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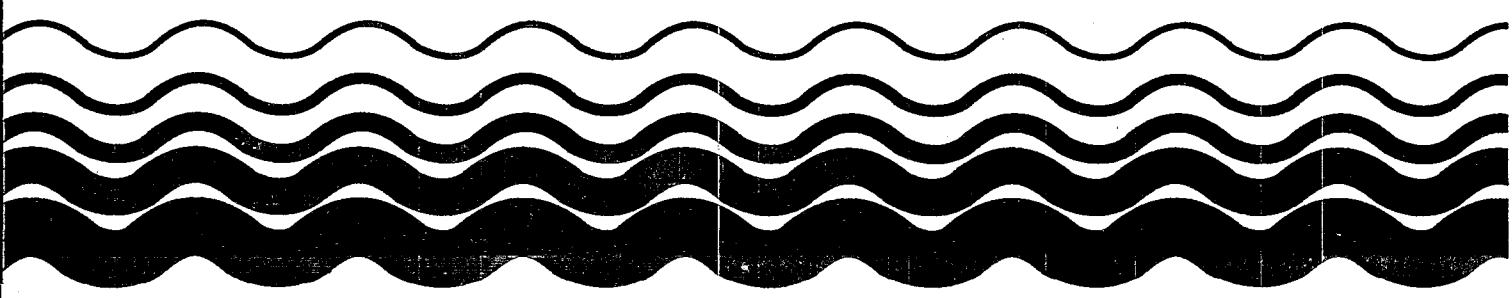

COST-EFFECTIVENESS ANALYSIS OF PROPOSED EFFLUENT LIMITATIONS GUIDELINES FOR THE PULP, PAPER, AND PAPERBOARD INDUSTRY

October 1993

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SECTION ONE

INTRODUCTION

EPA is proposing effluent limitations guidelines and standards and MACT[1] standards for the pulp, paper, and paperboard industry. This cost-effectiveness (CE) analysis presents an evaluation of the technical efficiency of pollutant control options for the proposed effluent limitations guidelines. The analysis covers the cost-effectiveness of effluent limitations based on BAT and PSES.[2]

The proposed BAT and PSES apply to six subcategories:

- Dissolving Kraft
- Dissolving Sulfite
- Bleached Papergrade Kraft
- Papergrade Sulfite
- Unbleached Kraft
- Semichemical

This CE analysis evaluates several pollution control options for BAT and PSES in each subcategory, each with differing levels of pollution abatement and compliance cost. Two subcategories— unbleached kraft and semichemical—are not included in the CE analysis because

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[1] Maximum Achievable Control Technology (MACT) standards are set under the National Emissions Standards for Hazardous Air Pollutants (NESHAP). The term "MACT floor" refers to the minimum control technology on which MACT can be based.

[2]Best Available Technology Economically Achievable (BAT) is required under Section 304(b)(2) of the Clean Water Act. These rules control the discharge of priority and non-conventional pollutants and apply to existing industrial direct dischargers. Pretreatment Standards for Existing Sources (PSES) are analogous to BAT; these rules apply to existing indirect dischargers (whose discharges flow to publicly-owned treatment works, or POTWs).

their only toxic and nonconventional pollutant removals are for COD (chemical oxygen demand), for which there is no toxic weighting factor.

This document compares the total annualized cost incurred for each of the regulatory options within each subcategory to the corresponding effectiveness of that option in reducing the discharge of pollutants. The effectiveness measure used is the cost-effectiveness ratio, which compares the incremental cost of an option to the incremental pollutants removed by that option. The pollutants removed are expressed as pounds of pollutant removed weighted by an estimate of the relative toxicity of the pollutant. This measure, referred to as "pound equivalents (PE) removed," is described later in this document.

Section Two discusses the cost-effectiveness methodology and identifies the pollutants included in the analysis and their toxic weighting factors. Section Three describes the options evaluated for each subcategory. Section Four presents the results of the CE analysis. Section Five presents a separate analysis of AOX (adsorbable organic halides). Appendix A contains tables of pollutant removals in pounds. Appendix B contains tables of pollutant removals expressed in terms of weighted pound-equivalents. Appendix C contains the tables supporting the calculation of the industry cost-effectiveness.

SECTION TWO

BACKGROUND METHODOLOGY

Cost-effectiveness (CE) is defined as the incremental annualized cost of a pollution control option in an industry or industry subcategory per incremental pound-equivalent of pollutant removed by that control option. Several inputs are critical to calculating CE ratios:

- Toxic and nonconventional pollutants to be included in the CE calculations.
- Toxic weighting factors for the pollutants included in the CE calculations (the adjustments to pounds of pollutants to reflect toxicity).
- POTW removal factors for the pollutants included in the CE calculations (the adjustments to pounds of pollutants to reflect the ability of a publicly-owned treatment works [POTW] to remove pollutants).
- Pollution control options.
- Pollutant removals for each pollution control option.
- Annualized cost of each pollution control option.

The following sections discuss these six inputs and the cost-effectiveness calculations.

2.1 POLLUTANTS INCLUDED IN THE CE ANALYSIS

The CE analysis includes 26 individual pollutants generated in the production of pulp, paper, and paperboard. The pollutants in the analysis are listed in Table 2-1. A separate analysis for adsorbable organic halides (AOX)—a general measure of the presence of chlorinated organics in the wastestream—is presented in Section Five. Removals of AOX are not included in the CE ratios. There are additional pollutants that are not included in the cost-effectiveness analysis because pollutant removals were not estimated for each of the pollution control options. These pollutants include other congeners of dioxin and furan. The pollution control options that are evaluated in this report are likely to be effective in removing additional chlorinated phenolic

compounds and other congeners of dioxins and furans. The cost-effectiveness results in this report are likely to be overestimates due to the omission of these unspecified pollutants.

2.2 TOXIC WEIGHTING FACTORS

Cost-effectiveness analysis accounts for differences in toxicity among the pollutants by using toxic weighting factors. These factors are necessary because different pollutants have different potential effects on human and aquatic life. For example, a pound of zinc in an effluent stream has a significantly different effect than a pound of PCBs. Toxic weighting factors for pollutants are derived using ambient water quality criteria and toxicity values. For most industries, toxic weighting factors are derived from chronic freshwater aquatic criteria. In cases where a human health criterion has also been established for the consumption of fish, then the sum of both the human and aquatic criteria are used to derive toxic weighting factors. For details on toxic weighting factors used in the analysis, see "Toxic Weighting Factors for Pulp, Paper, and Paperboard Industry Proposed Effluent Guidelines," Environmental Protection Agency, Office of Science and Technology, October 1993. The toxic weighting factors used in this CE analysis are listed in Table 2-1.

The factors are standardized by relating them to the water quality criterion for copper. Although this criterion has been revised, the cost-effectiveness analyses for effluent guideline regulations use a previous criterion (of 5.6 μg/l) so that cost-effectiveness results can be compared for effluent guidelines across industries. Examples of the effects of different aquatic and human health criteria on weighting factors are presented in Table 2-2. As shown in this table, the toxic weighting factor is the sum of two criteria-weighted ratios: the copper criterion divided by the human health criterion for the particular pollutant and the copper criterion divided by the aquatic chronic criterion. For example, using the values reported in Table 2-2, 10.96 pounds of copper pose the same relative hazard in surface waters as one pound of cadmium because cadmium has a toxic weight 10.96 times as large as the toxic weight of copper (5.124/0.467=10.96).

2.3 POTW REMOVAL FACTORS

The calculation of pound-equivalents differs for direct and indirect dischargers because of the ability of POTWs to remove certain pollutants. Table 2-1 presents the POTW removal factors for pollutants included in the analysis. The POTW removal factors are used as follows. 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 38 percent, then the cadmium discharged to surface waters is only 62 pounds. If the regulation results in a reduction of cadmium in the effluent stream such that total cadmium discharged to the POTW is 50 pounds, then the amount discharged to surface waters is calculated as 50 pounds multiplied by the POTW removal factor (1 - 0.38, or 0.62 times 50 pounds equals 31 pounds). The cost-effectiveness calculations then reflect the fact that the actual reduction of pollutant discharged to surface water is not 50 pounds (the change in the amount discharged to the POTW), but 31 pounds (the change in the amount actually discharged to surface water). A pollutant that is unaffected by the POTW has a removal factor of 1.

2.4 POUND-EQUIVALENT CALCULATIONS

Pollutant removals, in pounds, for each option are given by subcategory and pollution control option in Appendix A. These pollutant removals are converted into pound-equivalents (pe) for the CE analysis. For direct dischargers, removals in pound-equivalents are calculated as follows:

$$\text{Removals}_{pe} = \text{Removals}_{pounds} \times \text{Toxic weighting factor}$$

For indirect dischargers, removals in pound-equivalents are calculated as:

$$\text{Removals}_{pe} = \text{Removals}_{pounds} \times \text{Toxic weighting factor} \times \text{POTW removal factor}$$

Total removals for each option are then calculated by summing the removals for each pollutant for each facility affected by each option.

For this analysis, pollutant removals for indirect dischargers were calculated at the point of discharge to the water body, not discharge to the POTW. Pollutant removal by the POTW is therefore already incorporated in the removals shown in Appendix A. For this report, pound-equivalents are calculated as the product of the removals (in pounds) and the toxic weighting factor for both direct and indirect dischargers. The removals—in terms of pound-equivalents—are reported in Appendix B.

