resorcinol	1,2,3-Trichloropropane
Safrole	1,2,3-Trimethoxybenzene
Squalene	1,2,4-Trichlorobenzene

## Appendix B. Initial Pollutants Included in Sampling Program (continued)

### Organics (continued)

1,2,4,5-Tetrachlorobenzene  
1,2:3,4-Diepoxybutane  
1,3-Butadiene,2-chloro-  
1,3-Dichloro-2-propanol  
1,3-Dichlorobenzene  
1,3-Dichloropropene  
1,3,5-Trithiane  
1,4-Dichlorobenzene  
1,4-Dinitrobenzene  
1,4-Dioxane  
1,4-Naphthoquinone  
1,5-Naphthalenediamine  
2-(Methylthio)benzothiazole  
2-Chloroethylvinyl Ether  
2-Chloronaphthalene  
2-Chlorophenol  
2-Hexanone  
2-Isopropyl naphthalene  
2-Methylbenzothiazole  
2-Methylnaphthalene  
2-Nitroaniline  
2-Nitrophenol  
2-Phenylnaphthalene  
2-Picoline  
2-Propanone  
2-Propen-1-ol  
2-Propenal  
2-Propenenitrile,z-methyl-  
2,3-Benzofluorene  
2,3-Dichloroaniline  
2,3-Dichloronitrobenzene  
2,3,4,6-Tetrachlorophenol  
2,3,6-Trichlorophenol  
2,4-Dichlorophenol  
2,4-Dimethylphenol  
2,4-Dinitrophenol  
2,4-Dinitrotoluene  
2,4,5-Trichlorophenol  
2,4,6-Trichlorophenol  
2,6-di-tert-butyl-p-benzoquinone  
2,6-Dichloro-4-nitroaniline  
2,6-Dichlorophenol

2,6-Dinitrotoluene  
3-Chloropropene  
3-Methylcholanthrene  
3-Nitroaniline  
3,3'-Dichlorobenzidine  
3,3'-Dimethoxybenzidine  
3,6-Dimethylphenanthrene  
4-Aminophenyl  
4-Bromophenyl Phenyl Ether  
4-Chloro-2-nitroaniline  
4-Chloro-3-methylphenol  
4-Chlorophenylphenyl Ether  
4-Methyl-2-pentanone  
4-Nitrophenol  
4,4'-Methylenebis(2-chloroaniline)  
4,5-Methylene Phenanthrene  
5-Nitro-o-toluidine  
7,12-Dimethyl Benz(a)anthracene

### Pesticides/Herbicides

a-Chlordane  
Acetic Acid(2,4-dichlorophenoxy)  
Aldrin  
Alpha-bhc  
Azinphos-ethyl  
Azinphos Methyl  
Beta-bhc  
Carbophenothion(trithion)  
Chlorobenzilate  
Chlorofenvinphos  
Chorpyrifos  
Coumaphos  
Crotoxyphos-cgc/fpd  
Dalapon  
Delta-bhc  
Demeton  
Diallate  
Diazinon  
Dicamba  
Dichlorofeuthion

## Appendix B. Initial Pollutants Included in Sampling Program (continued)

### Pesticides/Herbicides

Dichlorprop	PCB-1242
Dichlorvos	PCB-1248
Dicrotophos(bidrin)	PCB-1254
Dieldrin	PCB-1260
Dimethoate	Pentachloronitrobenzene
Dioxathion	Phorate
Disulfoton	Phosmet
Endosulfan Sulfate	Phosphamidone
Endosulfan-i	Phosphamidon Z
Endosulfan-ii	Ronnel
Endrin	Santox(epn)
Endrin Aldehyde	Sulprofos
Endrin Ketone	Terbufos
Ethion	Tetrachlorinphos
Ethoprop	Tetraethyldithiopyrophosphate
Famphur	Toxaphene
Fensulfothion	Trichloronate
Funthion	Trifluralin(treflan)
G-chlordane	2-Sec-butyl-4,6-dinitrophenol
Heptachlor	2,4-DB
Heptachlor Epoxide	2,4,5-Trichlorophenoxyacetic Acid
Isodrin	2,4,5-Trichlorophenoxypropionic Acid
Leptophos	4,4'-DDD
Lindane(gamma-bhc)	4,4'-DDE
Malathion	4,4'-DDT
Mcpa	Captafol
Mcpp	Captan
Merphos a	Kepone
Merphos B (Def)	Phosphamidon
Methoxychlor	Phosphoric Acid,trimethyl Ester
Methyl Chlorpyrifos	Phphoric Acid,tri-o-tolye Ester
Methyl Parathion	Phosphoric Triamide,hexamethyl
Methyl Trithion	TEPP
Mevinphos(phosdrin)	Trichlor Fon
Mirex	1,4-Naphthoquinone,2,3-dichloro
Monocrotophos	Dithiocarbamate Anion
Naled(dibrom)	
Nitrofen(tok)	
Parathion	
PCB-1016	
PCB-1221	
PCB-1232	

