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Cost Effectiveness Analysis of Effluent Limitations Guidelines and Standards for the Centralized Waste Treatment Industry

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SECTION 1
INTRODUCTION

EPA has proposed effluent limitations guidelines and standards for the centralized waste treatment (CWT) industry. This report investigates the cost-effectiveness of all possible combinations of proposed control options for the three subcategories of CWT operations. EPA considered three control options for metals, two for oils and two for organics, with 12 possible combinations of these options. The report measures cost-effectiveness through a comparison of compliance costs to the quantity of pollutants removed under each combination of control options. The cost of the regulation is defined as the estimated nationally-aggregated annualized cost for the industry to comply with the regulation. The effectiveness of the regulation is measured in terms of reductions in the pounds of pollutants discharged to surface waters, weighted to account for the pollutants' toxicity. Some pollutants removed are specifically addressed by the regulation, while others are not directly regulated but are removed incidentally as a result of controlling for other pollutants.

This analysis measures the quantity of pollutants removed in standardized "pound-equivalents." A pound-equivalent (lb-eq) is a pound of pollutant weighted for its toxicity. Using pound-equivalents reflects the fact that some pollutants are more toxic than others and permits a comparison of removals and, thus, a summary measure of removals. To measure removals, the total number of pounds per year of each pollutant removed is multiplied by its corresponding toxic weighting factor. Only those toxic pollutants for which EPA has developed toxic weighting factors (TWFs) are included in this analysis. This means that the analysis will necessarily understate toxic removals for which EPA has not assigned TWFs. This cost-effectiveness analysis employs the TWF approach for weighting pollutants according to their relative toxicity. This approach has been used historically by the U.S. Environmental Protection Agency (EPA) for developing effluent guidelines. Some of the pollutants removed by the control options are specifically addressed by the regulation. Others would be incidentally removed from CWT facility discharges as a result of complying with the regulation, even though they are not specifically regulated under the proposed guidelines and standards. EPA's cost-effectiveness assessment does not analyze removal efficiencies for conventional pollutants, such as oil and grease, biological oxygen demand, and total suspended solids; thus the removal of conventional pollutants is not addressed in this report.

The cost-effectiveness (in dollars per pound-equivalent removed) of a treatment option can be computed by summing the costs of complying with the option across all affected dischargers and dividing this cost by the sum of the toxicity-weighted removals for these dischargers. The cost-effectiveness of the various combinations of options can then be compared to one another. One way to compare combinations of options is to look at the incremental cost-effectiveness, which measures changes in costs and removals that result from switching from one combination to another.

No absolute scale can be used to evaluate a cost-effectiveness value because cost-effectiveness is a relative measure. Comparisons of cost-effectiveness values are meaningful only when the costs being compared are taken from, or are adjusted to, the same time period. Cost-effectiveness is therefore expressed in 1981 dollars to facilitate comparisons. In addition, the removals must be estimated using a consistent toxic weighting approach. Generally, lower cost-effectiveness values are preferable to higher values, because they indicate lower average unit costs of removals. However, weighing the factors that the CWA requires EPA to consider in establishing limitations and standards may preclude choosing some regulatory options with low cost-effectiveness values.

Cost-effectiveness values are a useful tool for comparing the relative merits of regulatory options proposed at the same time, for the same group of dischargers in a specific industry. They also provide a limited basis for comparing the efficiency of a regulatory option currently being considered for one industry with the efficiencies of previously promulgated effluent limitations guidelines for other industries. Comparing across industries may be imperfect, however, because the TWFs that have been used in the past for effluent guidelines development have been modified for some pollutants.

Section 2 of this report discusses the methods used for this cost-effectiveness analysis. It details the pollutants included in calculations of pollutant removals, lists the TWFs used to estimate pound-equivalent removals, and describes the subcategory control options that are combined to create the 12 regulatory options. Section 2 also discusses the differences in how EPA measured removals for direct and indirect dischargers. (Indirect dischargers are facilities whose effluent receives treatment at a publicly owned treatment works [POTW] before it is discharged to surfaces waters.) In addition, Section 2 describes how EPA annualized compliance costs, calculated two different cost-effectiveness values, and may compare the merits of each regulatory option. Section 3 presents the findings of this cost-effectiveness analysis and identifies the options that are superior. Section 4 compares the cost-effectiveness of these options for the CWT industry to the cost-effectiveness of control options that have been proposed for other industries under other promulgated rules.

SECTION 2
BACKGROUND AND METHODOLOGY

As part of the process of setting effluent limitations guidelines and developing standards, EPA uses cost-effectiveness calculations to compare the efficiencies of regulatory options for removing pollutants. The Agency evaluates both overall cost-effectiveness and incremental cost-effectiveness. The overall cost-effectiveness of a control option is the ratio of the annualized cost of that control option to the quantity of pollutants not discharged to surface water because of that option. Incremental cost-effectiveness measures the difference in costs divided by the difference in removals that result from comparing one control option to another control option, or to a benchmark measure. (Cost Option A—Cost Option B)/(Removals Option A—Removals Option B). Examples of benchmarks include existing treatments and previously promulgated regulations. Although not required by the Clean Water Act (CWA), a cost-effectiveness analysis offers a useful metric for comparing the efficiency of alternative regulatory options in removing toxic pollutants. The analysis compares removals for pollutants either directly regulated by the guidelines and standards or are incidentally removed along with regulated pollutants. EPA's cost-effectiveness assessment does not analyze removal efficiencies for conventional pollutants, such as oil and grease, biological oxygen demand, and total suspended solids; thus the removal of conventional pollutants is not addressed in this report.

EPA's cost-effectiveness analysis includes seven steps:

1. Determine the pollutants of concern.

2. Estimate relative toxic weights for these pollutants.

3. Define pollution control options.

4. Calculate pollutant removals for each control option.

5. Determine the total annualized cost for each control option.

6. Calculate cost-effectiveness values (and adjust to 1981 dollars).

7. Compare cost-effectiveness values.

The following sections discuss these steps as they apply to the CWT industry.

2.1 POLLUTANTS OF CONCERN

In conducting the CE analysis for the CWT industry, EPA included 146 pollutants of concern. These pollutants include those regulated directly by the guidelines and standards, as well as selected non-regulated pollutants. The analysis includes non-regulated pollutants when they are removed incidentally as a result of a particular treatment technology, even though they are not specifically limited.

Section 6 of the Technical Development Document (TDD) details the pollutants of concern for each subcategory and Section 7 of the TDD discusses the pollutants that were selected for regulation. Generally, pollutants of concern were not included for the following reasons:

- the pollutant was not effectively treated by the option technology (the pollutant level increased across the technology)
- the pollutant was not detected at treatable levels in the influent streams at the facilities forming the basis for the options limitations and standards

- the pollutant is pervasive in the environment as a mineral and is relatively non-toxic (for example, calcium)

- the pollutant is often used as a treatment chemical, and

- the pollutant's TWF is zero.

Table 2-1 lists the pollutants that are considered in the CE analysis and presents their TWFs and POTW removal efficiencies.[1] All non-conventional pollutants (out of the 146 pollutants of concern) are listed for the sake of completeness, even if their TWF is zero.

2.2 RELATIVE TOXIC WEIGHTS OF POLLUTANTS

EPA's cost-effectiveness analyses account for differences in toxicity among pollutants of concern by using the TWFs as explained in Section 1. These weighting factors are necessary so that quantities of different pollutants, each with different potential effects on human and aquatic life, can be compared on a common basis.

The TWFs that EPA has traditionally used to develop effluent guidelines and standards are based on two values: the chronic aquatic life value and the human health value. The chronic aquatic life value indicates the concentration in water at which a pollutant has a toxic effect on aquatic life. It is measured in µg/L. The human health value, also measured in µg/L, indicates the concentration in water that would cause harm to humans eating at least 6.5 grams of fish per day from that water. (For carcinogenic substances, a harmful level is considered to be a concentration that would lead to more than 1 in 100,000 additional cancer cases over background.) This analysis standardizes these values by relating them to copper, a toxic metal pollutant that is commonly detected and removed from industrial effluent. EPA uses the value of 5.6 µg/L as the benchmark figure because at this concentration, copper

[1] POTW removal efficiencies are detailed in Section 7 of the TDD.

TABLE 2-1. POLLUTANTS OF CONCERN FOR CWT INDUSTRY AND TOXIC WEIGHTING FACTORS

Pollutant Type and CAS Number	Pollutant Name	TWF	POTW % REM
METALS			
7429905	Aluminum	0.0640	88.22
7440360	Antimony	0.1900	71.13
7440382	Arsenic	4.0000	90.89
7440393	Barium	0.0020	27.66
7440428	Boron	0.1770	20.04
7440439	Cadmium	5.2000	90.05
7440702	Calcium	0.0270	51.79
7440473	Chromium	0.0270	91.25
7440484	Cobalt	0.1100	6.11
7440508	Copper	0.4700	84.11
7553562	Iodine	0.0000	39.25
7439885	Iridium	0.000	74.00
7439896	Iron	0.0060	83.00
7439921	Lead	1.8000	91.83
7439932	Lithium	0.0120	26.00
7439954	Magnesium	0.0000	31.83
7439965	Manganese	0.0140	40.60
7439976	Mercury	500.0000	90.16
7439987	Molybdenum	0.2000	52.17
7440020	Nickel	0.0360	51.44
7723140	Phosphorus	0.0000	69.42
7440097	Potassium	0.0000	20.20
7782492	Selenium	1.1000	34.33
7440213	Silicon	0.0000	27.29
7440224	Silver	47.000	92.42
7440235	Sodium	0.0000	51.79

(continued)

TABLE 2-1. POLLUTANTS OF CONCERN FOR CWT INDUSTRY AND TOXIC WEIGHTING FACTORS (CONTINUED)

Pollutant Type and CAS Number	Pollutant Name	TWF	POTW % REM
METALS (continued)			
7440246	Strontium	0.0000	14.83
7704349	Sulfur	0.0000	14.33
7440280	Thallium	0.140	53.80
7440315	Tin	0.3000	65.20
7440326	Titanium	0.029	68.77
7440622	Vanadium	0.620	42.28
7440655	Yttrium	0.000	57.93
7440666	Zinc	0.0510	77.97
7440677	Zirconium	0.540	60.00
ORGANICS			
50328	Benzo(a)pyrene	4,300.0000	95.20
56235	Tetrachloromethane	0.1280	91.72
56553	Benzo(a)anthracene	24.00000	97.50
58902	2,3,4,6-tetrachlorophenol	0.0645	33.00
59507	4-chloro-3-methylphenol	0.00430	63.00
60297	Diethyl ether	0.0001	7.00
65850	Benzoic acid	0.00033	80.50
67641	2-propanone	0.0000	83.75
75014	Vinyl chloride	0.0013	93.49
75150	Carbon disulfide	2.80000	84.00
78933	2-butanone	0.0000	96.60
79005	1,1,2-trichloroethane	0.0140	74.79
83329	Acenapthene	0.25000	98.29
84662	Diethyl phthalate	0.00061	59.73
84742	di-n-butyl phthalate	0.01200	79.31
85018	Phenanthrene	19.00000	94.89
85687	Butyl benzyl phthalate	0.02300	94.33