2.5 ANNUALIZED COSTS OF COMPLIANCE

Annualized costs of compliance have been developed for each regulatory option. A detailed description of the methodology used to estimate compliance costs can be found in the *Economic Impact and Regulatory Flexibility Analysis of Proposed Effluent Guidelines and NESHAP for the Pulp, Paper, and Paperboard Industry* (EPA, 1993). In brief, the annualized cost considers the initial capital investment for new equipment (including installation), the annual costs of operating and maintaining the equipment, and the cost of money needed to finance the investment. The annualized costs presented in Section Four represent after-tax costs to the industry.

The annualized cost for each pollution control option is expressed in 1991 dollars in all tables in this analysis, with the exception of the industry comparisons for BAT and PSES (Tables 4-9 and 4-10), which are reported in 1981 dollars. Industry cost-effectiveness ratios are deflated to 1981 dollars in Section Four for comparison with other effluent guidelines.

2.6 CALCULATION OF COST-EFFECTIVENESS RATIOS

Cost-effectiveness ratios are calculated separately for direct and indirect dischargers and by subcategory. Within each of these groupings, the pollution control options are ranked in ascending order of pound-equivalents of pollutants removed. The cost-effectiveness ratio for each control option is calculated as the ratio of incremental annual cost of that option to the incremental pound equivalents removed by that option.

The equation to calculate cost-effectiveness is:

$$CE_k = \frac{ATC_k - ATC_{k-1}}{PE_k - PE_{k-1}}$$

where:

CE_k=	Cost-effectiveness of Option k
ATC_k=	Total annualized treatment cost under Option k
PE_k=	Pound-equivalents removed by Option k

The numerator of the equation, ATC_k minus ATC_{k-1}, is the incremental annualized treatment cost in going from Option k-1 (an option that removes fewer pound-equivalent pollutants) to Option k (an option that removes more pound-equivalent pollutants). Similarly, the denominator is the incremental removals achieved in going from Option k-1 to k. Thus, cost-effectiveness measures the incremental unit cost of pollutant removal of Option k (in pound-equivalents) in comparison to Option k-1.

2.7 IDENTIFYING AND ELIMINATING "INEFFICIENT" OPTIONS

Because the options are ranked in ascending order of pound-equivalents of pollutants removed, an option that has higher costs but lower removals than the subsequent option is determined to be "inefficient" because the cost-effectiveness ratio for the subsequent option is negative. When negative values are computed for Option k, Option k-1 is noted as inefficient (having a higher cost and lower removals than Option k). Option k-1 is then removed from the cost-effectiveness calculations, and all cost-effectiveness ratios within a regulatory grouping are then recalculated without the inefficient option. The remaining options are then presented in terms of their incremental cost-effectiveness values.

TABLE 2-1

POLLUTANTS, TOXIC WEIGHTING FACTORS, AND POTW REMOVAL FACTORS INCLUDED IN THE CE ANALYSIS

Pollutant Name	Toxic Weighting Factor	POTW Removal Factor
2-Butanone (MEK)	9.04×10^{-5}	0.02
2-Propanone (Acetone)	1.12×10^{-2}	0.21
2,3,4,6-Tetrachlorophenol	5.62×10^{-1}	0.67
2,3,7,8-Tetrachlorodibenzofuran	6.69×10^{6}	0.61
2,3,7,8-Tetrachlorodibenzo-p-dioxin	4.24×10^{8}	0.56
2,4-Dichlorophenol	8.71×10^{-2}	0.25
2,4,5-Trichlorophenol	1.25×10^{0}	1.00
2,4,6-Trichlorophenol	1.93×10^{0}	0.48
2,6-Dichlorophenol	3.46×10^{-2}	1.00
2,6-Dichlorosyringaldehyde	3.80×10^{-2}	1.00
3,4,5-Trichlorocatechol	3.11×10^{-1}	0.37
3,4,5-Trichloroguaiacol	7.47×10^{-1}	0.57
3,4,6-Trichlorocatechol	1.47×10^{-1}	1.00
3,4,6-Trichloroguaiacol	1.85×10^{-1}	0.82
4-Chlorocatechol	7.09×10^{-2}	1.00
4-Chlorophenol	1.24×10^{-2}	1.00
4,5-Dichlorocatechol	1.26×10^{-1}	0.63
4,5,6-Trichloroguaiacol	1.81×10^{0}	0.65
5,6-Dichlorovanillin	6.40×10^{-2}	0.09
6-Chlorovanillin	5.23×10^{-2}	0.31
Chloroform (Trichloromethane)	5.71×10^{-3}	0.27
Methylene Chloride (Dichloromethane)	9.30×10^{-4}	0.46
Pentachlorophenol	4.99×10^{-1}	0.37
Tetrachlorocatechol	7.67×10^{-1}	0.41
Tetrachloroguaiacol	1.75×10^{0}	0.44
Trichlorosyringol	1.06×10^{-1}	0.97

TABLE 2-2

EXAMPLES OF TOXIC WEIGHTING FACTORS BASED ON COPPER FRESHWATER CHRONIC CRITERIA

Pollutant	Human Health Criteria (μg/l)	Aquatic Chronic Criteria (μg/l)	Weighting Calculation	Toxic Weighting Factor
Copper[a]	---	12.0	5.6/12.0	0.467
Acetone	2,761,341	500	5.6/2,761,341 + 5.6/500	0.0112
Cadmium	170	1.1	5.6/170 + 5.6/1.1	5.124
Chloroform	4707.9	1240	5.6/4707.9 + 5.6/1240	5.71×10^{-3}

Sources: Versar, Inc. 1991. Toxic weighting factors for oil and gas extraction industry pollutants. Prepared for U.S. Environmental Protection Agency, Office of Water, October 1992.

Notes: Human health and aquatic chronic criteria are maximum contamination thresholds. Units for criteria are micrograms of pollutant per liter of water.

[a]Although the water quality criterion for copper has been revised (to 12.0 μg/l), the cost effectiveness analysis used the previous criterion (5.6 μg/l) to facilitate comparisons with cost-effectiveness values for other effluent limitations guidelines. The revised higher criteria for copper results in a toxic weighting factor for copper equal to 0.467 instead of 1.0, which was the result of the previous criterion.

SECTION THREE

POLLUTION CONTROL OPTIONS

Effluent limitations may be subcategorized based on manufacturing process or other characteristics. The pulp, paper, and paperboard industry is divided into 12 subcategories that are subject to revised pollution control costs under the proposed regulations. Six of these subcategories were considered for the CE analysis: dissolving kraft, dissolving sulfite, bleached papergrade kraft and soda, papergrade sulfite, unbleached kraft, and semichemical.

In addition to subcategory descriptions, facilities are also characterized by discharge status: direct or indirect. BAT applies to direct dischargers; PSES applies to indirect dischargers. Both BAT and PSES control the toxic and nonconventional pollutants that are included in this CE analysis. There are additional pollutants controlled by BAT and PSES (and others that are expected to be reduced by BAT and PSES), but they are not part of this CE analysis because (i) there is no toxic weighting factor for the pollutant, or (ii) accurate estimates of pollutant removals are not available.

3.1 SUMMARY OF POLLUTION CONTROL OPTIONS BY SUBCATEGORY

A detailed description of the subcategories and the pollution control options is presented in the Development Document. The following summary highlights various compliance components of the pollution control options.

The technology basis for BAT and PSES includes process changes, best management practices (BMP), and wastewater treatment. Process changes to pulping and bleaching operations apply to approximately 103 mills in four subcategories: dissolving kraft, dissolving sulfite, bleached papergrade kraft and soda, and papergrade sulfite. The pulping and bleaching process changes are directly responsible for removals of toxic and nonconventional pollutants. A summary of the process changes for each of these four subcategories is presented in Tables 3-1 through 3-4.

Process changes also include closing the pulping area screen room for the control of chemical oxygen demand (COD), which is a nonconventional pollutant. For the unbleached kraft and semichemical subcategories, screen room closure is the only process change (i.e., the technology basis for those two subcategories does not include changes to bleaching operations). COD does not have a toxic weighting factor; thus, removals of COD are not included in cost-effectiveness calculations.

Best management practices are also included in the pollution control options for the six subcategories in this analysis. BMP focus on the prevention and spills from pulping and chemical recovery areas.

3.2 POLLUTION CONTROL OPTIONS FOR INDUSTRY COST-EFFECTIVENESS RATIOS

In addition to subcategory-specific cost-effectiveness ratios, this analysis also includes cost-effectiveness ratios for BAT and PSES for the entire industry. Because there are six subcategories and several options within some subcategories, numerous combinations for the industry CE ratios are possible. For the purpose of this analysis, one combination was chosen by selecting one option for each of the six subcategories. That combination reflects the options that form the basis of the proposed regulations:

- Dissolving Kraft—Option 2
- Dissolving Sulfite—Option 1
- Bleached Papergrade Kraft and Soda—Option 4
- Papergrade Sulfite—Option 2
- Unbleached Kraft—Option 1 (BMP and COD control)
- Semichemical—Option 1 (BMP and COD control)

In contrast to the subcategory-specific CE ratios, the industry CE ratios include costs for pollution control options where the removals are not always incorporated. However, the industry cost-effectiveness considers only the costs and removals for the effluent guidelines. The calculation does not incorporate air pollution control costs or air pollutant removals. The industry CE ratios do not represent the cost-effectiveness for the integrated regulatory alternatives described in the notice of proposed rulemaking.