## APPENDIX C. ACRONYMS AND DEFINITIONS

**Administrator** - The Administrator of the U.S. Environmental Protection Agency.

**Agency** - The U.S. Environmental Protection Agency.

**Average monthly discharge limitation** - The highest allowable average of "daily discharges" over a calendar month, calculated as the sum of all "daily discharges" measured during the calendar month divided by the number of "daily discharges" measured during the month.

**BAT** - The best available technology economically achievable, as described in Sec. 304(b)(2) of the CWA.

**BCT** - The best conventional pollutant control technology, as described in Sec. 304(b)(4) of the CWA.

**BOD<sub>5</sub>** - Biochemical oxygen demand - Five Day. A measure of biochemical decomposition of organic matter in a water sample. It is determined by measuring the dissolved oxygen consumed by microorganisms to oxidize the organic contaminants in a water sample under standard laboratory conditions of five days and 70°C. BOD<sub>5</sub> is not related to the oxygen requirements in chemical combustion.

**BPT** - The best practicable control technology currently available, as described in Sec. 304(b)(1) of the CWA.

**Centralized waste treatment facility** - Any facility that treats any hazardous or non-hazardous industrial wastes received from off-site by tanker truck, trailer/roll-off bins, drums, barge, or other forms of shipment. A "centralized waste treatment facility" includes 1) a facility that treats waste received from off-site exclusively and 2) a facility that treats wastes generated on-site as well as waste received from off-site.

**Centralized waste treatment wastewater** - Water that comes in contact with wastes received from off-site for treatment or recovery or that comes in contact with the area in which the off-site wastes are received, stored or collected.

**Clarifier** - A treatment unit designed to remove suspended materials from wastewater--typically by sedimentation.

**COD** - Chemical oxygen demand. A bulk parameter that measures the oxygen-consuming capacity of refractory organic and inorganic matter present in water or wastewater. COD is expressed as the amount of oxygen consumed from a chemical oxidant in a specific test.

**Commercial facility** - Facilities that accept waste from off-site for treatment from facilities not under the same ownership as their facility.

## APPENDIX C. ACRONYMS AND DEFINITIONS (continued)

**Conventional pollutants** - The pollutants identified in Sec. 304(a)(4) of the CWA and the regulations thereunder (biochemical oxygen demand (BOD<sub>5</sub>), total suspended solids (TSS), oil and grease, fecal coliform, and pH).

**CWA** - Clean Water Act. The Federal Water Pollution Control Act Amendments of 1972 (33 U.S.C. 1251 et seq.), as amended, *inter alia*, by the Clean Water Act of 1977 (Public Law 95-217) and the Water Quality Act of 1987 (Public Law 100-4).

**CWT** - Centralized Waste Treatment

**Daily discharge** - The discharge of a pollutant measured during any calendar day or any 24-hour period that reasonably represents a calendar day.

**Direct discharger** - A facility that discharges or may discharge treated or untreated pollutants into waters of the United States.

**Effluent** - Wastewater discharges.

**Effluent limitation** - Any restriction, including schedules of compliance, established by a State or the Administrator on quantities, rates, and concentrations of chemical, physical, biological, and other constituents which are discharged from point sources into navigable waters, the waters of the contiguous zone, or the ocean. (CWA Sections 301(b) and 304(b).)

**EPA** - The U.S. Environmental Protection Agency.

**Facility** - A facility is all contiguous property owned, operated, leased or under the control of the same person. The contiguous property may be divided by public or private right-of-way.