(continued)

TABLE 2-1. POLLUTANTS OF CONCERN FOR CWT INDUSTRY AND TOXIC WEIGHTING FACTORS (CONTINUED)

Pollutant Type and CAS Number	Pollutant Name	TWF	POTW % REM
ORGANICS (continued)			
86737	Fluorene	0.70000	69.85
86748	Carbazole	0.27000	62.00
87865	Pentachlorophenol	0.4990	13.88
91203	Naphthalene	0.01500	94.69
91576	2-methylnaphthalene	0.01800	28.00
92524	Biphenyl	0.03700	96.28
95487	o-cresol	0.0033	52.50
95501	1,2-dichlorobenzene	0.01100	88.98
95954	2,4,5-trichlorophenol	0.0988	28.00
96184	1,2,3-trichloropropane	0.0020	5.00
98555	Alpha-terpinol	0.00100	94.40
98862	Acetophenone	0.0002	95.34
99876	p-cymene	0.04300	99.79
100414	Ethylbenzene	0.00140	93.76
100425	Styrene	0.01400	93.65
100516	Benzyl alcohol	0.00560	78.00
101848	Diphenyl ether	0.02600	97.80
105679	2,4-dimethylphenol	0.00530	51.22
106445	p-cresol	0.0024	71.67
106467	1,4-dichlorobenzene	0.07700	52.35
106934	1,2-dibromoethane	44.0000	17.00
107062	1,2-dichloroethane	0.0062	89.03
108101	4-methyl-2-pentanone	0.0001	87.87
108907	Chlorobenzene	0.00290	96.37
108952	Phenol	0.0280	95.25
110861	Pyridine	0.0013	95.40
112403	n-dodecane	0.00430	95.05

(continued)

TABLE 2-1. POLLUTANTS OF CONCERN FOR CWT INDUSTRY AND TOXIC WEIGHTING FACTORS (CONTINUED)

Pollutant Type and CAS Number	Pollutant Name	TWF	POTW % REM
ORGANICS (continued)			
112958	n-eicosane	0.00430	92.40
117817	Bis(2-ethylhexyl) phthalate	0.11000	59.78
117840	di-n-octyl phthalate	0.22000	68.99
120127	Anthracene	2.50000	95.56
120821	1,2,4-trichlorobenzene	0.08200	91.52
122394	Diphenylamine	0.02000	79.27
124185	n-decane	0.00430	9.00
129000	Pyrene	0.07500	83.90
132649	Dibenzofuran	0.02000	97.80
132650	Dibenzothiopene	0.04600	84.68
142621	Hexanoic acid	0.0003	84.00
156605	Trans-1,2-dichloroethene	0.0009	78.38
205992	Benzo(b)fluoranthene	1.60000	95.40
206440	Fluoranthene	0.92000	42.46
207089	Benzo(k)fluoranthene	0.75000	94.70
208968	Acenaphthylene	0.00840	98.72
218019	Chrysene	18.00000	96.90
243174	2,3-benzofluorene	0.22000	87.97
541731	1,3-dichlorobenzene	0.00950	88.89
544763	n-hexadecane	0.00430	71.11
608275	2,3-dichloroaniline	0.0108	41.00
612942	2-phenylnaphthalene	0.00000	87.97
629594	N-tetradecane	0.00430	71.11
629970	N-docosane	0.000082	88.00
630206	1,1,1,2-tetrachloroethane	0.0240	23.00
700129	Pentamethylbenzene	0.29000	91.87
832699	1-methylphenanthrene	0.14000	87.97
1576676	3,6-dimethylphenanthrene	0.47000	87.97

(continued)

TABLE 2-1. POLLUTANTS OF CONCERN FOR CWT INDUSTRY AND TOXIC WEIGHTING FACTORS (CONTINUED)

Pollutant Type and CAS Number	Pollutant Name	TWF	POTW % REM
ORGANICS (continued)			
1730376	1-methylfluorene	0.08900	87.97
20324338	Tripropyleneglycol methyl ether	0.0000082	52.40
136777612	o + p xylene	0.00850	95.07
593453	n-octadecane	0.00430	71.11
67663	Chloroform	0.0021	73.44
71432	Benzene	0.0180	94.76
71556	1,1,1-trichloro ethane	0.0043	90.45
75092	Methylene chloride	0.0004	54.28
75354	1,1-dichloroethene	0.1800	75.34
79016	Trichloroethene	0.0630	86.85
108383	m-xylene	0.0015	98.21
108883	Toluene	0.0056	96.18
127184	Tetrachloroethene	0.0740	84.61

becomes toxic. (This is the former water quality value for copper, which has been revised to 12 µg/L. The Agency still uses the former value, however, to allow comparisons with cost-effectiveness values for previously promulgated guidelines and limitations.) TWFs are calculated as follows:

$$TWF = 5.6/AQ + 5.6/HH$$

where

TWF = toxic weighting factor,

AQ = chronic aquatic life value (µg/L), and

HH = human health value (µg/L).

First, EPA estimated the ratio of the baseline value (5.6 µg/L) to the human health value for that pollutant. Then, EPA estimated the ratio of the baseline value (5.6 µg/L) to the aquatic life value for that pollutant. Finally, the analysis summed these two values.

Table 2-2 further illustrates the process for calculating each TWF. This table shows that because the water quality criterion for copper has been revised to 12.0 µg/L, the TWF for copper is 0.467 rather than 1, the weighting factor that one would normally expect for a benchmark pollutant. It also shows how high human health and aquatic figures lead to low TWFs. In other words, if a pollutant causes adverse effects only at high concentrations, then it will have a low TWF.

TABLE 2-2. TWFs BASED ON COPPER CRITERIA

Pollutant	Human Health Value (µg/L)	Chronic Aquatic Life Value (µg/L)	Calculation	Toxic Weighting Factor
Copper	–	12.0	5.6/12.0	0.467
Lead	–	3.2	5.6/3.2	1.750
Nickel	4,600	160.0	5.6/4,600 + 5.6/160	0.036
Cadmium	84	1.1	5.6/84 + 5.6/1.1	5.158
Benzene	710	530.0	5.6/710 + 5.6/530	0.018

Table 2-2 shows how 11.04 pounds of copper pose the same relative hazard in surface waters as one pound of cadmium, because cadmium has a TWF that is 11.04 times as large as the TWF for copper (5.158/0.467 = 11.04). Similarly, by the TWF method, 97.22 pounds of benzene present the same net risk as a single pound of lead, because the TWF for lead is 97.22 as large (1.75/0.018 = 97.22) as the TWF for benzene. By multiplying the reduction in industry loadings (lbs/yr) of each pollutant by each pollutant's corresponding copper-based

TWF and summing this product across all pollutants of concern, the Agency can derive the total TWF-weighted pollutant removals (lbs-equivalent/yr) attributable to each proposed regulatory option.

2.3 POLLUTION CONTROL OPTIONS

The proposed effluent limitations guidelines and standards for the CWT industry are intended to cover discharges generated during the treatment or recovery of hazardous and nonhazardous industrial waste received from off-site. The proposed effluent guidelines and standards were developed for three subcategories:

- metal-bearing waste treatment and recovery,
- oily waste treatment and recovery, and
- organic waste treatment and recovery.

A total of seven control options, each applicable to one of the three subcategories to be regulated, can be combined to present 12 possible regulatory options. Table 2-3 offers a brief description of each control option and identifies the subcategory to which it applies. Additional information on the control options can be found in Section 9 of the Agency's TDD. Each regulatory option combines one control option for each of the treatment subcategories. Thus, for example, ORG4MET3OIL8 combines Control Option 4 for the Organics subcategory, Control Option 3 for the Metals subcategory, and Control Option 8 for the Oils subcategory.

TABLE 2-3. DESCRIPTIONS OF THE INDIVIDUAL CWT CONTROL OPTIONS

Treatment Subcategory	Control Option Number	Control Option Name	Control Option Description
Metals	1	MET2	Selective metals precipitation, liquid-solid separation, secondary precipitation, and liquid-solid separation.
	2	MET3	Selective metals precipitation, liquid-solid separation, secondary precipitation, liquid-solid separation, tertiary separation, and clarification.
	3	MET4	Batch precipitation, liquid-solid separation, secondary precipitation, and sand filtration.
Oils	1	OIL8	Emulsion breaking/gravity separation and dissolved air flotation.
	2	OIL9	Emulsion breaking/gravity separation, secondary gravity separation, and dissolved air flotation.
Organics	1	ORG3	Equalization, air stripping with emissions control, and biological treatment.
	2	ORG4	Equalization and biological treatment.

2.4 CALCULATION OF POLLUTANT REMOVALS

The analysis calculated the reduction in pollutant loadings released by each CWT facility to receiving waters for each control option. These reductions are detailed in Section 12 of the TDD. These *at-stream* pollutant removals are equal to *end-of-pipe* (i.e., at the edge of the facility) pollutant removals for direct dischargers. For indirect dischargers, however, at-stream and end-of-pipe removals may differ because a portion of the end-of-pipe pollutant loadings for indirect dischargers may be removed by the POTW where the CWT facility's sewage receives some wastewater treatment before it is ultimately discharged to surface waters. Therefore, pollutant loadings discharged to surface water from an indirect discharging facility may be less than pollutant loadings leaving the facility. This analysis bases the comparison of removals across control options at the point of discharge into surface water. Thus, the analysis adjusts removals at indirect discharging facilities to account for pollutants removed by the POTW.

For example, if a facility is discharging 100 pounds of cadmium in its effluent stream to a POTW, and the POTW has a removal efficiency for cadmium of 90.05 percent, then 90.05 pounds of the cadmium discharged by the facility would be removed from the facility's effluent when the wastewater is initially treated at the POTW. The amount of cadmium that is ultimately discharged to surface waters would only amount to 9.05 pounds. If the indirect discharging facility then changes its waste treatment operations to comply with the regulation and thereby dramatically reduces the amount of cadmium in its end-of-pipe discharges to the sewer system, only a portion of these end-of-pipe pollutant discharge reductions qualify as at-stream pollutant removals. Thus, if an indirect discharger cut its baseline indirect discharges of cadmium from 100 pounds to 60 pounds, the net reduction in cadmium discharged to surface waters attributable to the regulation is not 40 percent of its baseline discharges to the sewer system (40 pounds), but rather 40 percent of the 9.95 pounds of the CWT facility's cadmium that are ultimately discharged to surface waters at baseline (3.98 pounds).