TABLE 3-1

PROCESS CHANGE OPTIONS FOR THE DISSOLVING KRAFT SUBCATEGORY

Option	Abbreviated Description	Description
1	70% ClO_2	Substitution of chlorine dioxide for chlorine at a rate of 70%
2	OD + 70% ClO_2	Oxygen delignification, substitution of chlorine dioxide for chlorine at a rate of 70%, and COD control
3	OD + 100% ClO_2	Oxygen delignification, complete substitution of chlorine dioxide for chlorine, and COD control

All options include:

- Adequate wood chip size control
- Eliminating dioxin precursor defoamers
- Improving pulp washing
- Eliminating hypochlorite
- High shear mixing pulp
- Enhancing extraction in bleaching (with oxygen or peroxide)

TABLE 3-2

PROCESS CHANGE OPTIONS FOR THE DISSOLVING SULFITE SUBCATEGORY

Option	Abbreviated Description	Description
1	OD and 100% ClO_2	Oxygen delignification and complete substitution of chlorine dioxide for chlorine
2	TCF	Totally chlorine-free bleaching using oxygen delignification, ozone and/or peroxide

Both options include:

- Adequate wood chip size control
- Eliminating dioxin precursor defoamers

TABLE 3-3

PROCESS CHANGE OPTIONS FOR THE BLEACHED PAPERGRADE KRAFT AND SODA SUBCATEGORY

Option	Abbreviated Description	Description
1	Split Cl_2	Split addition of chlorine
2	70% ClO_2	Substitution of chlorine dioxide for chlorine at a rate of 70%
3	OD **or** Ext. Cook + 70% ClO_2	Oxygen delignification or extended delignification, substitution of chlorine dioxide for chlorine at a rate of 70%, and COD control
4	OD **or** Ext. Cook + 100% ClO_2	Oxygen delignification or extended delignification, complete substitution of chlorine dioxide for chlorine, and COD control
5	OD **and** Ext. Cook + 100% ClO_2	Oxygen delignification and extended cooking, complete substitution of chlorine dioxide for chlorine, and COD control

All options include:

- Adequate wood chip size control
- Eliminating dioxin precursor defoamers
- Improving pulp washing
- Eliminating hypochlorite
- High shear mixing pulp
- Enhancing extraction in bleaching (with oxygen or peroxide)

TABLE 3-4

PROCESS CHANGE OPTIONS FOR THE PAPERGRADE SULFITE SUBCATEGORY

Option	Abbreviated Description	Description
1	OD and 100% ClO_2	Oxygen delignification, complete substitution of chlorine dioxide for chlorine, and COD control
2	TCF	Totally chlorine-free bleaching using oxygen delignification or extraction followed by peroxide, and COD control

Both options include:

- Adequate wood chip size control
- Eliminating dioxin precursor defoamers
- Eliminating hypochlorite

SECTION FOUR

COST-EFFECTIVENESS RESULTS

Cost-effectiveness (CE) ratios were calculated for direct and indirect dischargers in the dissolving kraft, dissolving sulfite, bleached papergrade kraft and soda, and papergrade sulfite subcategories. Section Three provides summaries of the options for each subcategory.

Section 4.1 presents the results for direct dischargers (BAT). Section 4.2 presents the results for indirect dischargers (PSES). The CE ratios in Sections 4.1 and 4.2 are expressed in 1991 dollars. Section 4.3 summarizes the CE ratios for the pulp, paper, and paperboard industry (in 1991 dollars) and compares the values to those for other industries (in 1981 dollars).

4.1 CE RESULTS FOR BAT

Table 4-1 presents the results of the cost-effectiveness analysis for the dissolving kraft subcategory. The CE ratio ranges from $0.84/pe to $254/pe. For the two options for the dissolving sulfite subcategory (Table 4-2), the CE ratios are $13/pe and $17/pe. There are five options for the bleached papergrade kraft and soda subcategory (Table 4-3). The CE ratio ranges from $2/pe at Option 1 to $80/pe at Option 4 and $4,849/pe at Option 5. There is only one cost-effective option for papergrade sulfite (Table 4-4). Option 1 was removed from the analysis because it was inefficient compared to Option 2 (see Section Two for an explanation of inefficient options). The CE ratio for Option 2 is less than $27/pe.

4.2 CE RESULTS FOR PSES

There are no indirect dischargers in the dissolving kraft and dissolving sulfite subcategories. Table 4-5 summarizes the results for the bleached papergrade kraft and soda

subcategory. The CE ratio ranges from $3/pe to $7,444/pe. There is only one cost-effective option for the papergrade sulfite subcategory, for which the CE ratio is $45/pe (Table 4-6).

4.3 INDUSTRY COST-EFFECTIVENESS

As explained in Section Two, the CE ratio for the industry is calculated by taking the incremental annualized cost and incremental removals for the following combination of options for each subcategory:

- Dissolving Kraft—Option 2
- Dissolving Sulfite—Option 1
- Bleached Papergrade Kraft and Soda—Option 4
- Papergrade Sulfite—Option 2
- Unbleached Kraft—Option 1 (BMP and COD control)
- Semichemical—Option 1 (BMP and COD control).

These incremental values are summed to provide the CE ratio for the industry.

Table 4-7 illustrates the process for BAT (direct dischargers). The value for the dissolving kraft subcategory is taken from the incremental cost and removal columns on Table 4-1 for Option 2. The value for dissolving sulfite is taken from Table 4-2, Option 1. The value for bleached papergrade kraft and soda is taken from Table 4-3, Option 4. The value for papergrade sulfite is taken from Table 4-4. The costs for best management practices and COD control for the unbleached kraft and semichemical subcategories are included in the calculation of cost-effectiveness for the industry even though there are no pound-equivalent removals associated with these costs. The industry CE ratio is $53/pe for direct dischargers.

Table 4-8 illustrates the calculation of the industry CE ratio for indirect dischargers (PSES). The data are taken from Tables 4-5 and 4-6. The CE ratio for PSES for the industry is $89/pe.

The industry CE ratios are compared to cost-effectiveness results for other industries in Tables 4-9 and 4-10 for direct and indirect dischargers, respectively. Appendix C contains pollutant-specific data for pounds and pound-equivalents currently discharged and total removals under the selected option. The pound-equivalents remaining, which is reported on the industry comparison tables, is the difference between baseline loadings and removals.

The industry comparisons are all reported 1981 dollars. The Engineering News-Record Construction Cost Index is used to deflate the CE values from this analysis to 1981 dollars. The value of the index is 3535 and the value for 1991 is 4835. For BAT (direct dischargers), the industry cost-effectiveness is $53.04/pe*(3535/4835) or $39/pe, which is reported in Table 4-9. For PSES (indirect dischargers), the industry cost-effectiveness is $89.14/pe*(3535/4835) or $65/pe, which is reported in Table 4-10.

TABLE 4-1

INCREMENTAL COST-EFFECTIVENESS OF POLLUTION CONTROL OPTIONS
DISSOLVING KRAFT SUBCATEGORY
DIRECT DISCHARGERS

Option	Annualized Cost ($000, 1991)	Pound Equivalents Removed (pe)	Incremental Annualized Cost ($000, 1991)	Incremental pe Removed	Incremental Cost Effectiveness ($/pe)
Baseline	$0	0	n/a	n/a	n/a
1	$1,726	2,042,785	$1,726	2,042,785	$0.84
2	$11,900	2,082,841	$10,174	40,056	$253.99
3	$14,711	2,123,725	$2,812	40,884	$68.77

TABLE 4-2

INCREMENTAL COST-EFFECTIVENESS OF POLLUTION CONTROL OPTIONS
DISSOLVING SULFITE SUBCATEGORY
DIRECT DISCHARGERS

Option	Annualized Cost ($000, 1991)	Pound Equivalents Removed (pe)	Incremental Annualized Cost ($000, 1991)	Incremental pe Removed	Incremental Cost Effectiveness ($/pe)
Baseline	$0	0	n/a	n/a	n/a
1	$4,943	384,664	$4,943	384,664	$12.85
2	$14,829	978,814	$9,885	594,150	$16.64

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TABLE 4-3

INCREMENTAL COST-EFFECTIVENESS OF POLLUTION CONTROL OPTIONS
BLEACHED PAPERGRADE KRAFT AND SODA SUBCATEGORY
DIRECT DISCHARGERS

Option	Annualized Cost ($000, 1991)	Pound Equivalents Removed (pe)	Incremental		
			Annualized Cost ($000, 1991)	pe Removed	Cost Effectiveness ($/pe)
Baseline	$0	0	n/a	n/a	n/a
1	$97,480	48,599,678	$97,480	48,599,678	$2.01
2	$113,437	53,599,234	$15,957	4,999,556	$3.19
3	$200,190	54,356,066	$86,753	756,831	$114.63
4	$260,093	55,104,321	$59,903	748,255	$80.06
5	$561,570	55,166,488	$301,477	62,167	$4,849.44

TABLE 4-4

INCREMENTAL COST-EFFECTIVENESS OF POLLUTION CONTROL OPTIONS
PAPERGRADE SULFITE SUBCATEGORY
DIRECT DISCHARGERS

Option	Annualized Cost ($000, 1991)	Pound Equivalents Removed (pe)	Incremental		
			Annualized Cost ($000, 1991)	pe Removed	Cost Effectiveness ($/pe)
Baseline	$0	0	n/a	n/a	n/a
2	$24,500	920,232	$24,500	920,232	$26.62

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TABLE 4-5

INCREMENTAL COST-EFFECTIVENESS OF POLLUTION CONTROL OPTIONS
BLEACHED PAPERGRADE KRAFT AND SODA SUBCATEGORY
INDIRECT DISCHARGERS