**Fuel Blending** - The process of mixing organic waste for the purpose of generating a fuel for reuse.

**Indirect discharger** - A facility that discharges or may discharge pollutants into a publicly-owned treatment works.

**LTA** - Long-term average. For purposes of the effluent guidelines, average pollutant levels achieved over a period of time by a facility, subcategory, or technology option. LTAs were used in developing the limitations and standards in today's proposed regulation.

**Metal-bearing wastes** - Wastes that contain metal pollutants from manufacturing or processing facilities or other commercial operations. These wastes may include, but are not limited to, the following: process wastewater, process residuals such as tank bottoms or stills and process wastewater treatment residuals, such as treatment sludges.

**New Source** - "New source" is defined at 40 CFR 122.2 and 122.29.

## APPENDIX C. ACRONYMS AND DEFINITIONS (continued)

**Non-commercial facility** - Facilities that accept waste from off-site for treatment only from facilities under the same ownership as their facility.

**Non-conventional pollutants** - Pollutants that are neither conventional pollutants nor priority pollutants listed at 40 CFR Section 401.

**NPDES** - The National Pollutant Discharge Elimination System authorized under Sec. 402 of the CWA. NPDES requires permits for discharge of pollutants from any point source into waters of the United States.

**NSPS** - New Source Performance Standards.

**OCPSF** - Organic Chemicals, Plastics, and Synthetic Fibers Manufacturing Effluent Guideline.

**Off-Site** - "Off-site" means outside the boundaries of a facility.

**Oily Wastes** - Wastes that contain oil and grease from manufacturing or processing facilities or other commercial operations. These wastes may include, but are not limited to, the following: spent lubricants, cleaning fluids, process wastewater, process residuals such as tank bottoms or stills and process wastewater treatment residuals, such as treatment sludges.

**On-site** - "On-site" means within the boundaries of a facility.

**Organic-bearing Wastes** - Wastes that contain organic pollutants from manufacturing or processing facilities or other commercial operations. These wastes may include, but are not limited to, process wastewater, process residuals such as tank bottoms or stills and process wastewater treatment residuals, such as treatment sludges.

**Outfall** - The mouth of conduit drains and other conduits from which a facility effluent discharges into receiving waters.

**Pipeline** - "Pipeline" means an open or closed conduit used for the conveyance of material. A pipeline includes a channel, pipe, tube, trench or ditch.

**Point source category** - A category of sources of water pollutants.

**Pollutant (to water)** - Dredged spoil, solid waste, incinerator residue, filter backwash, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, certain radioactive materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt, and industrial, municipal, and agricultural waste discharged into water.

**POTW or POTWs** - Publicly-owned treatment works, as defined at 40 CFR 403.3(0).

**Pretreatment standard** - A regulation that establishes industrial wastewater effluent quality required for discharge to a POTW. (CWA Section 307(b).)

## APPENDIX C. ACRONYMS AND DEFINITIONS (continued)

**Priority pollutants** - The pollutants designated by EPA as priority in 40 CFR Part 423 Appendix A.

**Process wastewater** - "Process wastewater" is defined at 40 CFR 122.2.

**PSES** - Pretreatment standards for existing sources of indirect discharges, under Sec. 307(b) of the CWA.

**PSNS** - Pretreatment standards for new sources of indirect discharges, under Sec. 307(b) and (c) of the CWA.

**RCRA** - Resource Conservation and Recovery Act (PL 94-580) of 1976, as amended.

**SIC** - Standard Industrial Classification (SIC). A numerical categorization system used by the U.S. Department of Commerce to catalogue economic activity. SIC codes refer to the products, or group of products, produced or distributed, or to services rendered by an operating establishment. SIC codes are used to group establishments by the economic activities in which they are engaged. SIC codes often denote a facility's primary, secondary, tertiary, etc. economic activities.

**Solidification** - The addition of agents to convert liquid or semi-liquid hazardous waste to a solid before burial to reduce the leaching of the waste material and the possible migration of the waste or its constituent from the facility. The process is usually accompanied by stabilization.

**Stabilization** - A hazardous waste process that decreases the mobility of waste constituents by means other than solidification. Stabilization techniques include mixing the waste with sorbents such as fly ash to remove free liquids. For the purpose of this rule, chemical precipitation is not a technique for stabilization.