Table 2-4 presents two different estimates of the annual mass loading of at-stream pollutant removals anticipated from direct and indirect dischargers for each control option. At the top of the table, estimated total pollutant removals (lbs/yr) for each control option are presented for all non-conventional and priority pollutants of concern without weighting the individual pollutants removed according to their toxicity. The mass loading reductions presented in this part of the table include expected removals of the CWT pollutants of concern that have been excluded from the cost-effectiveness analysis because

TABLE 2-4. SUMMARY OF WEIGHTED AND UNWEIGHTED POLLUTANT REMOVALS FOR DIRECT AND INDIRECT DISCHARGERS

Weighting Method	Control Option Name	Total Removals by Direct Dischargers (lbs/yr)	Total Removals by Indirect Dischargers (lbs/yr)	Total Removals by All Dischargers (lbs/yr)
Unweighted				
	MET2	1,281,197	221,883	1,503,080
	MET3	1,409,327	245,276	1,654,603
	MET4	1,363,861	231,957	1,595,818
	OIL8	20,470	1,369,326	1,389,797
	OIL9	23,833	1,448,728	1,472,561
	ORG3	50,050	706,722	756,772
	ORG4	0	1,179,176	1,179,176
TWF				
	MET2	369,112	26,943	396,055
	MET3	379,571	27,480	407,051
	MET4	372,040	25,843	397,883
	OIL8	13,943	510,740	524,683
	OIL9	14,811	515,620	530,431
	ORG3	11,410	165,392	176,802
	ORG4	0	87,917	87,917

information about their relative toxicity is lacking or their TWF is zero. The lower section of the table presents the weighted mass loading reductions attributable to each control option. These values are based only on weighted removals of the pollutants for which TWFs have been estimated.

2.5 ANNUALIZED COST FOR EACH CONTROL OPTION

Section 8 of the TDD describes the methods used to estimate the costs of complying with the regulatory options. This section provides a brief summary of the compliance costs.

EPA evaluated four categories of compliance costs: capital costs (including RCRA permit-modification costs), land costs, operating and maintenance costs (including sludge disposal), and monitoring costs. While the operating and maintenance and monitoring costs are annual costs, the capital and land are one-time "lump-sum" costs. These lump-sum expenditures are too large for most CWT facilities to finance out of current revenues; they will probably be paid for by equity or debt financing. Therefore, EPA annualized these costs over the expected life of the capital equipment to better represent the annual cost of financing the lump-sum cost. EPA assumed the capital and land to have a productive life of 20 years. Therefore, the Agency annualized these lump-sum costs over a period of 20 years using company-specific interest rates (real weighted average cost of capital or RWACC). For facilities responding to the Agency's 1991 Waste Treatment Industry Questionnaire, the estimated RWACC reflects company-specific information provided. For facilities that did not provide this information, the Agency assumes an RWACC of 7 percent. It is important to note that the Agency gives indirect discharging facilities an extra 2 years to comply with the regulation, effectively lowering the costs of compliance for these facilities. Cost-effectiveness values are always presented using pre-tax costs. For more detail on the cost annualization, see Section 4 of the EA.

2.6 CALCULATION OF COST-EFFECTIVENESS VALUES

Typically, the cost-effectiveness value for a particular control option is the ratio of incremental annual cost of that option to the incremental pound-equivalents removed by that option. The incremental effectiveness can be viewed both in comparison to the baseline scenario and to another regulatory option. Cost-effectiveness values are reported in units of dollars per pound-equivalent of pollutant removed. For the purpose of comparing cost-effectiveness values of options under review to those of other promulgated rules, EPA adjusted compliance costs used in the cost-effectiveness analysis to 1981 dollars using *Engineering News Record's* Construction Cost Index (CCI). This adjustment factor is calculated as follows:

Adjustment factor = CCI 1981/CCI Current Year =

The equation used to calculate incremental cost-effectiveness is

$$CE_k = (TAC_k - TAC_{k-1})/(Pe_k - PE_{k-1})$$

where

CE_k = incremental cost-effectiveness of Option k,

TAC_k = total annualized cost of compliance under Option k, and

PE_k = pound-equivalents removed by Option k.

The numerator of the equation, TAC_k minus TAC_{k-1}, is simply the incremental annualized treatment cost in going from Option k-1 to Option k. The denominator is similarly the incremental removals achieved in going from Option k-1 to Option k. Thus, the incremental cost-effectiveness of Option k represents the unit cost of additional pound-equivalent removals (beyond what is achievable by Option k-1), assuming that the removals achievable by Option k-1 can be removed for the average unit cost of Option k-1. In other words, incremental cost-effectiveness values show how much more it would cost per incremental pound-equivalent of pollutant removed to raise the effluent guideline from one level of stringency to the next higher level of stringency.

The method of comparing average cost-effectiveness values of options to current treatment uses the same formula and sets the benchmark costs (TAC_{k-1}) equal to zero. For the total cost-effectiveness method, the benchmark pollutant removals (PE_{k-1}) are set equal to zero.

2.7 COMPARISONS OF COST-EFFECTIVENESS VALUES

Two types of comparisons are typically done using cost-effectiveness values. In addition to being presented in tabular form, the data are plotted with compliance costs on the y axis, and pollutant removals on the x axis to visually identify the efficient regulatory options. Alternatively, cost-effectiveness values are compared to other cost-effectiveness values that have been previously estimated for promulgated effluent limitations guidelines for other industries.

SECTION 3
COST-EFFECTIVENESS RESULTS

EPA performed the cost-effectiveness analyses on the seven individual regulatory options described in Table 2-3 and on the combined regulatory options. In each case, the cost-effectiveness of the regulatory options were analyzed separately for direct and indirect dischargers.

This section first presents the total costs, total removals, cost-effectiveness, and incremental cost-effectiveness values for each separate regulatory option, for each subcategory. Then it presents this information for the combined regulatory options and further examines the most efficient options.

3.1 COST-EFFECTIVENESS OF INDIVIDUAL CONTROL OPTIONS

Tables 3-1 and 3-2 present the total cost, total removals, cost-effectiveness, and incremental cost-effectiveness values associated with each individual control option for direct and indirect dischargers, respectively. Options are ordered, by subcategory, by pounds-equivalent removed. The tables present costs in $1997 (to facilitate comparison with other documents, particularly the EA) and in $1981 (to maintain comparability with previously promulgated effluent guidelines).

Calculating incremental cost-effectiveness values involves sorting the regulatory options in order of increasing removals. Incremental cost-effectiveness values are calculated

TABLE 3-1. COST-EFFECTIVENESS COMPARISON OF INDIVIDUAL CONTROL OPTIONS FOR DIRECT DISCHARGING CWT FACILITIES

Control Option Name	Costs ($1997)	Costs ($1981)	Removals (lbs-eq)	Cost-Effectiveness ($1981/lb-eq)	Incremental Cost-Effectiveness ($1981)
Individual Costs and Removals					
Metals 2	$13,701,757	$8,853,173	369,112	23.99	23.99
Metals 4	$2,852,818	$1,843,303	372,040	4.95	-$2394.08 [a]
Metals 3	$14,207,475	$9,179,935	379,571	24.18	$974.19
Oils 8	$485,230	$313,523	13,943	22.49	$22.49
Oils 9	$485,230	$313,523	14,811	21.17	0.00
Organics 4	$233,223	$150,694	—		
Organics 3	$425,723	$275,074	27,055	10.17	$10.17

[a] A negative cost-effectiveness indicates that the option has more removals for lower cost.

TABLE 3-2. COST-EFFECTIVENESS COMPARISON OF INDIVIDUAL CONTROL OPTIONS FOR INDIRECT DISCHARGING CWT FACILITIES

Control Option Name	Costs ($1997)	Costs ($1981)	Removals (lbs-eq)	Cost-Effectiveness ($1981/lb-eq)	Incremental Cost-Effectiveness ($1981)
Individual Costs and Removals					
Metals 4	$8,088,212	$5,226,070	25,843	$202.22	$202.22
Metals 2	$27,640,375	$17,859,390	26,943	$662.86	$11,484.84
Metals 3	$29,157,805	$18,839,854	27,480	$685.58	$1,825.82
Oils 8	$13,362,064	$8,633,686	510,740	$16.90	$16.90
Oils 9	$19,037,993	$12,301,098	514,398	$23.91	$725.50
Organics 4	$2,929,197	$1,892,654	87,917	$21.53	$21.53
Organics 3	$3,744,344	$2,419,348	165,392	$14.63	$6.80

by dividing the change in total annualized cost of compliance by the change in removals, as described in Section 2.6. Regulatory options that are cost-effective (superior) have the same removals at lower cost than other options or have higher removals at the same or lower cost than other options.

Table 3-1 shows that for direct dischargers Metals 4 has the lowest cost. For oils, both options have the same cost, but Oils 9 has slightly higher removals than Oils 8. There are no TWF-weighted removals for Organics 4 for direct dischargers. Table 3-2 shows that for indirect dischargers, Metals 4 also has the lowest cost. Oils 9 provides higher removals than Oils 8, but at higher cost. Organics 3 has higher removals than Organics 4, but also at higher cost.

3.2 COST-EFFECTIVENESS OF COMBINED REGULATORY OPTION

Cost-effectiveness values for individual control options alone do not provide enough information to guide the Agency in selecting an optimal regulatory option, because each proposed control option only applies to one of the three subsets of wastes treated in CWT operations covered by these guidelines. Three individual control options (one addressing each subcategory of waste managed in affected CWT operations) must be combined to create each regulatory option capable of meeting the Agency's regulatory responsibilities. Table 3-3 shows the combined cost-effectiveness results for the combined options for direct and indirect dischargers.

TABLE 3-3. COST-EFFECTIVENESS COMPARISON OF COMBINED REGULATORY OPTIONS FOR DISCHARGING CWTs BY DISCHARGE STATUS

Discharge Status	Regulatory Option	Total Costs Including RCRA ($1981)	Total TWF Removals (lb eq.)	Cost-Effectiveness ($/lb eq.)
Direct	Met 4 Oil 9 Org 4	$2,159,698	386,851	$5.58
Indirect	Met 4 Oil 8 Org 4	$14,734,637	624,500	$23.59

SECTION 4

COMPARISON OF THE COST-EFFECTIVENESS OF SELECTED CWT REGULATORY OPTIONS WITH THE COST-EFFECTIVENESS OF PREVIOUSLY APPROVED EFFLUENT GUIDELINES AND STANDARDS

Table 4-1 compares the estimated cost-effectiveness of each of the Agency's preferred regulatory alternatives for direct discharging CWT facilities to the cost-effectiveness of BAT regulations that have been approved for direct dischargers in other industries. Table 4-2 provides a similar comparision for indirect dischargers. This type of comparison is only possible using the cost-effectiveness values that are derived with pound-equivalent removals estimated using the TWF weighting approach. All costs are in 1981 dollars.