Option	Annualized Cost ($000, 1991)	Pound Equivalents Removed (pe)	Incremental Annualized Cost ($000, 1991)	Incremental pe Removed	Incremental Cost Effectiveness ($/pe)
Baseline	$0	0	n/a	n/a	n/a
1	$24,693	8,938,888	$24,693	8,938,888	$2.76
2	$26,257	9,281,031	$1,564	342,144	$4.57
3	$37,003	9,330,522	$10,746	49,490	$217.13
4	$42,478	9,385,882	$5,475	55,361	$98.90
5	$79,006	9,390,599	$36,528	4,717	$7,744.47

TABLE 4-6

INCREMENTAL COST-EFFECTIVENESS OF POLLUTION CONTROL OPTIONS
PAPERGRADE SULFITE SUBCATEGORY
INDIRECT DISCHARGERS

Option	Annualized Cost ($000, 1991)	Pound Equivalents Removed (pe)	Incremental Annualized Cost ($000, 1991)	Incremental pe Removed	Incremental Cost Effectiveness ($/pe)
Baseline	$0	0	n/a	n/a	n/a
2	$2,226	49,430	$2,226	49,430	$45.03

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TABLE 4-7

INCREMENTAL COST-EFFECTIVENESS OF POLLUTANT CONTROL OPTIONS
PULP, PAPER, AND PAPERBOARD INDUSTRY
DIRECT DISCHARGERS

BAT

	Incremental		
Subcategory	Annualized Cost ($000, 1991)	pe Removed	Cost Effectiveness ($/pe)
Dissolving Kraft	$10,174	40,056	$253.99
Dissolving Sulfite	$4,943	384,664	$12.85
Bleached Papergrade Kraft and Soda	$59,903	748,255	$80.06
Papergrade Sulfite	$24,500	920,232	$26.62
Unbleached Kraft	$4,772	0	
Semichemical	$6,741	0	
Industry Total	$111,033	2,093,207	$53.04

Notes: Incremental costs and removals are calculated from the selected option and preceding option in the subcategory cost effectiveness analysis.

TABLE 4-8

INCREMENTAL COST-EFFECTIVENESS OF POLLUTANT CONTROL OPTIONS
PULP, PAPER, AND PAPERBOARD INDUSTRY
INDIRECT DISCHARGERS

PSES

Subcategory	Incremental Annualized Cost ($000, 1991)	Incremental pe Removed	Incremental Cost Effectiveness ($/pe)
Dissolving Kraft	$0	0	
Dissolving Sulfite	$0	0	
Bleached Papergrade Kraft and Soda	$5,475	55,361	$98.90
Papergrade Sulfite	$2,226	49,430	$45.03
Unbleached Kraft	$1,232	0	
Semichemical	$408	0	
Industry Total	$9,341	104,791	$89.14

Notes: Incremental costs and removals are calculated from the selected option and preceding option in the subcategory cost effectiveness analysis.

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TABLE 4-9

INDUSTRY COMPARISON OF BAT COST-EFFECTIVENESS FOR DIRECT DISCHARGERS
(Toxic and Nonconventional Pollutants Only; Copper-Based Weights[a]; $ 1981)

Industry	PE Currently Discharged (thousands)	PE Remaining at Selected Option (thousands)	Cost-Effectiveness of Selected Option(s) ($/PE removed)
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
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 & 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 Mfg I	6,653	313	4
Nonferrous Metals Mfg 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 & Forming	44	41	BAT=BPT
Porcelain Enameling	1,086	63	6
Petroleum Refining	BAT=BPT	BAT=BPT	BAT=BPT
Pulp & Paper	61,713	2,628	39
Textile Mills	BAT=BPT	BAT=BPT	BAT=BPT

[a]Although toxic weighting factors for priority pollutants varied 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 4-10

INDUSTRY COMPARISON OF PSES COST-EFFECTIVENESS FOR INDIRECT DISCHARGERS
(Toxic and Nonconventional Pollutants Only; Copper-Based Weights[a]; $ 1981)

Industry	PE Currently Discharged (To Surface Waters) (thousands)	PE Remaining at Selected Option (To Surface Waters (thousands)	Cost-Effectiveness of Selected Option(s) Beyond BPT ($/PE removed)
Aluminum Forming	1,602	18	155
Battery Manufacturing	1,152	5	15
Canmaking	252	5	38
Coal Mining	NA	NA	NA[c]
Coil Coating	2,503	10	10
Copper Forming	34	4	10
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 & 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 Mfg I	3,187	19	15
Nonferrous Metals Mfg II	38	0.41	12
Offshore Oil and Gas[b]	NA	NA	NA
Organic Chemicals	5,210	72	34
Pharmaceuticals	340	63	1
Plastics Molding & Forming	NA	NA	NA
Porcelain Enameling	1,565	96	14
Pulp & Paper	9,539	103	65

[a]Although toxic weighting factors for priority pollutants varied across these rules, this table reflects the cost-effectiveness at the time of regulation.
[b]No known indirect dischargers at this time.

SECTION FIVE

AOX ANALYSIS

AOX (adsorbable organic halides) is a measure of the chlorinated organics in the wastestream. As such, it is a measure of a mixture of chlorine compounds whose composition can change as pulping processes change. AOX is a nonconventional pollutant, and removals were calculated for each option and each subcategory. Developing a toxic weighting factor (TWF) for AOX, however, is a difficult process and involves a great deal of uncertainty. A TWF for AOX was approximated by calculating a weighted average of 47 chlorinated organics that could be present in the AOX fraction. The estimated TWF derived by this procedure is 2.7.[1]

Due to the uncertainty in the TWF for AOX, removals of AOX are not included in the cost-effectiveness analysis. Subcategory costs and AOX removals are examined in this section as a supplement to the cost-effectiveness analysis presented in Section Four. This supplemental AOX analysis presents CE ratios for AOX in terms of both unweighted and weighted removals. All costs are expressed in 1991 dollars. Section 5.1 examines the unweighted removals, while Section 5.2 examines the weighted removals.

5.1 AOX ANALYSIS - UNWEIGHTED REMOVALS

Tables 5-1 through 5-4 show the CE ratios for BAT (direct dischargers) with the unweighted AOX removals. Tables 5-5 and 5-6 list the CE ratios for PSES (indirect dischargers). All ratios are less than $8/lb. Option 2 and Option 5 for the bleached papergrade kraft subcategory are inefficient for both BAT and PSES and are removed from the analysis. The only efficient option for the papergrade sulfite subcategory is Option 2 for both direct and indirect dischargers.

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[1]Approach and Assumptions Used for Developing Toxic Weighting Factor (TWF) for AOX, Memorandum from Richard Healy (EPA, OW, Environmental Assessment Section) to Debra Nicoll (EPA, OW, Economics Section), dated 14 July 1993.

Tables 5-7 and 5-8 show the industry CE ratio for unweighted AOX removals for BAT and PSES, respectively. The industry CE ratio is about $4/lb for both BAT and PSES.

5.2 AOX ANALYSIS - WEIGHTED REMOVALS

Tables 5-9 through 5-12 show the CE ratios for BAT (direct dischargers) with the weighted AOX removals. Tables 5-13 and 5-14 list the CE ratios for PSES (indirect dischargers). All ratios are less than $3/pe. Option 2 and Option 5 for the bleached papergrade kraft subcategory are inefficient for both BAT and PSES and are removed from the analysis. The only efficient option for the papergrade sulfite subcategory is Option 2 for both direct and indirect dischargers.

Tables 5-15 and 5-16 show the industry CE ratio for weighted AOX removals for BAT and PSES, respectively. The industry CE ratio is less than $1.60/pe for both BAT and PSES.

TABLE 5-1

INCREMENTAL COST-EFFECTIVENESS OF POLLUTION CONTROL OPTIONS
DISSOLVING KRAFT SUBCATEGORY
DIRECT DISCHARGERS
AOX - POUNDS

Option	Annualized Cost ($000, 1991)	Pounds Removed	Incremental Annualized Cost ($000, 1991)	Incremental Pounds Removed	Incremental Cost Effectiveness $/lb
Baseline	$0	0	n/a	n/a	n/a
1	$1,726	511,361	$1,726	511,361	$3.38
2	$11,900	3,677,076	$10,174	3,165,716	$3.21
3	$14,711	4,627,830	$2,812	950,754	$2.96

TABLE 5-2

INCREMENTAL COST-EFFECTIVENESS OF POLLUTION CONTROL OPTIONS
DISSOLVING SULFITE SUBCATEGORY
DIRECT DISCHARGERS
AOX - POUNDS

Option	Annualized Cost ($000, 1991)	Pounds Removed	Incremental Annualized Cost ($000, 1991)	Incremental Pounds Removed	Incremental Cost Effectiveness $/lb
Baseline	$0	0	n/a	n/a	n/a
1	$4,943	2,216,028	$4,943	2,216,028	$2.23
2	$14,829	4,587,852	$9,885	2,371,824	$4.17

TABLE 5-3

INCREMENTAL COST-EFFECTIVENESS OF POLLUTION CONTROL OPTIONS
BLEACHED PAPERGRADE KRAFT AND SODA SUBCATEGORY
DIRECT DISCHARGERS
AOX - POUNDS