**TSS** - Total Suspended Solids. A measure of the amount of particulate matter that is suspended in a water sample. The measure is obtained by filtering a water sample of known volume. The particulate material retained on the filter is then dried and weighed.

**Variability factor** - The daily variability factor is the ratio of the estimated 99th percentile of the distribution of daily values divided by the expected value, median or mean, of the distribution of the daily data. The monthly variability factor is the estimated 95th percentile of the distribution of the monthly averages of the data divided by the expected value of the monthly averages.

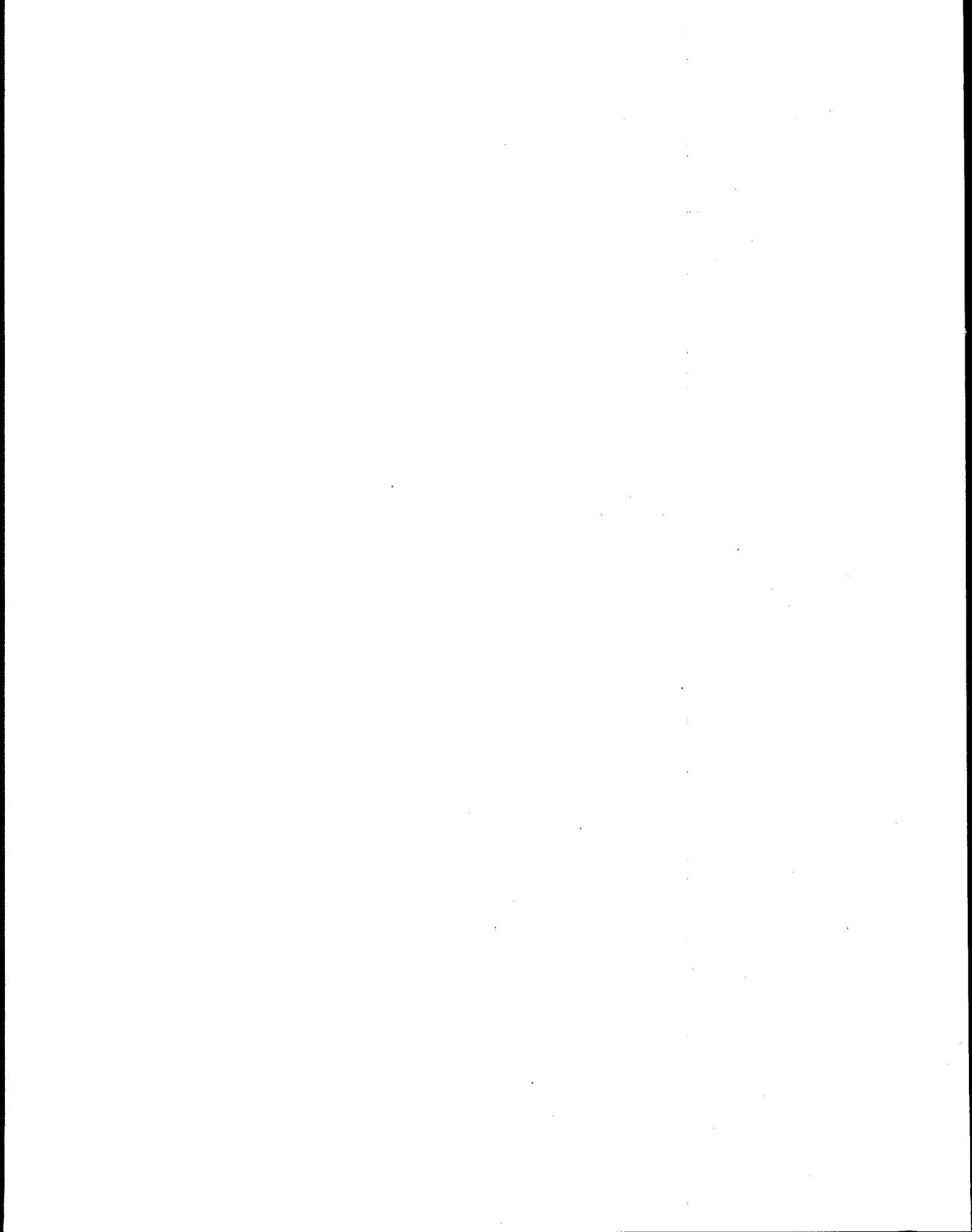
**Waste Receipt** - Wastes received for treatment or recovery.