TABLE 4-1. INDUSTRY COMPARISON OF BAT COST-EFFECTIVENESS FOR DIRECT DISCHARGERS

Industry	Currently Discharged (10^3 lb. eq.)	Remaining at Selected Option(s) (10^3 lb. eq.)	Cost-Effectiveness of Selected Option(s) ($1981/lb. eq.)
Aluminum Forming	1,340	90	121
Battery Manufacturing	4,126	5	2
Canmaking	12	0.2	10
Coal Mining	BAT=BPT	BAT=BPT	BAT=BPT
Coil Coating	2,289	9	49
Copper Forming	70	8	27
Centralized Waste Treatment	435	48	6
Electronics I	9	3	404
Electronics II	NA	NA	NA
Foundries	2,308	39	84
Inorganic Chemicals I	32,503	1,290	<1
Inorganic Chemicals II	605	27	6
Iron and Steel	40,746	1,040	2
Leather Tanning	259	112	BAT=BPT
Metal Finishing	3,305	3,268	12
Nonferrous Metals Forming	34	2	69
Nonferrous Metals Manufacturing I	6,653	313	4
Nonferrous Metals Manufacturing II	1,004	12	6
Offshore Oil and Gas[b]	3,808	2,328	33
Organic Chemicals	54,225	9,735	5
Pesticides	2,461	371	15
Pharmaceuticals	208	4	1
Plastics Molding and Forming	44	41	BAT=BPT
Porcelain Enameling	1,086	63	6
Petroleum Refining	BAT=BPT	BAT=BPT	BAT=BPT
Pulp and Paper	61,713	2,628	39
Textile Mills	BAT=BPT	BAT=BPT	BAT=BPT

[a] TWFs for some priority pollutants have changed across these rules; this table reflects the cost-effectiveness at the time of regulation.

[b] Produced water only, for produced sand and drilling fluids and drill cuttings, BAT=NSPS.

TABLE 4-2. INDUSTRY COMPARISON OF PSES COST-EFFECTIVENESS FOR INDIRECT DISCHARGERS

Industry	Pollutants Currently Discharged (10^3 lb. eq.)	Pollutants Remaining at Selected Option (10^3 lb. eq.)	Cost-Effectiveness of Selected Option(s) ($1981/lb. eq.)
Aluminum Forming	1,602	18	155
Battery Manufacturing	1,152	5	15
Canmaking	252	5.0	38
Coal Mining	NA	NA	NA
Coil Coating	2,503	10	10
Copper Forming	34	4	10
Centralized Waste Treatment	760	135	24
Electronics I	75	35	14
Electronics II	260	24	14
Foundries	2,136	18	116
Inorganic Chemicals I	3,971	3,004	9
Inorganic Chemicals II	4,760	6	<1
Iron and Steel	5,599	1,404	6
Leather Tanning	16,830	1,899	111
Metal Finishing	11,680	755	10
Nonferrous Metals Forming	189	5	90
Nonferrous Metals Manufacturing I	3,187	19	15
Nonferrous Metals Manufacturing II	38	0	12
Offshore Oil and Gas[b]	NA	NA	NA
Organic Chemicals	5, 210	72	34
Pharmaceuticals	340	63	1
Plastics Molding and Forming	NA	NA	NA
Porcelain Enameling	1,565	96	14
Pulp and Paper	9,539	103	65

[a] TWFs for some priority pollutants have changed across these rules; this table reflects the cost effectiveness at the time of regulation.
[b] No known indirect dischargers at this time.

APPENDIX A

Results of Cost Effectiveness Analysis Using the Pollutant Weighting Factor (PWF) Method

Pollutant weighting factors (PWFs) provide an alternative method to toxic weighting factors (TWFs) for weighting pollutant removals. While TWFs are related to a benchmark pollutant, PWFs are derived from chronic aquatic life criteria or human health criteria established from the consumption of water and fish. For instance, for carcinogenic substances, the human health risk level is 10^{-6}, that is, protective to a level allowing 1 in 1,000,000 excess cancer cases over background. PWFs are calculated as follows:

$$PWF = 1/AQ, \text{ if } AG < HHWO$$

or

$$PWF = 1/HHWO, \text{ if } HHWO < AQ$$

where

PWF	=	pollutant weighting factor,
AQ	=	aquatic life chronic value (µg/L), and
HHWO	=	human health (ingesting water and organisms) value (µg/L).

In other words, the PWF is equal to the inverse of the most stringent level of the two criteria-weighted ratios.

For some pollutants the comparisons between TWFs and PWFs may yield drastically different results. For example, the PWF for benzene is more than 2.5 times greater than the PWF for lead. In the TWF method, 97.22 pounds of benzene were shown to be about as harmful as 1 pound of lead. One reason for this large discrepancy is that the PWF is ten times more stringent in its assessment of the health risk associated with carcinogenic contaminants. In addition, the PWF approach sets human health criteria based on the potential health effects of the pollutant's presence in drinking water as well as the effect of ingesting organisms that have been exposed to the pollutant. In contrast, the TWF method only considers the health effects of humans eating fish that have been chronically exposed to the pollutants.

Table A-1 summarizes the conceptual differences between the TWF and PWF approaches to weighting pollutants with respect to each pollutant's relative toxicity.

TABLE A-1. CONCEPTUAL DIFFERENCES BETWEEN TWFS AND PWFS

Feature	Standard TWF	Alternative PWF
Benchmark value (numerator)	5.6 (former freshwater chronic criterion for copper)	1
Carginogenic risk level	10^{-5} (1 in 100,000 excess cancer cases)	10^{-6} (1 in 100,000 excess cancer cases)
Human health exposure	Fish consumption only	Drinking water and fish consumption
Aquatic life effects vs. human health effects	TWFs are added	More stringent PWF is used

This appendix presents a second cost-effectiveness analysis of the seven control options as well as the regulatory options. The only difference between this appendix and the previous analysis presented in Chapters 2 and 3 is that the analysis in this appendix uses PWF pound-equivalent removals to measure the effectiveness of different control and regulatory options; the previous analysis uses the traditional TWF approach.

Table A-2 is a list of the PWFs that were used to conduct the analysis.

TABLE A-2. PWFS USED TO CONDUCT THE ANALYSIS

Pollutant Type	CAS Number	Pollutant Name	PWF	POTW % Remaining
Metals				
	7429905	Aluminum	1.1×10^{-2}	88.22
	7440360	Antimony	7.2×10^{-2}	71.13
	7440382	Arsenic	$5.7 \times 10^{+1}$	90.89
	7440393	Barium	1.0×10^{-3}	27.66
	7440428	Boron	3.2×10^{-2}	20.04
	7440439	Cadmium	9.1×10^{-1}	90.05
	7440702	Calcium	$0.0 \times 10^{+1}$	51.79
	7440473	Chromium	4.8×10^{-3}	91.25
	7440484	Cobalt	2.0×10^{-2}	6.11
	7440508	Copper	8.3×10^{-2}	84.11
	7553562	Iodine	$0.0 \times 10^{+0}$	39.25
	7439885	Iridium	$0.0 \times 10^{+0}$	74.00
	7439896	Iron	1.0×10^{-3}	83.00
	7439921	Lead	3.1×10^{-1}	91.83
	7439932	Lithium	2.2×10^{-3}	26.00
	7439954	Magnesium	$0.0 \times 10^{+0}$	31.83
	7439965	Manganese	1.0×10^{-2}	40.60
	7439976	Mercury	$8.3 \times 10^{+1}$	90.16
	7439987	Molybdenum	3.6×10^{-2}	52.17
	7440020	Nickel	6.3×10^{-3}	51.11
	7723140	Phosphorus	$0.0 \times 10^{+0}$	69.42
	7440097	Potassium	$0.0 \times 10^{+0}$	20.20
	7782492	Selenium	2.0×10^{-1}	34.33
	7440213	Silicon	$0.0 \times 10^{+0}$	27.29

(continued)

TABLE A-2. PWFS USED TO CONDUCT THE ANALYSIS (CONTINUED)

Pollutant Type	CAS Number	Pollutant Name	PWF	POTW % Remaining
Metals (continued)	7440224	Silver	$8.3 \times 10^{+0}$	92.42
	7440235	Sodium	$0.0 \times 10^{+0}$	51.79
	7440246	Strontium	$0.0 \times 10^{+0}$	14.83
	7704349	Sulfur	$0.0 \times 10^{+0}$	14.33
	7440280	Thallium	2.5×10^{-2}	53.80
	7440315	Tin	5.4×10^{-2}	65.20
	7440326	Titanium	5.2×10^{-3}	68.77
	7440622	Vanadium	1.1×10^{-1}	42.28
	7440655	Yttrium	$0.0 \times 10^{+0}$	57.93
	7440666	Zinc	9.1×10^{-3}	77.97
	7440677	Zirconium	9.7×10^{-2}	55.89
Organics				
	50328	Benzo(a)pyrene	7.7×10^{-3}	95.20
	56235	Tetrachloromethane	$3.9 \times 10^{+0}$	91.72
	56553	Benzo(a)anthracene	$3.6 \times 10^{+1}$	97.50
	58902	2,3,4,6-tetrachlorophenol	1.1×10^{-2}	33.00
	59507	4-chloro-3-methylphenol	7.7×10^{-4}	63.00
	60297	Diethyl ether	1.4×10^{-4}	7.00
	65850	Benzoic acid	5.8×10^{-5}	80.50
	67641	2-propanone	2.9×10^{-4}	83.75
	75014	Vinyl chloride	5.0×10^{-2}	93.49
	75150	Carbon disulfide	5.0×10^{-1}	84.00
	78933	2-butanone	4.8×10^{-5}	96.60
	79005	1,1,2-trichloroethane	$1.7 \times 10^{+0}$	74.79
	83329	Acenapthene	4.3×10^{-2}	98.29

(continued)

TABLE A-2. PWFS USED TO CONDUCT THE ANALYSIS (CONTINUED)

Pollutant Type	CAS Number	Pollutant Name	PWF	POTW % Remaining
Organics (continued)	84662	Diethyl phthalate	1.0×10^{-4}	59.73
	84742	di-n-butyl phthalate	2.0×10^{-3}	79.31
	85018	Phenanthrene	$3.6 \times 10^{+1}$	94.89
	85687	Butyl benzyl phthalate	3.8×10^{-3}	94.33
	86737	Fluorene	1.3×10^{-1}	69.85
	86748	Carbazole	$1.0 \times 10^{+0}$	84.68
	87865	Pentachlorophenol	$3.6 \times 10^{+0}$	13.88
	91203	Naphthalene	2.7×10^{-3}	94.69
	91576	2-methylnaphthalene	3.2×10^{-3}	28.00
	92524	Biphenyl	5.9×10^{-3}	96.28
	95487	o-cresol	6.0×10^{-4}	52.50
	95501	1,2-dichlorobenzene	1.8×10^{-3}	88.98
	95954	2,4,5-trichlorophenol	1.6×10^{-2}	28.00
	96184	1,2,3-trichloropropane	5.1×10^{-3}	5.00
	98555	Alpha-terpinol	1.8×10^{-4}	94.40
	98862	Acetophenone	3.0×10^{-4}	95.34
	99876	p-cymene	7.7×10^{-3}	99.79
	100414	Ethylbenzene	3.2×10^{-4}	93.76
	100425	Styrene	2.5×10^{-3}	93.65
	100516	Benzyl alcohol	1.0×10^{-3}	78.00
	101848	Diphenyl ether	4.7×10^{-3}	97.80
	105679	2,4-dimethylphenol	1.9×10^{-3}	51.22
	106445	p-cresol	6.0×10^{-4}	71.67
	106467	1,4-dichlorobenzene	8.1×10^{-1}	52.35
	106934	1,2-dibromoethane	$2.5 \times 10^{+3}$	17.00