Option	Annualized Cost ($000, 1991)	Pounds Removed	Incremental Annualized Cost ($000, 1991)	Incremental Pounds Removed	Incremental Cost Effectiveness $/lb
Baseline	$0	0	n/a	n/a	n/a
1	$97,480	25,489,030	$97,480	25,489,030	$3.82
3	$200,190	57,780,430	$102,710	32,291,400	$3.18
4	$260,093	74,599,218	$59,903	16,818,788	$3.56

TABLE 5-4

INCREMENTAL COST-EFFECTIVENESS OF POLLUTION CONTROL OPTIONS
PAPERGRADE SULFITE SUBCATEGORY
DIRECT DISCHARGERS
AOX - POUNDS

Option	Annualized Cost ($000, 1991)	Pounds Removed	Incremental Annualized Cost ($000, 1991)	Incremental Pounds Removed	Incremental Cost Effectiveness $/lb
Baseline	$0	0	n/a	n/a	n/a
2	$24,500	9,603,474	$24,500	9,603,474	$2.55

TABLE 5-5

INCREMENTAL COST-EFFECTIVENESS OF POLLUTION CONTROL OPTIONS
BLEACHED PAPERGRADE KRAFT AND SODA SUBCATEGORY
INDIRECT DISCHARGERS
AOX - POUNDS

			Incremental		
Option	Annualized Cost ($000, 1991)	Pounds Removed	Annualized Cost ($000, 1991)	Pounds Removed	Cost Effectiveness $/lb
Baseline	$0	0	n/a	n/a	n/a
1	$24,693	3,169,802	$24,693	3,169,802	$7.79
3	$37,003	7,076,532	$12,310	3,906,730	$3.15
4	$42,478	8,544,736	$5,475	1,468,204	$3.73

TABLE 5-6

INCREMENTAL COST-EFFECTIVENESS OF POLLUTION CONTROL OPTIONS
PAPERGRADE SULFITE SUBCATEGORY
INDIRECT DISCHARGERS
AOX - POUNDS

			Incremental		
Option	Annualized Cost ($000, 1991)	Pounds Removed	Annualized Cost ($000, 1991)	Pounds Removed	Cost Effectiveness $/lb
Baseline	$0	0	n/a	n/a	n/a
2	$2,226	820,228	$2,226	820,228	$2.71

TABLE 5-7

INCREMENTAL COST-EFFECTIVENESS OF POLLUTION CONTROL OPTIONS
PULP, PAPER, AND PAPERBOARD INDUSTRY
DIRECT DISCHARGERS
AOX - POUNDS

BAT

Subcategory	Incremental Annualized Cost ($000, 1991)	Incremental Pounds Removed	Incremental Cost Effectiveness $/lb
Dissolving Kraft	$10,174	3,165,716	$3.21
Dissolving Sulfite	$4,943	2,216,028	$2.23
Bleached Papergrade Kraft and Soda	$59,903	16,818,788	$3.56
Papergrade Sulfite	$24,500	9,603,474	$2.55
Unbleached Kraft	$4,772	0	
Semichemical	$6,741	0	
Industry Total	$111,033	31,804,005	$3.49

Notes: Incremental costs and removals are calculated from the selected option and preceding option in the subcategory cost effectiveness analysis.

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TABLE 5-8

INCREMENTAL COST- EFFECTIVENESS OF POLLUTION CONTROL OPTIONS
PULP, PAPER, AND PAPERBOARD INDUSTRY
INDIRECT DISCHARGERS
AOX-POUNDS

PSES

Subcategory	Incremental Annualized Cost ($000, 1991)	Incremental Pounds Removed	Incremental Cost Effectiveness $/lb
Dissolving Kraft	$0	0	
Dissolving Sulfite	$0	0	
Bleached Papergrade Kraft and Soda	$5,475	1,468,204	$3.73
Papergrade Sulfite	$2,226	820,228	$2.71
Unbleached Kraft	$1,232	0	
Semichemical	$408	0	
Industry Total	$9,341	2,288,432	$4.08

Notes: Incremental costs and removals are calculated from the selected option and preceding option in the subcategory cost effectiveness analysis.

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TABLE 5-9

INCREMENTAL COST-EFFECTIVENESS OF POLLUTION CONTROL OPTIONS
DISSOLVING KRAFT SUBCATEGORY
DIRECT DISCHARGERS
AOX - POUND-EQUIVALENTS

Option	Annualized Cost ($000, 1991)	Pound Equivalents Removed (pe)	Incremental Annualized Cost ($000, 1991)	Incremental pe Removed	Incremental Cost Effectiveness $/pe
Baseline	$0.00	0	n/a	n/a	n/a
1	$1,726	1,380,674	$1,726	1,380,674	1.25
2	$11,900	9,928,106	$10,174	8,547,433	1.19
3	$14,711	12,495,141	$2,812	2,567,035	1.10

TABLE 5-10

INCREMENTAL COST-EFFECTIVENESS OF POLLUTION CONTROL OPTIONS
DISSOLVING SULFITE SUBCATEGORY
DIRECT DISCHARGERS
AOX - POUND-EQUIVALENTS

Option	Annualized Cost ($000, 1991)	Pound Equivalents Removed (pe)	Incremental Annualized Cost ($000, 1991)	Incremental pe Removed	Incremental Cost Effectiveness $/pe
Baseline	$0	0	n/a	n/a	n/a
1	$4,943	5,983,277	$4,943	5,983,277	0.83
2	$14,829	12,387,201	$9,885	6,403,924	1.54

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TABLE 5-11

INCREMENTAL COST-EFFECTIVENESS OF POLLUTION CONTROL OPTIONS
BLEACHED PAPERGRADE KRAFT AND SODA SUBCATEGORY
DIRECT DISCHARGERS
AOX - POUND-EQUIVALENTS

Option	Annualized Cost ($000, 1991)	Pound Equivalents Removed (pe)	Incremental Annualized Cost ($000, 1991)	Incremental pe Removed	Incremental Cost Effectiveness $/pe
Baseline	$0.00	0	n/a	n/a	n/a
1	$97,480	68,820,381	$97,480	68,820,381	1.42
3	$200,190	156,007,161	$102,710	87,186,780	1.18
4	$260,093	201,417,887	$59,903	45,410,726	1.32

TABLE 5-12

INCREMENTAL COST-EFFECTIVENESS OF POLLUTION CONTROL OPTIONS
PAPERGRADE SULFITE SUBCATEGORY
DIRECT DISCHARGERS
AOX - POUND-EQUIVALENTS

Option	Annualized Cost ($000, 1991)	Pound Equivalents Removed (pe)	Incremental Annualized Cost ($000, 1991)	Incremental pe Removed	Incremental Cost Effectiveness $/pe
Baseline	$0.00	0	n/a	n/a	n/a
2	$24,500	25,929,379	$24,500	25,929,379	0.94

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TABLE 5-13

INCREMENTAL COST-EFFECTIVENESS OF POLLUTION CONTROL OPTIONS
BLEACHED PAPERGRADE KRAFT SUBCATEGORY
INDIRECT DISCHARGERS
AOX - POUND-EQUIVALENTS

Option	Annualized Cost ($000, 1991)	Pound Equivalents Removed (pe)	Incremental Annualized Cost ($000, 1991)	Incremental pe Removed	Incremental Cost Effectiveness $/pe
Baseline	$0.00	0	n/a	n/a	n/a
1	$24,693	8,558,465	$24,693	8,558,465	2.89
3	$37,003	19,106,636	$12,310	10,548,171	1.17
4	$42,478	23,070,787	$5,475	3,964,151	1.38

TABLE 5-14

INCREMENTAL COST-EFFECTIVENESS OF POLLUTION CONTROL OPTIONS
PAPERGRADE SULFITE SUBCATEGORY
INDIRECT DISCHARGERS
AOX - POUND-EQUIVALENTS

Option	Annualized Cost ($000, 1991)	Pound Equivalents Removed (pe)	Incremental Annualized Cost ($000, 1991)	Incremental pe Removed	Incremental Cost Effectiveness $/pe
Baseline	$0.00	0	n/a	n/a	n/a
2	$2,226	2,214,615	$2,226	2,214,615	1.01

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TABLE 5-15

INCREMENTAL COST-EFFECTIVENESS OF POLLUTION CONTROL OPTIONS
PULP, PAPER, AND PAPERBOARD INDUSTRY
DIRECT DISCHARGERS
AOX - POUND-EQUIVALENTS

BAT

Subcategory	Incremental Annualized Cost ($000, 1991)	Incremental pe Removed	Cost Effectiveness $/pe
Dissolving Kraft	$10,174	8,547,433	$1.19
Dissolving Sulfite	$4,943	5,983,277	$0.83
Bleached Papergrade Kraft and Soda	$59,903	45,410,726	$1.32
Papergrade Sulfite	$24,500	25,929,379	$0.94
Unbleached Kraft	$4,772	0	
Semichemical	$6,741	0	
Industry Total	$111,033	85,870,815	$1.29

Notes: Incremental costs and removals are calculated from the selected option and preceding option in the subcategory cost effectiveness analysis.

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TABLE 5-16

INCREMENTAL COST-EFFECTIVENESS OF POLLUTION CONTROL OPTIONS
PULP, PAPER, AND PAPERBOARD INDUSTRY
INDIRECT DISCHARGERS
AOX - POUND-EQUIVALENTS

PSES

Subcategory	Incremental Annualized Cost ($000, 1991)	Incremental pe Removed	Cost Effectiveness $/pe
Dissolving Kraft	$0	0	
Dissolving Sulfite	$0	0	
Bleached Papergrade Kraft and Soda	$5,475	3,964,151	$1.38
Papergrade Sulfite	$2,226	2,214,615	$1.01
Unbleached Kraft	$1,232	0	
Semichemical	$408	0	
Industry Total	$9,341	6,178,766	$1.51

Notes: Incremental costs and removals are calculated from the selected option and preceding option in the subcategory cost effectiveness analysis.