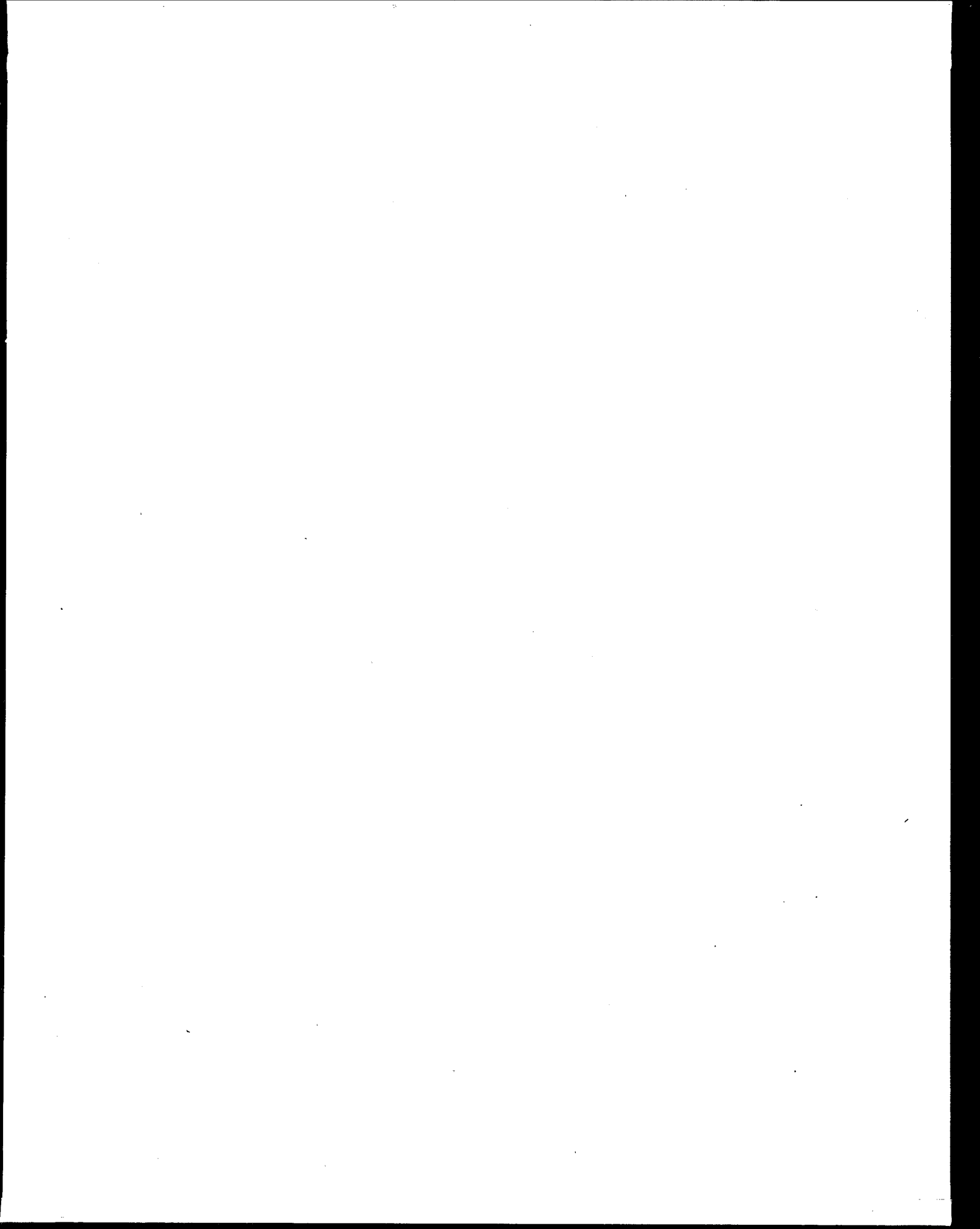
**Waters of the United States** - The same meaning set forth in 40 CFR 122.2.



## APPENDIX C. ACRONYMS AND DEFINITIONS (continued)

***Zero discharge*** - No discharge of pollutants to waters of the United States or to a POTW. Also included in this definition are discharge of pollutants by way of evaporation, deep-well injection, off-site transfer, and land application.





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