(continued)

TABLE A-2. PWFS USED TO CONDUCT THE ANALYSIS (CONTINUED)

Pollutant Type	CAS Number	Pollutant Name	PWF	POTW % Remaining
Organics (continued)	107062	1,2-dichloroethane	$2.6 \times 10^{+0}$	89.03
	108101	4-methyl-2-pentanone	3.6×10^{-4}	87.87
	108907	Chlorobenzene	1.5×10^{-3}	96.37
	108952	Phenol	5.0×10^{-3}	95.25
	110861	Pyridine	2.9×10^{-2}	95.40
	112403	n-dodecane	7.7×10^{-4}	95.05
	112958	n-eicosane	7.7×10^{-4}	92.40
	117817	bis(2-ethylhexyl) phthalate	5.7×10^{-1}	59.78
	117840	di-n-octyl phthalate	2.7×10^{-2}	68.99
	120127	Anthracene	4.5×10^{-1}	95.56
	120821	1,2,4-trichlorobenzene	1.4×10^{-2}	91.52
	122394	Diphenylamine	2.6×10^{-3}	79.27
	124185	n-decane	7.7×10^{-4}	9.00
	129000	Pyrene	9.9×10^{-3}	83.90
	132649	Dibenzofuran	3.6×10^{-3}	97.80
	132650	Dibenzothiopene	8.2×10^{-3}	84.68
	142621	Hexanoic acid	6.1×10^{-5}	84.00
	156605	Trans-1,2-dichloroethene	1.4×10^{-3}	78.38
	205992	Benzo(b)fluoranthene	$3.2 \times 10^{+1}$	95.40
	206440	Fluoranthene	1.6×10^{-1}	42.46
	207089	Benzo(k)fluoranthene	$1.5 \times 10^{+1}$	94.70
	208968	Acenaphthylene	1.5×10^{-3}	98.72
	218019	Chrysene	$3.6 \times 10^{+1}$	96.90
	243174	2,3-benzofluorene	3.8×10^{-2}	87.97
	541731	1,3-dichlorobenzene	2.5×10^{-3}	88.89

(continued)

TABLE A-2. PWFS USED TO CONDUCT THE ANALYSIS (CONTINUED)

Pollutant Type	CAS Number	Pollutant Name	PWF	POTW % Remaining
Organics (continued)	544763	n-hexadecane	7.7×10^{-4}	71.11
	608275	2,3-dichloroaniline	1.9×10^{-3}	41.00
	612942	2-phenylnaphthalene	$0.0 \times 10^{+0}$	87.97
	629594	n-tetradecane	7.7×10^{-4}	71.11
	629970	n-docosane	1.5×10^{-5}	88.00
	630206	1,1,1,2-tetrachloroethane	7.8×10^{-1}	23.00
	700129	Pentamethylbenzene	5.3×10^{-2}	91.87
	832699	1-methylphenanthrene	2.5×10^{-2}	87.97
	1576676	3,6-dimethylphenanthrene	8.3×10^{-2}	87.97
	1730376	1-methylfluorene	1.6×10^{-2}	87.97
	20324338	Tripropyleneglycol methyl ether	1.5×10^{-6}	52.40
	136777612	o+p xylene	1.5×10^{-3}	95.07
	593453	n-octadecane	7.7×10^{-4}	71.11
	67663	Chloroform	1.8×10^{-1}	73.44
	71432	Benzene	8.4×10^{-1}	94.76
	71556	1,1,1-trichloro ethane	7.7×10^{-4}	90.45
	75092	Methylene chloride	2.1×10^{-1}	54.28
	75354	1,1-dichloroethene	$1.7 \times 10^{+1}$	75.34
	79016	Trichloroethene	3.7×10^{-2}	86.85
	108383	m-xylene	2.6×10^{-4}	98.21
	108883	Toluene	1.0×10^{-3}	96.18
	127184	Tetrachloroethene	1.3×10^{-1}	84.61

Tables A-3 and A-4 present the PWF-weighted pound-equivalent removals achievable by each individual control option for direct dischargers and indirect dischargers, respectively. While the order of increasing removals of the individual organic and oil removal options remain consistent with the TWF analysis, the metals do not. Furthermore, unlike in the TWF analysis, the metals options ranked by increasing removals for direct and indirect dischargers are inconsistent with each other.

TABLE A-3. PWF COST-EFFECTIVENESS COMPARISON OF INDIVIDUAL CONTROL OPTIONS FOR DIRECT DISCHARGING CWT FACILITIES

Control Option Name	Costs ($1997)	Costs ($1981)	Removals (lbs)	Cost-Effectiveness ($1981/lb)	Incremental Cost-Effectiveness ($1981)
Individual Costs and Removals					
Metals 4	$2,817,201	$1,820,290	65,917.00	$27.61	$27.61
Metals 3	$14,171,859	$9,156,922	98,883.00	$92.60	$222.55
Metals 2	$13,666,141	$8,830,161	99,505.00	$88.74	-$525.34
Oils 8	$480,417	$310,414	21,359.00	$14.53	$14.53
Oils 9	$480,417	$310,414	22,898.00	$13.56	$0.00
Organics 4	$221,942	$143,404	—	—	—
Organics 3	$414,441	$267,784	38,036.00	$7.04	$3.27

Table A-5 shows the PWF cost-effectiveness for each of the control options for direct and indirect discharging CWT facilities, respectively.

TABLE A-4. PWF COST-EFFECTIVENESS COMPARISON OF INDIVIDUAL CONTROL OPTIONS FOR INDIRECT DISCHARGING CWT FACILITIES

Control Option Name	Costs ($1997)	Costs ($1981)	Removals (lbs)	Cost-Effectiveness ($1981/lb)	Incremental Cost-Effectiveness ($1981)
Individual Costs and Removals					
Metals 3	$29,010,557	$18,744,712	4,538.00	$4,130.61	$4,130.61
Metals 4	$7,940,964	$5,130,928	4,831.00	$1,062.08	-$46,463.43
Metals 2	$27,493,127	$17,764,249	6,496.00	$2,734.64	$7,587.58
Oils 8	$13,196,850	$8,526,936	923,846.00	$9.23	$9.23
Oils 9	$18,872,780	$12,194,348	930,743.00	$13.10	$531.74
Organics 4	$2,881,108	$1,861,582	4,875,645.00	$0.38	$0.38
Organics 3	$3,696,255	$2,388,277	4,921,690.00	$0.49	$11.44

TABLE A-5. PWF COST-EFFECTIVENESS COMPARISON Of COMBINED REGULATORY OPTIONS FOR DISCHARGING CWTs BY DISCHARGE STATUS

Discharge Status	Regulatory Option	Total Costs Including RCRA ($1981)	Total PWF Removals (lb eq.)	Cost-Effectiveness ($/lb eq.)
Direct	**Met4Oil9Org4**	**$2,159,699**	**88,815**	**$24.32**
Indirect	**Met4Oil8Org4**	**$14,734,638**	**5,804,322**	**$2.54**

APPENDIX B

Detailed Pollutant Loadings and Removals Data

The following tables give detailed information concerning loadings and removals of pollutants. Tables B-1 through B-4 provide a summary of the pollutant loadings and removals for the CWT metals, oils, organics, and the entire industry, respectively. Table B-5 provides the pound-equivalent removals for the considered options. Some of the removals numbers changed after these tables were prepared, as a result some of the totals given in Table B-5 do not exactly match those provided in Sections 2 and 3. The primary difference relates to changes made to a few long-term averages for the oils and metals subcategories. For a small number of pollutants, slight changes to the long-term averages were made which are not incorporated into the results listed in this appendix. The overall effect on pound-equivalent removals for the oils subcategory is less than two percent and the overall effect for the metals subcategory is smaller still. The results presented in this appendix will be updated to match the corrected results presented in Sections 2 and 3 before promulgation of the rule.

Table B-1. Summary of Pollutant Loadings and Removals for the CWT **Metals Subcategory**[1]

Pollutant of Concern	Current Wastewater Pollutant Loading (lbs/yr)		Post-Compliance Wastewater Pollutant Loading (lbs/yr)		Post-Compliance Pollutant Reductions (lbs/yr)		Post-Compliance Wastewater Pound-Equivalent Removals (lb-eq/yr)	
	Direct Discharges	**Indirect Discharges**	**Direct Discharges**	**Indirect Discharges**	**Direct Discharges**	**Indirect Discharges**	**Direct Discharges**	**Indirect Discharges**
CONVENTIONALS								
Biochemical Oxygen Demand 5-Day (BOD_5)	8,366,557	N/A	570,816	N/A	7,795,741	N/A	N/A	N/A
Oil and Grease (measured as HEM)	519,480	N/A	74,445	N/A	445,035	N/A	N/A	N/A
Total Suspended Solids (TSS)	6,109,653	N/A	64,680	N/A	6,044,973	N/A	N/A	N/A
PRIORITY METALS								
Antimony	34,215	7,504	608	184	33,607	7,320	6,385	1,391
Arsenic	676	37	301	29	375	8	1,502	33
Cadmium	5,380	16	125	9	5,255	7	27,328	35
Chromium	140,366	289	1,727	147	138,639	142	3,702	4
Copper	205,011	669	1,811	278	203,200	391	95,504	184
Lead	26,012	139	441	36	25,571	103	46,027	186
Mercury	164	16	4	1	160	15	79,961	7,735
Nickel	52,686	5,024	3,917	1,945	48,769	3,079	1,765	111
Selenium	1,838	1,226	1,346	854	492	372	541	409
Silver	421	24	80	6	341	18	16,025	856
Thallium	347	82	347	82	0	0	0	0
Zinc	127,400	3,359	1,605	347	125,795	3,012	6,416	154
TOTAL PRIORITYMETALS	**594,516**	**18,385**	**12,312**	**3,918**	**582,204**	**14,467**	**285,156**	**11,098**
NON-CONVENTIONAL METALS								
Aluminum	82,842	3,455	3,042	377	79,800	3,078	5,139	198
Barium	308	64	308	64	0	0	0	0
Boron	168,406	92,315	34,766	25,153	133,640	67,162	23,654	11,888
Cobalt	3,865	885	435	401	3,430	484	377	53
Iridium	17,288	3,122	3,499	953	13,789	2,169	0	0