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APPENDIX A

POLLUTANT REMOVALS IN POUNDS FOR EACH POLLUTION CONTROL OPTION

TABLE A-1

POLLUTANT REMOVALS - POUNDS
DISSOLVING KRAFT SUBCATEGORY - ALL FACILITIES

CHEMICAL NAME	POLLUTANTS REMOVED (pounds) OPTION 1	OPTION 2	OPTION 3
2-BUTANONE (MEK)	2,073.46	3,928.59	2,775.39
2-PROPANONE (ACETONE)	0.00	8,870.46	0.00
2,3,4,6-TETRACHLOROPHENOL	359.73	262.97	372.54
2,3,7,8-TETRACHLORODIBENZOFURAN	0.05	0.05	0.05
2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN	0.00	0.00	0.00
2,4-DICHLOROPHENOL	514.03	728.12	884.09
2,4,5-TRICHLOROPHENOL	135.56	143.95	148.68
2,4,6-TRICHLOROPHENOL	1,925.88	2,300.34	2,708.47
2,6-DICHLOROPHENOL	133.45	142.26	134.09
2,6-DICHLOROSYRINGALDEHYDE	848.36	852.15	903.79
3,4,5-TRICHLOROCATECHOL	0.00	96.69	363.17
3,4,5-TRICHLOROGUAIACOL	0.00	212.32	467.02
3,4,6-TRICHLOROCATECHOL	351.08	369.53	445.24
3,4,6-TRICHLOROGUAIACOL	354.73	361.47	386.38
4-CHLOROCATECHOL	0.00	20.21	56.26
4-CHLOROPHENOL	0.00	45.30	86.62
4,5-DICHLOROCATECHOL	0.00	95.46	246.35
4,5,6-TRICHLOROGUAIACOL	0.00	267.12	387.06
5,6-DICHLOROVANILLIN	0.00	484.56	774.07
6-CHLOROVANILLIN	0.00	0.00	311.92
CHLOROFORM	0.00	11,999.37	12,328.71
METHYLENE CHLORIDE	2,663.29	2,950.07	2,559.12
PENTACHLOROPHENOL	376.95	151.01	415.49
TETRACHLOROCATECHOL	0.00	106.42	343.17
TETRACHLOROGUAIACOL	706.18	779.67	831.47
TRICHLOROSYRINGOL	0.00	333.56	333.56
TOTAL	10,442.76	35,501.64	28,262.72
ADSORBABLE ORGANIC HALIDES (AOX)	511,360.61	3,677,076.44	4,627,830.17

Note: Removals are rounded to the nearest 0.01 pound. For example, even though a removal of 2 grams of dioxin would appear as 0.00 pounds, there is a non-zero entry for pound-equivalent removals in Appendix B.

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TABLE A-2

POLLUTANT REMOVALS - POUNDS
DISSOLVING SULFITE SUBCATEGORY - ALL FACILITIES

CHEMICAL NAME	POLLUTANTS REMOVED (pounds) OPTION 1	OPTION 2
2-BUTANONE (MEK)	0.00	0.00
2-PROPANONE (ACETONE)	0.00	0.00
2,3,4,6-TETRACHLOROPHENOL	0.00	344.19
2,3,7,8-TETRACHLORODIBENZOFURAN	0.00	0.01
2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN	0.00	0.00
2,4-DICHLOROPHENOL	467.18	851.88
2,4,5-TRICHLOROPHENOL	0.00	344.19
2,4,6-TRICHLOROPHENOL	1,744.33	2,356.07
2,6-DICHLOROPHENOL	0.00	341.62
2,6-DICHLOROSYRINGALDEHYDE	0.00	687.73
3,4,5-TRICHLOROCATECHOL	0.00	689.57
3,4,5-TRICHLOROGUAIACOL	0.00	344.19
3,4,6-TRICHLOROCATECHOL	0.00	689.57
3,4,6-TRICHLOROGUAIACOL	0.00	344.19
4-CHLOROCATECHOL	0.00	183.25
4-CHLOROPHENOL	0.00	310.77
4,5-DICHLOROCATECHOL	0.00	342.92
4,5,6-TRICHLOROGUAIACOL	0.00	347.76
5,6-DICHLOROVANILLIN	0.00	687.73
6-CHLOROVANILLIN	0.00	580.52
CHLOROFORM	118,535.42	156,326.27
METHYLENE CHLORIDE	0.00	982.10
PENTACHLOROPHENOL	3,095.85	3,788.62
TETRACHLOROCATECHOL	0.00	689.34
TETRACHLOROGUAIACOL	0.00	693.10
TRICHLOROSYRINGOL	0.00	344.19
TOTAL	123,842.80	172,269.74
ADSORBABLE ORGANIC HALIDES (AOX)	2,216,028.46	4,587,852.11

Note: Removals are rounded to the nearest 0.01 pound. For example, even though a removal of 2 grams of dioxin would appear as there is a non-zero entry for pound-equivalent removals in Appendix B.

TABLE A-3

POLLUTANT REMOVALS - POUNDS
PAPERGRADE KRAFT SUBCATEGORY - ALL FACILITIES

CHEMICAL NAME	POLLUTANTS REMOVED (pounds)				
	OPTION 1	OPTION 2	OPTION 3	OPTION 4	OPTION 5
2-BUTANONE (MEK)	219,337.74	255,286.68	291,972.69	268,365.32	263,951.04
2-PROPANONE (ACETONE)	52,125.34	25,988.37	166,896.83	36,670.28	91,267.54
2,3,4,6-TETRACHLOROPHENOL	1,427.57	3,471.96	1,743.00	3,782.77	3,751.11
2,3,7,8-TETRACHLORODIBENZOFURAN	0.64	0.66	0.67	0.66	0.67
2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN	0.12	0.14	0.14	0.14	0.14
2,4-DICHLOROPHENOL	22,806.46	22,977.23	27,659.83	31,699.87	31,704.20
2,4,5-TRICHLOROPHENOL	168,267.42	168,739.06	168,940.61	169,057.24	169,025.57
2,4,6-TRICHLOROPHENOL	12,065.07	26,925.88	35,284.32	43,519.93	43,744.47
2,6-DICHLOROPHENOL	4,421.32	4,875.58	5,107.98	4,891.75	5,246.43
2,6-DICHLOROSYRINGALDEHYDE	26.21	6,719.59	6,788.59	7,754.96	7,716.58
3,4,5-TRICHLOROCATECHOL	19,658.39	13,472.49	33,426.33	38,836.20	38,761.91
3,4,5-TRICHLOROGUAIACOL	106,095.87	87,407.59	120,404.51	124,846.14	124,812.12
3,4,6-TRICHLOROCATECHOL	3,714.97	4,303.02	4,638.96	6,064.69	5,987.64
3,4,6-TRICHLOROGUAIACOL	184.72	1,817.32	1,972.81	2,566.11	2,547.90
4-CHLOROCATECHOL	339,831.64	333,130.16	339,963.30	340,600.37	341,814.03
4-CHLOROPHENOL	2,322,142.62	2,319,513.35	2,322,266.89	2,323,310.41	2,323,217.77
4,5-DICHLOROCATECHOL	4,674.02	0.00	17,516.01	20,044.27	20,386.86
4,5,6-TRICHLOROGUAIACOL	15,210.65	12,826.03	16,337.56	20,663.69	20,536.17
5,6-DICHLOROVANILLIN	3,668.85	1,181.63	3,698.29	8,240.29	7,175.69
6-CHLOROVANILLIN	7,735.06	4,409.94	7,898.12	14,163.49	8,412.70
CHLOROFORM	2,169,659.02	1,978,457.89	2,276,209.15	2,282,703.25	2,282,918.90
METHYLENE CHLORIDE	44,281.58	49,963.13	55,132.82	48,203.50	58,245.79
PENTACHLOROPHENOL	96,416.52	98,335.33	95,517.22	98,911.04	99,016.69
TETRACHLOROCATECHOL	8,357.75	6,343.24	10,205.23	15,188.73	15,082.16
TETRACHLOROGUAIACOL	21,683.18	25,253.66	26,350.82	27,145.25	27,300.37
TRICHLOROSYRINGOL	8,266.96	0.00	12,311.44	12,311.44	0.00
TOTAL	5,652,059.67	5,451,399.94	6,050,244.12	5,949,562.00	5,992,624.43
ADSORBABLE ORGANIC HALIDES (AOX)	28,658,831.83	22,640,992.58	64,856,961.89	83,143,953.46	75,932,024.56

Note: Removals are rounded to the nearest 0.01 pound. For example, even though a removal of 2 grams of dioxin would appear as 0.00 pounds, there is a non-zero entry for pound-equivalent removals in Appendix B.