Pollutant of Concern	Current Wastewater Pollutant Loading (lbs/yr)		Post-Compliance Wastewater Pollutant Loading (lbs/yr)		Post-Compliance Pollutant Reductions (lbs/yr)		Post-Compliance Wastewater Pound-Equivalent Removals (lb-eq/yr)	
	Direct Discharges	Indirect Discharges	Direct Discharges	Indirect Discharges	Direct Discharges	Indirect Discharges	Direct Discharges	Indirect Discharges
Iron	114,752	9,248	24,042	4,329	90,710	4,919	508	28
Lithium	146,215	125,992	5,884	5,056	140,331	120,936	1,684	1,451
Manganese	5,645	1,007	175	107	5,470	900	77	13
Molybdenum	16,864	5,863	6,445	3,126	10,419	2,737	2,084	547
Silicon	41,066	6,810	5,100	3,876	35,966	2,934	0	0
Strontium	10,831	10,106	350	319	10,481	9,787	0	0
Tin	159,531	1,856	330	116	159,201	1,740	47,760	522
Titanium	93,683	586	188	64	93,495	522	2,739	15
Vanadium	4,686	119	150	81	4,536	38	2,812	24
Yttrium	122	43	21	8	101	35	0	0
Zirconium	857	223	835	223	22	0	12	0
TOTAL NON-CONVENTIONAL METALS	**866,961**	**261,694**	**85,570**	**44,253**	**781,391**	**217,441**	**86,846**	**14,739**
CLASSICAL PARAMETERS								
Chemical Oxygen Demand (COD)	32,170,276	N/A	4,733,770	N/A	27,436,506	N/A	N/A	N/A
Hexavalent Chromium	235,527	15,106	2,431	2,660	233,096	12,446	N/A	N/A
Ammonia as N	411,874	N/A	60,506	N/A	351,368	N/A	N/A	N/A
Cyanide	5,295	1,046	304	96	4,991	950		

[1]All loadings and reductions take into account the removals by POTWs for indirect discharges.

HEM - Hexane extractable material

Table B-2. Summary of Pollutant Loadings and Removals for the CWT **Oils Subcategory**[1]

Pollutant of Concern	Current Wastewater Pollutant Loading (lbs/yr)		Post-Compliance Wastewater Pollutant Loading (lbs/yr)		Post-Compliance Pollutant Reductions (lbs/yr)		Post-Compliance Pollutant Pound-Equivalent Removals (lb-eq/yr)	
	Direct Discharges	**Indirect Discharges**	**Direct Discharges**	**Indirect Discharges**	**Direct Discharges**	**Indirect Discharges**	**Direct Discharges**	**Indirect Discharges**
CONVENTIONALS								
Biochemical Oxygen Demand 5-Day (BOD_5)	1,099,760	N/A	845,531	N/A	254,229	N/A	N/A	N/A
Oil and Grease (measured as HEM)	324,206	N/A	4,840	N/A	319,366	N/A	N/A	N/A
Total Suspended Solids (TSS)	291,300	N/A	4,214	N/A	287,086	N/A	N/A	N/A
PRIORITY ORGANICS								
1,1,1-Trichloroethane	38	808	13	71	25	737	0	3
1,2,4-Trichlorobenzene	12	723	10	56	2	667	0	55
1,4-Dichlorobenzene	8	1,012	7	230	1	782	0	60
1,1-Dichloroethene	4	185	4	112	0	73	0	13
1,2-Dichloroethane	3	66	3	61	0	5	0	0
2,4-Dimethylphenol	19	1,088	19	1,088	0	0	0	0
Acenapthene	10	80	10	13	0	67	0	17
Anthracene	14	242	12	42	2	200	5	500
Benzene	166	562	84	117	82	445	2	8
Benzo(a)anthracene	11	60	9	15	2	45	39	1,073
Benzo(a)pyrene	9	123	6	19	3	104	11,786	448,031
Benzo(b)fluoranthene	8	100	6	18	2	82	3	131
Benzo(k)fluoranthene	8	122	5	20	3	102	2	77
Bis(2-ethylhexyl) Phthalate	24	126,764	7	287	17	126,477	2	13,912
Butyl Benzyl Phthalate	13	576	4	18	9	558	0	13
Chlorobenzene	2	14	2	11	0	3	0	0
Chloroform	5	396	5	303	0	93	0	0
Chrysene	15	102	8	16	7	86	128	1,545
Diethyl Phthalate	13	1,902	13	1,304	0	598	0	0
Di-*n*-butyl Phthalate	3	171	3	62	0	109	0	1
Ethylbenzene	129	794	36	107	93	687	0	1
Fluoranthene	12	4,514	2	812	10	3,702	9	3,405

Table B-2. Summary of Pollutant Loadings and Removals for the CWT **Oils Subcategory**[1]

Pollutant of Concern	**Current Wastewater Pollutant Loading (lbs/yr)**		**Post-Compliance Wastewater Pollutant Loading (lbs/yr)**		**Post-Compliance Pollutant Reductions (lbs/yr)**		**Post-Compliance Pollutant Pound-Equivalent Removals (lb-eq/yr)**	
	Direct Discharges	**Indirect Discharges**	**Direct Discharges**	**Indirect Discharges**	**Direct Discharges**	**Indirect Discharges**	**Direct Discharges**	**Indirect Discharges**
Fluorene	10	1,459	10	348	0	1,111	0	777
Methylene Chloride	26	3,616	26	3,353	0	263	0	0
Naphthalene	52	2,319	39	328	13	1,991	0	30
Phenanthrene	50	933	13	196	37	737	694	14,001
Phenol	393	2,020	393	1,598	0	422	0	0
Pyrene	35	1,309	10	135	25	1,174	2	88
Tetrachloroethene	11	823	11	303	0	520	0	38
Toluene	677	2,122	314	574	363	1,548	2	9
Trichloroethene	7	308	7	179	0	129	0	8
TOTAL PRIORITY ORGANICS	**1,787**	**155,313**	**1,091**	**11,796**	**696**	**143,517**	**12,675**	**483,795**
NON-CONVENTIONAL ORGANICS								
1-Methylfluorene	12	384	5	48	7	336	1	30
1-Methylphenanthrene	29	592	8	76	21	516	3	72
2,3-Benzofluorene	14	236	9	236	5	0	1	0
2-Butanone	392	1,508	392	1,144	0	364	0	0
2-Methylnaphthalene	45	13,986	26	5,581	19	8,405	0	151
2-Phenylnaphthalene	4	90	2	90	2	0	0	0
2-Propanone	4,313	62,551	4,313	62,551	0	0	0	0
3,6-Dimethylphenanthrene	14	236	8	236	6	0	3	0
4-Chloro-3-methylphenol	207	18,504	61	18,504	146	0	1	0
4-Methyl-2-pentanone	51	2,158	51	1,894	0	264	0	0
∝-Terpineol	8	196	4	17	4	179	0	0
Benzoic Acid	875	18,858	875	13,631	0	5,227	0	1
Benzyl Alcohol	8	287	8	287	0	0	0	0
Biphenyl	37	189	20	19	17	170	1	6
Carbazole	5	209	5	109	0	100	0	27
Carbon Disulfide	5	141	4	26	1	115	4	321
Dibenzofuran	10	101	10	14	0	87	0	2

Table B-2. Summary of Pollutant Loadings and Removals for the CWT **Oils Subcategory**[1]

Pollutant of Concern	Current Wastewater Pollutant Loading (lbs/yr)		Post-Compliance Wastewater Pollutant Loading (lbs/yr)		Post-Compliance Pollutant Reductions (lbs/yr)		Post-Compliance Pollutant Pound-Equivalent Removals (lb-eq/yr)	
	Direct Discharges	Indirect Discharges	Direct Discharges	Indirect Discharges	Direct Discharges	Indirect Discharges	Direct Discharges	Indirect Discharges
Dibenzothiopene	16	414	10	90	6	324	0	15
Diphenyl Ether	105	201	94	201	11	0	0	0
Hexanoic Acid	488	6,880	488	4,271	0	2,609	0	1
m-Xylene	206	332	83	116	123	216	0	0
n-Decane	675	283,150	39	11,910	636	271,240	3	1,166
n-Docosane	24	616	3	60	21	556	0	0
n-Dodecane	479	12,720	39	1,173	440	11,547	2	50
n-Eicosane	207	10,863	8	295	199	10,568	1	45
n-Hexadecane	992	178,720	418	2,645	574	176,075	2	757
n-Octadecane	143	108,045	33	1,478	110	106,567	0	458
n-Tetradecane	1,303	324,806	373	3,374	930	321,432	4	1,382
o-Cresol	32	1,872	32	1,872	0	0	0	0
o-&*p*-Xylene	100	649	100	359	0	290	0	2
p-Cresol	28	1,301	28	1,046	0	255	0	1
p-Cymene	8	5	4	1	4	4	0	0
Pentamethylbenzene	29	422	4	24	25	398	7	115
Pyridine	4	57	4	57	0	0	0	0
Styrene	4	67	4	20	0	47	0	1
Tripropyleneglycol Methyl Ether	1,370	62,292	79	1,484	1,291	60,808	0	0
TOTAL NON-CONVENTIONAL ORGANICS	**12,242**	**1,113,638**	**7,644**	**134,939**	**4,598**	**978,699**	**33**	**4,606**
PRIORITY METALS								
Antimony	13	203	13	128	0	75	0	14
Arsenic	15	299	15	155	0	144	0	574
Cadmium	16	52	1	4	15	48	76	248
Chromium	113	633	18	86	95	547	3	15
Copper	1,022	6,240	18	161	1,004	6,079	472	2,857
Lead	684	1,420	16	52	668	1,368	1,202	2,463

Table B-2. Summary of Pollutant Loadings and Removals for the CWT **Oils Subcategory**[1]

Pollutant of Concern	Current Wastewater Pollutant Loading (lbs/yr)		Post-Compliance Wastewater Pollutant Loading (lbs/yr)		Post-Compliance Pollutant Reductions (lbs/yr)		Post-Compliance Pollutant Pound-Equivalent Removals (lb-eq/yr)	
	Direct Discharges	Indirect Discharges	Direct Discharges	Indirect Discharges	Direct Discharges	Indirect Discharges	Direct Discharges	Indirect Discharges
Mercury	0	2	0	1	0	1	0	631
Nickel	3,405	15,625	133	2,927	3,272	12,698	118	460
Selenium	3	259	3	231	0	28	0	109
Zinc	977	24,957	229	3,626	748	21,331	38	1,088
TOTAL PRIORITY METALS	**6,248**	**49,690**	**446**	**7,371**	**5,802**	**42,319**	**1,909**	**8,458**
NON-CONVENTIONAL METALS								
Aluminum	2,071	21,296	2,071	9,185	0	12,111	0	891
Barium	198	5,132	26	905	172	4,227	0	8
Boron	3,726	258,434	3,074	208,873	652	49,561	117	10,340
Cobalt	45	21,953	45	8,563	0	13,390	0	1,473
Iron	13,460	124,007	2,482	43,448	10,978	80,559	61	451
Manganese	427	20,365	406	13,275	21	7,090	0	102
Molybdenum	151	3,606	151	2,780	0	826	0	171
Silicon	2,811	91,782	2,033	66,395	778	25,387	0	0
Strontium	117	4,631	81	3,067	36	1,564	0	0
Tin	58	1,661	11	214	47	1,447	14	434
Titanium	27	329	3	38	24	291	1	9
TOTAL NON-CONVENTIONAL METALS	**23,091**	**553,196**	**10,383**	**356,743**	**12,708**	**196,453**	**194**	**13,880**
CLASSICAL PARAMETERS								
Chemical Oxygen Demand (COD)	3,389,871	N/A	2,613,803	N/A	776,068	N/A	N/A	N/A
Ammonia as N	24,847	N/A	14,843	N/A	10,004	N/A	N/A	N/A
Total Dissolved Solids	1,046,736	N/A	1,046,736	N/A	0	N/A	N/A	N/A
Total Organic Carbon (TOC)	1,756,618	N/A	666,656	N/A	1,089,962	N/A	N/A	N/A
Total Cyanide	7	330	6	181	1	149		

[1]All loadings and reductions take into account the removals by POTWs for indirect discharges.

HEM - Hexane extractable material

Table B-3. Summary of Pollutant Loadings and Removals for the CWT **Organics Subcategory**[1]

Pollutant of Concern	Current Wastewater Pollutant Loading (lbs/yr)		Post-Compliance Wastewater Pollutant Loading (lbs/yr)		Post-Compliance Pollutant Reductions (lbs/yr)		Post-Compliance Pollutant Pound-Equivalent Removals (lbs/yr)	
	Direct Discharges	**Indirect Discharges**	**Direct Discharges**	**Indirect Discharges**	**Direct Discharges**	**Indirect Discharges**	**Direct Discharges**	**Indirect Discharges**
CONVENTIONALS								
Biochemical Oxygen Demand 5-Day (BOD_5)	5,366	N/A	5,366	N/A	0	N/A	N/A	N/A
Oil and Grease (measured as HEM)	23,062	N/A	23,062	N/A	0	N/A	N/A	N/A
Total Suspended Solids (TSS)	5,888	N/A	5,888	N/A	0	N/A	N/A	N/A
PRIORITY ORGANICS								
1,1,1-Trichloroethane	1	154	1	0	0	154	0	1
1,1,2-Trichloroethane	2	463	2	1	0	462	0	2
1,1-Dichloroehtane	1	48	1	1	0	47	0	8
1,1-Dichloroethene	1	183	1	1	0	182	0	33
1,2-Dichloroethane	1	314	1	0	0	314	0	2
Benzene	1	109	1	1	0	108	0	2
Chloroform	9	631	9	6	0	625	0	1
Methylene Chloride	27	258,747	27	40	0	258,707	0	109
Pentachlorophenol	103	1,779	103	243	0	1,536	0	767
Phenol	47	54	47	3	0	51	0	1
Tetrachloroethene	15	368	15	7	0	361	0	27
Toluene	1	7,722	1	0	0	7,722	0	43
Trichloroethene	9	211	9	2	0	209	0	13
Vinyl Chloride	1	110	1	0	0	110	0	0
TOTAL PRIORITY ORGANICS	**219**	**270,893**	**219**	**305**	**0**	**270,588**	**0**	**1,009**
NON-CONVENTIONAL ORGANICS								
1,1,1,2-Tetrachloroethane	1	1,312	1	4	0	1,308	0	31
1,2,3-Trichloropropane	1	1,576	1	4	0	1,572	0	3
1,2-Dibromoethane	1	1,926	1	5	0	1,921	0	84,929
2,3,4,6-Tetrachlorophenol	82	661	82	140	0	521	0	34
2,3-Dichloroaniline	3	243	3	7	0	236	0	3
2,4,5-Trichlorophenol	13	292	13	26	0	266	0	26

Table B-3. Summary of Pollutant Loadings and Removals for the CWT **Organics Subcategory**[1]

Pollutant of Concern	Current Wastewater Pollutant Loading (lbs/yr)		Post-Compliance Wastewater Pollutant Loading (lbs/yr)		Post-Compliance Pollutant Reductions (lbs/yr)		Post-Compliance Pollutant Pound-Equivalent Removals (lbs/yr)	
	Direct Discharges	Indirect Discharges	Direct Discharges	Indirect Discharges	Direct Discharges	Indirect Discharges	Direct Discharges	Indirect Discharges
2,4,6-Trichlorophenol	11	140	11	10	0	130	0	0
2-Butanone	115	2,432	115	26	0	2,406	0	0
2-Propanone	269	361,967	269	146	0	361,821	0	4
4-Methyl-2-pentanone	19	1,028	19	8	0	1,020	0	0
Acetophenone	5	21	5	1	0	20	0	0
Aniline	1	151	1	1	0	150	0	0
Benzoic Acid	42	594	42	19	0	575	0	0
Diethyl Ether	0	7,640	0	24	0	7,616	0	1
Dimethyl Sulfonone	21	22	21	2	0	20	0	0
Ethylenethiourea	574	750	574	648	0	102	0	0
Hexanoic Acid	8	108	8	5	0	103	0	0
m-Xylene	1	638	1	2	0	636	0	1
N,N-Dimethylformamide	1	4,957	1	2	0	4,955	0	0
o-Cresol	24	1,019	24	31	0	988	0	3
Pyridine	15	53	15	2	0	51	0	0
p-Cresol	9	280	9	7	0	273	0	1
Tetrachloromethane	2	165	2	1	0	164	0	21
Trans-1,2-Dichloroehtene	3	400	3	2	0	398	0	0
TOTAL NON-CONVENTIONAL ORGANICS	**1,221**	**388,375**	**1,221**	**1,094**	**0**	**387,252**	**0**	**85,057**
PRIORITY METALS								
Antimony	74	40	74	40	0	0	0	0
Chromium	72	13	72	5	0	8	0	0
Copper	92	29	92	29	0	0	0	0
Nickel	186	351	186	351	0	0	0	0
Zinc	50	96	50	34	0	62	0	3
TOTAL PRIORITY METALS	**474**	**529**	**474**	**459**	**0**	**70**	**0**	**3**
NON-CONVENTIONAL METALS								

Table B-3. Summary of Pollutant Loadings and Removals for the CWT **Organics Subcategory**[1]

Pollutant of Concern	Current Wastewater Pollutant Loading (lbs/yr)		Post-Compliance Wastewater Pollutant Loading (lbs/yr)		Post-Compliance Pollutant Reductions (lbs/yr)		Post-Compliance Pollutant Pound-Equivalent Removals (lbs/yr)	
	Direct Discharges	**Indirect Discharges**	**Direct Discharges**	**Indirect Discharges**	**Direct Discharges**	**Indirect Discharges**	**Direct Discharges**	**Indirect Discharges**
Aluminum	323	15,395	323	854	0	14,541	0	931
Boron	6,279	5,535	6,279	545	0	4,990	0	898
Calcium	0	0	0	0	0	0	0	0
Iodine	0	1,982	0	0	0	1,982	0	0
Iron	515	1,847	515	292	0	1,555	0	9
Lithium	1,552	3,911	1,552	3,911	0	0	0	0
Magnesium	0	0	0	0	0	0	0	0
Manganese	30	219	30	68	0	151	0	2
Molybdenum	123	204	123	161	0	43	0	9
Phosphorus	904	751	904	0	0	751	0	0
Potassium	0	0	0	0	0	0	0	0
Silicon	350	893	350	858	0	35	0	0
Sodium	0	0	0	0	0	0	0	0
Strontium	269	1,723	269	803	0	920	0	0
Sulfur	178,861	496,299	178,861	0	0	496,299	0	3
Tin	128	147	128	147	0	0	0	0
TOTAL NON-CONVENTIONAL METALS	**189,334**	**528,906**	**189,334**	**7,639**	**0**	**521,267**	**0**	**1,852**
CLASSICAL PARAMETERS								
Total Cyanide	285	352	285	260	0	92	0	

[1]All loadings and reductions take into account the removals by POTWs for indirect discharges.

HEM - Hexane extractable material

Table B-4. Summary of Pollutant Loadings and Removals for the **Entire CWT Industry**[1]

Pollutant of Concern	Current Wastewater Pollutant Loading (lbs/yr)		Post-Compliance Wastewater Pollutant Loading (lbs/yr)		Post-Compliance Pollutant Reductions (lbs/yr)		Post-Compliance Pollutant Pound-Equivalent Removals (lbs/yr)	
	Direct Discharges	**Indirect Discharges**	**Direct Discharges**	**Indirect Discharges**	**Direct Discharges**	**Indirect Discharges**	**Direct Discharges**	**Indirect Discharges**
CONVENTIONALS	16,745,272	N/A	1,598,842	N/A	15,146,430	N/A	N/A	N/A
TOTAL PRIORITY ORGANICS	2,006	426,206	1,310	12,101	696	414,105	12,675	484,804
TOTAL NON-CONVENTIONAL ORGANICS	13,463	1,502,013	8,865	136,032	4,598	1,365,951	33	89,663
TOTAL PRIORITY METALS	601,238	68,604	13,232	11,748	588,006	56,856	287,065	19,559
TOTAL NON-CONVENTIONAL METALS	1,079,386	1,343,796	285,287	408,635	794,099	935,161	87,040	30,471

[1]All loadings and reductions take into account the removals by POTWs for indirect discharges.

HEM - Hexane extractable material

Table B-5. Pound-Equivalent Removals For Considered Options (units = lb-eq removed / year; POTW removals are accounted for in all calculations)