TABLE A-4

POLLUTANT REMOVALS - POUNDS
PAPERGRADE SULFITE SUBCATEGORY - ALL FACILITIES

CHEMICAL NAME	POLLUTANTS REMOVED (in pounds) OPTION 1	OPTION 2
2-BUTANONE (MEK)	0.00	0.00
2-PROPANONE (ACETONE)	0.00	0.00
2,3,4,6-TETRACHLOROPHENOL	0.00	348.38
2,3,7,8-TETRACHLORODIBENZOFURAN	0.02	0.02
2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN	0.00	0.00
2,4-DICHLOROPHENOL	252.94	566.87
2,4,5-TRICHLOROPHENOL	44.64	388.56
2,4,6-TRICHLOROPHENOL	3,933.95	4,283.19
2,6-DICHLOROPHENOL	0.00	343.61
2,6-DICHLOROSYRINGALDEHYDE	0.00	695.74
3,4,5-TRICHLOROCATECHOL	0.00	695.74
3,4,5-TRICHLOROGUAIACOL	0.00	348.38
3,4,6-TRICHLOROCATECHOL	0.00	695.74
3,4,6-TRICHLOROGUAIACOL	0.00	348.38
4-CHLOROCATECHOL	0.00	171.66
4-CHLOROPHENOL	0.00	257.50
4,5-DICHLOROCATECHOL	0.00	345.14
4,5,6-TRICHLOROGUAIACOL	0.00	348.56
5,6-DICHLOROVANILLIN	1,061.39	1,757.13
6-CHLOROVANILLIN	1,631.07	2,196.36
CHLOROFORM	23,402.25	43,487.49
METHYLENE CHLORIDE	2,692.44	5,055.75
PENTACHLOROPHENOL	1,495.97	2,144.23
TETRACHLOROCATECHOL	0.00	697.34
TETRACHLOROGUAIACOL	0.00	696.10
TRICHLOROSYRINGOL	0.00	348.38
TOTAL	34,514.67	66,220.23
ADSORBABLE ORGANIC HALIDES (AOX)	8,563,152.88	10,423,701.53

Note: Removals are rounded to the nearest 0.01 pound. For example, even though a removal of 2 grams of dioxin would appear as 0.00 there is a non-zero entry for pound-equivalent removals in Appendix B.

TABLE A-5

POLLUTANT REMOVAL - POUNDS
DISSOLVING KRAFT SUBCATEGORY - DIRECT DISCHARGERS

CHEMICAL NAME	POLLUTANTS REMOVED (pounds)		
	OPTION 1	OPTION2	OPTION 3
2-BUTANONE (MEK)	2,073.46	3,928.59	2,775.39
2-PROPANONE (ACETONE)	0.00	8,870.46	0.00
2,3,4,6-TETRACHLOROPHENOL	359.73	262.97	372.54
2,3,7,8-TETRACHLORODIBENZOFURAN	0.05	0.05	0.05
2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN	0.00	0.00	0.00
2,4-DICHLOROPHENOL	514.03	728.12	884.09
2,4,5-TRICHLOROPHENOL	135.56	143.95	148.68
2,4,6-TRICHLOROPHENOL	1,925.88	2,300.34	2,708.47
2,6-DICHLOROPHENOL	133.45	142.26	134.09
2,6-DICHLOROSYRINGALDEHYDE	848.36	852.15	903.79
3,4,5-TRICHLOROCATECHOL	0.00	96.69	363.17
3,4,5-TRICHLOROGUAIACOL	0.00	212.32	467.02
3,4,6-TRICHLOROCATECHOL	351.08	369.53	445.24
3,4,6-TRICHLOROGUAIACOL	354.73	361.47	386.38
4-CHLOROCATECHOL	0.00	20.21	56.26
4-CHLOROPHENOL	0.00	45.30	86.62
4,5-DICHLOROCATECHOL	0.00	95.46	246.35
4,5,6-TRICHLOROGUAIACOL	0.00	267.12	367.06
5,6-DICHLOROVANILLIN	0.00	484.56	774.07
6-CHLOROVANILLIN	0.00	0.00	311.92
CHLOROFORM	0.00	11,999.37	12,328.71
METHYLENE CHLORIDE	2,663.29	2,950.07	2,559.12
PENTACHLOROPHENOL	376.95	151.01	415.49
TETRACHLOROCATECHOL	0.00	106.42	343.17
TETRACHLOROGUAIACOL	706.18	779.67	831.47
TRICHLOROSYRINGOL	0.00	333.56	333.56
TOTAL	10,442.76	35,501.64	28,262.72
ADSORBABLE ORGANIC HALIDES (AOX)	511,360.61	3,677,076.44	4,627,830.17

Note: Removals are rounded to the nearest 0.01 pound. For example, even though a removal of 2 grams of dioxin would appear as 0.00 pounds, there is a non-zero entry for pound-equivalent removals in Appendix B.

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TABLE A-6

POLLUTANT REMOVALS - POUNDS
DISSOLVING SULFITE SUBCATEGORY - DIRECT DISCHARGERS

CHEMICAL NAME	POLLUTANTS REMOVED (pounds) OPTION 1	OPTION 2
2-BUTANONE (MEK)	0.00	0.00
2-PROPANONE (ACETONE)	0.00	0.00
2,3,4,6-TETRACHLOROPHENOL	0.00	344.19
2,3,7,8-TETRACHLORODIBENZOFURAN	0.00	0.01
2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN	0.00	0.00
2,4-DICHLOROPHENOL	467.18	851.88
2,4,5-TRICHLOROPHENOL	0.00	344.19
2,4,6-TRICHLOROPHENOL	1,744.33	2,356.07
2,6-DICHLOROPHENOL	0.00	341.62
2,6-DICHLOROSYRINGALDEHYDE	0.00	687.73
3,4,5-TRICHLOROCATECHOL	0.00	689.57
3,4,5-TRICHLOROGUAIACOL	0.00	344.19
3,4,6-TRICHLOROCATECHOL	0.00	689.57
3,4,6-TRICHLOROGUAIACOL	0.00	344.19
4-CHLOROCATECHOL	0.00	183.25
4-CHLOROPHENOL	0.00	310.77
4,5-DICHLOROCATECHOL	0.00	342.92
4,5,6-TRICHLOROGUAIACOL	0.00	347.76
5,6-DICHLOROVANILLIN	0.00	687.73
6-CHLOROVANILLIN	0.00	580.52
CHLOROFORM	118,535.42	156,326.27
METHYLENE CHLORIDE	0.00	982.10
PENTACHLOROPHENOL	3,095.85	3,788.62
TETRACHLOROCATECHOL	0.00	689.34
TETRACHLOROGUAIACOL	0.00	693.10
TRICHLOROSYRINGOL	0.00	344.19
TOTAL	123,842.80	172,269.74
ADSORBABLE ORGANIC HALIDES (AOX)	2,216,028.46	4,587,852.11

Note: Removals are rounded to the nearest 0.01 pound. For example, even though a removal of 2 grams of dioxin would appear as 0.00 pounds, there is a non-zero entry for pound-equivalent removals in Appendix B.

TABLE A-7

POLLUTANT REMOVALS - POUNDS
PAPERGRADE KRAFT SUBCATEGORY - DIRECT DISCHARGERS

CHEMICAL NAME	POLLUTANTS REMOVED (pounds)				
	OPTION 1	OPTION 2	OPTION 3	OPTION 4	OPTION 5
2-BUTANONE (MEK)	211,851.12	244,606.59	278,427.81	256,601.28	252,526.56
2-PROPANONE (ACETONE)	45,517.93	23,757.18	149,212.83	32,656.99	79,516.67
2,3,4,6-TETRACHLOROPHENOL	1,231.83	3,091.68	1,512.65	3,377.75	3,348.37
2,3,7,8-TETRACHLORODIBENZOFURAN	0.56	0.58	0.58	0.58	0.58
2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN	0.10	0.12	0.12	0.12	0.12
2,4-DICHLOROPHENOL	21,386.67	21,546.23	25,896.08	29,668.11	29,672.15
2,4,5-TRICHLOROPHENOL	160,963.42	161,395.86	161,581.19	161,688.70	161,659.32
2,4,6-TRICHLOROPHENOL	11,812.61	25,562.54	33,369.10	41,034.02	41,242.51
2,6-DICHLOROPHENOL	4,112.60	4,531.72	4,747.10	4,546.66	4,875.44
2,6-DICHLOROSYRINGALDEHYDE	26.21	6,040.86	6,104.74	6,997.95	6,962.43
3,4,5-TRICHLOROCATECHOL	19,348.03	13,410.61	32,165.33	37,139.06	37,069.80
3,4,5-TRICHLOROGUAIACOL	99,205.28	81,763.83	112,594.49	116,731.34	116,699.40
3,4,6-TRICHLOROCATECHOL	3,381.35	3,919.28	4,226.73	5,535.54	5,464.24
3,4,6-TRICHLOROGUAIACOL	162.21	1,635.22	1,777.68	2,322.86	2,305.93
4-CHLOROCATECHOL	316,230.11	310,110.80	316,349.40	316,930.78	318,045.41
4-CHLOROPHENOL	2,322,052.09	2,319,513.35	2,322,167.65	2,323,133.11	2,323,046.60
4,5-DICHLOROCATECHOL	3,783.86	0.00	15,402.37	17,720.34	18,033.01
4,5,6-TRICHLOROGUAIACOL	14,997.42	12,709.72	17,904.18	20,078.04	19,940.15
5,6-DICHLOROVANILLIN	3,429.24	1,106.68	3,456.37	7,640.44	6,647.30
6-CHLOROVANILLIN	7,148.29	4,098.79	7,300.16	13,158.81	7,779.67
CHLOROFORM	1,911,938.06	1,741,033.78	2,007,473.15	2,013,458.66	2,013,658.24
METHYLENE CHLORIDE	43,027.09	48,200.26	52,927.09	46,581.73	55,783.68
PENTACHLOROPHENOL	95,484.58	97,231.19	94,669.09	97,762.85	97,860.62
TETRACHLOROCATECHOL	7,781.70	5,953.69	9,485.27	14,112.07	14,012.53
TETRACHLOROGUAIACOL	21,421.13	24,703.22	25,716.39	26,451.60	26,595.40
TRICHLOROSYRINGOL	8,063.61	0.00	11,747.43	11,747.43	0.00
TOTAL	5,334,357.12	5,155,923.79	5,696,214.96	5,607,076.82	5,642,746.14
ADSORBABLE ORGANIC HALIDES (AOX)	25,489,029.89	20,386,945.72	57,780,429.97	74,599,217.56	67,936,382.23

Note: Removals are rounded to the nearest 0.01 pound. For example, even though a removal of 2 grams of dioxin would appear as 0.00 pounds, there is a non-zero entry for pound-equivalent removals in Appendix B.