Pollutant	Removals Indirects Oils Opt 8[1]	Removals Directs Oils Opt 8[1]	Removals Indirects Oils Opt 9[1]	Removals Directs Oils Opt 9[1]	Removals Indirects Metals Opt 4	Removals Directs Metals Opt 4	Removals Indirects Metals Opt 3	Removals Directs Metals Opt 3	Removals Indirects Metals Opt 2	Removals Directs Metals Opt 2	Removals Indirects Org. Opt 4[2]
Aluminum	891	0	891	0	198	5,139	220	5,316	213	5,256	931
Antimony	14	0	14	0	1,391	6,385	1,421	6,484	1,421	6,484	0
Arsenic	574	0	574	0	33	1,502	132	2,521	123	2,425	--
Barium	8	0	8	0	--	--	0	0	0	0	--
Boron	10,340	117	10,340	117	11,888	23,654	12,477	24,470	12,005	17,169	898
Cadmium	248	76	248	76	35	27,328	32	27,094	31	27,079	--
Chromium	15	3	15	3	4	3,702	7	3,743	4	3,703	0
Cobalt	1,473	0	1,473	0	53	377	75	399	50	373	0
Copper	2,857	468	2,877	472	184	95,504	267	96,026	177	95,390	0
Iridium	--	--	--	--	0	0	--	--	--	--	--
Iron	451	48	575	61	28	508	50	634	37	560	9
Lead	2,463	1,202	2,463	1,202	186	46,027	220	46,410	85	44,820	--
Lithium	--	--	--	--	1,451	1,684	1,451	1,684	1,451	1,684	0
Manganese	102	0	141	0	13	77	14	78	12	76	2
Mercury	631	0	631	0	7,735	79,961	7,899	81,518	7,708	79,699	--
Molybdenum	171	0	171	0	547	2,084	974	2,917	939	2,849	9
Nickel	460	118	460	118	111	1,765	164	1,867	112	1,767	0
Selenium	109	0	109	0	409	541	0	0	713	971	--
Silicon	0	0	0	0	0	0	--	--	--	--	0
Silver	--	--	--	--	856	16,025	1,016	17,998	1,096	18,984	--
Strontium	0	0	0	0	0	0	--	--	--	--	0
Thallium	--	--	--	--	0	0	7	37	6	34	--
Tin	434	14	434	14	522	47,760	545	47,822	545	47,823	0
Titanium	9	1	9	1	15	2,739	17	2,744	17	2,744	--
Vanadium	--	--	--	--	24	2,812	24	2,812	60	2,879	--
Yttrium	--	--	--	--	0	0	0	0	0	0	--
Zinc	1,088	34	1,148	38	154	6,416	163	6,454	137	6,340	3
Zirconium	--	--	--	--	0	12	0	12	0	12	--
PRIORITY METALS	**8,458**	**1,901**	**8,539**	**1,909**	**11,098**	**285,156**	**11,328**	**290,152**	**11,613**	**287,696**	**3**
NON-PRIORITY METALS	**13,880**	**180**	**14,043**	**194**	**14,739**	**86,846**	**15,847**	**88,888**	**15,329**	**81,425**	**1,849**
1-methylfluorene	30	0	31	1	--	--	--	--	--	--	--
1-methylphenanthrene	72	2	75	3	--	--	--	--	--	--	--

Table B-5. Pound-Equivalent Removals For Considered Options (units = lb-eq removed / year; POTW removals are accounted for in all calculations)

Pollutant	Removals Indirects Oils Opt 8[1]	Removals Directs Oils Opt 8[1]	Removals Indirects Oils Opt 9[1]	Removals Directs Oils Opt 9[1]	Removals Indirects Metals Opt 4	Removals Directs Metals Opt 4	Removals Indirects Metals Opt 3	Removals Directs Metals Opt 3	Removals Indirects Metals Opt 2	Removals Directs Metals Opt 2	Removals Indirects Org. Opt 4[2]
1,1,1,2-tetrachloroethane	--	--	--	--	--	--	--	--	--	--	31
1,2,3-tricholoropropane	--	--	--	--	--	--	--	--	--	--	3
1,1,2-trichloroethane	--	--	--	--	--	--	--	--	--	--	2
1,2,4-trichlorobenzene	55	0	55	0	--	--	--	--	--	--	--
1,4-dichlorobenzene	60	0	60	0	--	--	--	--	--	--	--
1,1-dichloroethene	13	0	13	0	--	--	--	--	--	--	33
1,1-dichloroethane	--	--	--	--	--	--	--	--	--	--	8
1,2-dichloroethane	0	0	0	0	--	--	--	--	--	--	2
1,2-dibromoethane	--	--	--	--	--	--	--	--	--	--	84,929
2,3,4,6-tetrachlorophenol	--	--	--	--	--	--	--	--	--	--	34
2,3-benzofluorene	0	0	40	1	--	--	--	--	--	--	--
2,3-dichloroaniline	--	--	--	--	--	--	--	--	--	--	3
2,4-dimethylphenol	0	0	0	0	--	--	--	--	--	--	--
2,4,5-trichlorophenol	--	--	--	--	--	--	--	--	--	--	26
2,4,6-trichlorophenol	--	--	--	--	--	--	--	--	--	--	0
2-methylnaphthalene	151	0	238	0	--	--	--	--	--	--	--
1,1,1-Trichloroethane	3	0	3	0	--	--	--	--	--	--	1
butanone	0	0	0	0	--	--	--	--	--	--	0
2-phenylnaphthalene	0	0	0	0	--	--	--	--	--	--	--
2-propanone	0	0	0	0	--	--	--	--	--	--	4
3,4-dichlorophenol	--	--	--	--	--	--	--	--	--	--	0
3,5-dichlorophenol	--	--	--	--	--	--	--	--	--	--	0
3,6-dimethylphenanthrene	0	0	88	3	--	--	--	--	--	--	--
4-chloro-3-methylphenol	0	0	75	1	--	--	--	--	--	--	--
4-methyl-2-pentanone	0	0	0	0	--	--	--	--	--	--	0
acenapthene	17	0	17	0	--	--	--	--	--	--	--
acetophenone	--	--	--	--	--	--	--	--	--	--	0
alpha-terpinol	0	0	0	0	--	--	--	--	--	--	--
aniline	--	--	--	--	--	--	--	--	--	--	0
anthracene	500	0	541	5	--	--	--	--	--	--	--
benzene	8	2	8	2	--	--	--	--	--	--	2
benzo(a)anthracene	1,073	0	1,221	39	--	--	--	--	--	--	--

Table B-5. Pound-Equivalent Removals For Considered Options (units = lb-eq removed / year; POTW removals are accounted for in all calculations)

Pollutant	Removals Indirects Oils Opt 8[1]	Removals Directs Oils Opt 8[1]	Removals Indirects Oils Opt 9[1]	Removals Directs Oils Opt 9[1]	Removals Indirects Metals Opt 4	Removals Directs Metals Opt 4	Removals Indirects Metals Opt 3	Removals Directs Metals Opt 3	Removals Indirects Metals Opt 2	Removals Directs Metals Opt 2	Removals Indirects Org. Opt 4[2]
benzo(a)pyrene	448,031	11,786	448,041	11,786	--	--	--	--	--	--	--
benzo(b)fluoranthene	131	3	131	3	--	--	--	--	--	--	--
benzo(k)fluoranthene	77	2	77	2	--	--	--	--	--	--	--
benzoic acid	1	0	1	0	--	--	--	--	--	--	0
benzyl alcohol	0	0	1	0	--	--	--	--	--	--	--
biphenyl	6	1	6	1	--	--	--	--	--	--	--
bis(2-ethylhexyl) phthalate	13,912	1	13,926	2	--	--	--	--	--	--	--
butyl benzyl phthalate	13	0	13	0	--	--	--	--	--	--	--
carbazole	27	0	27	0	--	--	--	--	--	--	--
carbon disulfide	321	4	321	4	--	--	--	--	--	--	--
chlorobenzene	0	0	0	0	--	--	--	--	--	--	--
chloroform	0	0	0	0	--	--	--	--	--	--	1
chrysene	1,545	37	1,650	128	--	--	--	--	--	--	--
di-n-butyl phthalate	1	0	1	0	--	--	--	--	--	--	--
dibenzofuran	2	0	2	0	--	--	--	--	--	--	--
dibenzothiopene	15	0	16	0	--	--	--	--	--	--	--
diethyl ether	--	--	--	--	--	--	--	--	--	--	1
diethyl phthalate	0	0	1	0	--	--	--	--	--	--	--
dimethyl sulfonone	--	--	--	--	--	--	--	--	--	--	0
diphenyl ether	0	0	3	0	--	--	--	--	--	--	--
ethylbenzene	1	0	1	0	--	--	--	--	--	--	--
ethylenethiourea	--	--	--	--	--	--	--	--	--	--	0
fluoranthene	3,405	0	4,092	9	--	--	--	--	--	--	--
fluorene	777	0	868	0	--	--	--	--	--	--	--
hexanoic acid	1	0	1	0	--	--	--	--	--	--	0
methylene chloride	0	0	0	0	--	--	--	--	--	--	109
m-xylene	0	0	0	0	--	--	--	--	--	--	1
n-decane	1,166	2	1,211	3	--	--	--	--	--	--	--
n-docosane	0	0	0	0	--	--	--	--	--	--	--
n-dodecane	50	0	54	2	--	--	--	--	--	--	--
n-eicosane	45	1	47	1	--	--	--	--	--	--	--
n-hexadecane	757	3	748	2	--	--	--	--	--	--	--

Table B-5. Pound-Equivalent Removals For Considered Options (units = lb-eq removed / year; POTW removals are accounted for in all calculations)

Pollutant	Removals Indirects Oils Opt 8[1]	Removals Directs Oils Opt 8[1]	Removals Indirects Oils Opt 9[1]	Removals Directs Oils Opt 9[1]	Removals Indirects Metals Opt 4	Removals Directs Metals Opt 4	Removals Indirects Metals Opt 3	Removals Directs Metals Opt 3	Removals Indirects Metals Opt 2	Removals Directs Metals Opt 2	Removals Indirects Org. Opt 4[2]
n-octadecane	458	0	463	0	--	--	--	--	--	--	--
n-tetradecane	1,382	5	1,371	4	--	--	--	--	--	--	--
n,n-dimethylformamide	--	--	--	--	--	--	--	--	--	--	0
naphthalene	30	0	33	0	--	--	--	--	--	--	--
o-cresol	0	0	1	0	--	--	--	--	--	--	3
o+p xylene	2	0	3	0	--	--	--	--	--	--	--
p-cresol	1	0	0	0	--	--	--	--	--	--	1
p-cymene	0	0	0	0	--	--	--	--	--	--	--
pentachlorophenol	--	--	--	--	--	--	--	--	--	--	767
pentamethylbenzene	115	7	115	7	--	--	--	--	--	--	--
phenanthrene	14,001	0	17,196	694	--	--	--	--	--	--	--
phenol	0	0	1	0	--	--	--	--	--	--	1
pyrene	88	1	93	2	--	--	--	--	--	--	--
pyridine	0	0	0	0	--	--	--	--	--	--	0
styrene	1	0	1	0	--	--	--	--	--	--	--
tetrachloroethene	38	0	38	0	--	--	--	--	--	--	27
tetrachloromethane	--	--	--	--	--	--	--	--	--	--	21
toluene	9	2	9	2	--	--	--	--	--	--	43
trans-1,2-dichloroethene	--	--	--	--	--	--	--	--	--	--	0
trichloroethene	8	0	8	0	--	--	--	--	--	--	13
tripropyleneglycol methyl ether	0	0	0	0	--	--	--	--	--	--	--
vinyl chloride	--	--	--	--	--	--	--	--	--	--	0
PRIORITY ORGANICS	**483,795**	**11,836**	**488,097**	**12,675**	**--**	**--**	**--**	**--**	**--**	**--**	**1,009**
NON-PRIORITY ORGANICS	**4,606**	**26**	**4,941**	**33**	**--**	**--**	**--**	**--**	**--**	**--**	**85,057**
ALL POLLUTANTS	**510,739**	**13,943**	**515,619**	**14,811**	**25,837**	**372,002**	**27,180**	**379,040**	**26,942**	**369,120**	**87,918**

[1]For the organics subcategory, Options 3 and 4 have no removals for direct dischargers. Also, Options 3 and 4 are have the same removals.

[2] Oils subcategory Options 8v and 9v have the same lb-eq removals as Options 8 and 9, respectively.