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TABLE A-8

POLLUTANT REMOVALS - POUNDS
PAPERGRADE SULFITE SUBCATEGORY - DIRECT DISCHARGERS

CHEMICAL NAME	POLLUTANTS REMOVED (pounds) OPTION 1	OPTION 2
2-BUTANONE (MEK)	0.00	0.00
2-PROPANONE (ACETONE)	0.00	0.00
2,3,4,6-TETRACHLOROPHENOL	0.00	324.46
2,3,7,8-TETRACHLORODIBENZOFURAN	0.01	0.02
2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN	0.00	0.00
2,4-DICHLOROPHENOL	252.94	549.92
2,4,5-TRICHLOROPHENOL	34.66	354.66
2,4,6-TRICHLOROPHENOL	3,924.03	4,249.29
2,6-DICHLOROPHENOL	0.00	320.02
2,6-DICHLOROSYRINGALDEHYDE	0.00	647.99
3,4,5-TRICHLOROCATECHOL	0.00	647.99
3,4,5-TRICHLOROGUAIACOL	0.00	324.46
3,4,6-TRICHLOROCATECHOL	0.00	647.99
3,4,6-TRICHLOROGUAIACOL	0.00	324.46
4-CHLOROCATECHOL	0.00	159.87
4-CHLOROPHENOL	0.00	239.82
4,5-DICHLOROCATECHOL	0.00	321.45
4,5,6-TRICHLOROGUAIACOL	0.00	324.63
5,6-DICHLOROVANILLIN	905.77	1,553.76
6-CHLOROVANILLIN	1,391.93	1,918.42
CHLOROFORM	20,543.99	39,250.57
METHYLENE CHLORIDE	2,252.45	4,453.54
PENTACHLOROPHENOL	1,459.01	2,059.49
TETRACHLOROCATECHOL	0.00	649.47
TETRACHLOROGUAIACOL	0.00	648.32
TRICHLOROSYRINGOL	0.00	324.46
TOTAL	30,764.81	60,295.09
ADSORBABLE ORGANIC HALIDES (AOX)	7,870,633.97	9,603,473.59

Note: Removals are rounded to the nearest 0.01 pound. For example, even though a removal of 2 grams of dioxin would appear as 0.00 pounds, there is a non-zero entry for pound-equivalent removals in Appendix B.

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TABLE A-9

POLLUTANT REMOVALS - POUNDS
PAPERGRADE KRAFT SUBCATEGORY - INDIRECT DISCHARGERS

CHEMICAL NAME	POLLUTANTS REMOVED (pounds)				
	OPTION 1	OPTION 2	OPTION 3	OPTION 4	OPTION 5
2-BUTANONE (MEK)	7,486.62	10,680.09	13,544.88	11,764.04	11,424.48
2-PROPANONE (ACETONE)	6,607.41	2,231.19	17,684.00	4,013.29	11,750.87
2,3,4,6-TETRACHLOROPHENOL	195.74	380.27	230.35	405.02	402.74
2,3,7,8-TETRACHLORODIBENZOFURAN	0.08	0.08	0.08	0.08	0.08
2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN	0.02	0.02	0.02	0.02	0.02
2,4-DICHLOROPHENOL	1,419.80	1,431.00	1,763.76	2,031.76	2,032.05
2,4,5-TRICHLOROPHENOL	7,303.99	7,343.20	7,359.42	7,368.54	7,366.25
2,4,6-TRICHLOROPHENOL	252.46	1,363.33	1,915.22	2,485.91	2,501.97
2,6-DICHLOROPHENOL	308.73	343.87	360.88	345.09	370.99
2,6-DICHLOROSYRINGALDEHYDE	0.00	678.74	683.85	757.01	754.15
3,4,5-TRICHLOROCATECHOL	310.35	61.89	1,261.00	1,697.14	1,692.11
3,4,5-TRICHLOROGUAIACOL	6,890.59	5,643.76	7,810.01	8,114.79	8,112.72
3,4,6-TRICHLOROCATECHOL	333.61	383.74	412.23	529.15	523.40
3,4,6-TRICHLOROGUAIACOL	22.51	182.11	195.13	243.26	241.97
4-CHLOROCATECHOL	23,601.52	23,019.36	23,613.91	23,669.59	23,768.62
4-CHLOROPHENOL	90.52	0.00	99.24	177.30	171.17
4,5-DICHLOROCATECHOL	890.15	0.00	2,113.65	2,323.93	2,353.84
4,5,6-TRICHLOROGUAIACOL	213.23	116.32	433.38	605.85	596.02
5,6-DICHLOROVANILLIN	239.62	74.95	241.92	599.85	528.38
6-CHLOROVANILLIN	586.77	311.15	597.95	1,004.68	633.02
CHLOROFORM	257,720.96	237,424.10	268,736.00	269,244.59	269,260.66
METHYLENE CHLORIDE	1,254.48	1,762.87	2,205.73	1,621.77	2,462.11
PENTACHLOROPHENOL	931.95	1,104.14	848.14	1,148.19	1,156.07
TETRACHLOROCATECHOL	576.04	389.54	719.96	1,076.65	1,069.63
TETRACHLOROGUAIACOL	262.05	550.44	634.43	693.64	704.97
TRICHLOROSYRINGOL	203.35	0.00	564.01	564.01	0.00
TOTAL	317,702.54	295,476.16	354,029.16	342,485.18	349,878.30
ADSORBABLE ORGANIC HALIDES (AOX)	3,169,801.94	2,254,046.86	7,076,531.92	8,544,735.90	7,995,642.33

Note: Removals are rounded to the nearest 0.01 pound. For example, even though a removal of 2 grams of dioxin would appear as 0.00 pounds, there is a non-zero entry for pound-equivalent removals in Appendix B.

TABLE A-10

POLLUTANT REMOVALS - POUNDS
PAPERGRADE SULFITE SUBCATEGORY - INDIRECT DISCHARGERS

CHEMICAL NAME	POLLUTANTS REMOVED (pounds) OPTION 1	OPTION 2
2-BUTANONE (MEK)	0.00	0.00
2-PROPANONE (ACETONE)	0.00	0.00
2,3,4,6-TETRACHLOROPHENOL	0.00	23.91
2,3,7,8-TETRACHLORODIBENZOFURAN	0.00	0.00
2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN	0.00	0.00
2,4-DICHLOROPHENOL	0.00	16.95
2,4,5-TRICHLOROPHENOL	9.98	33.90
2,4,6-TRICHLOROPHENOL	9.92	33.90
2,6-DICHLOROPHENOL	0.00	23.59
2,6-DICHLOROSYRINGALDEHYDE	0.00	47.76
3,4,5-TRICHLOROCATECHOL	0.00	47.76
3,4,5-TRICHLOROGUAIACOL	0.00	23.91
3,4,6-TRICHLOROCATECHOL	0.00	47.76
3,4,6-TRICHLOROGUAIACOL	0.00	23.91
4-CHLOROCATECHOL	0.00	11.78
4-CHLOROPHENOL	0.00	17.67
4,5-DICHLOROCATECHOL	0.00	23.69
4,5,6-TRICHLOROGUAIACOL	0.00	23.93
5,6-DICHLOROVANILLIN	155.62	203.37
6-CHLOROVANILLIN	239.14	277.94
CHLOROFORM	2,858.25	4,236.92
METHYLENE CHLORIDE	439.99	602.21
PENTACHLOROPHENOL	36.96	84.74
TETRACHLOROCATECHOL	0.00	47.87
TETRACHLOROGUAIACOL	0.00	47.78
TRICHLOROSYRINGOL	0.00	23.91
TOTAL	3,749.86	5,925.14
ADSORBABLE ORGANIC HALIDES (AOX)	692,518.91	820,227.94

Note: Removals are rounded to the nearest 0.01 pound. For example, even though a removal of 2 grams of dioxin would appear as 0.00 pounds, there is a non-zero entry for pound-equivalent removals in Appendix B.

APPENDIX B

POLLUTANT REMOVALS IN POUND EQUIVALENTS FOR EACH POLLUTION CONTROL OPTION

TABLE B-1

POLLUTANT REMOVALS - POUND EQUIVALENTS
DISSOLVING KRAFT SUBCATEGORY - ALL FACILITIES
10^-5 TOXIC WEIGHTING METHODOLOGY

CHEMICAL NAME	POLLUTANT REMOVALS (pound equivalents)		
	OPTION 1	OPTION2	OPTION 3
2-BUTANONE (MEK)	0	0	0
2-PROPANONE (ACETONE)	0	99	0
2,3,4,6-TETRACHLOROPHENOL	202	148	209
2,3,7,8-TETRACHLORODIBENZOFURAN	360,211	361,102	360,896
2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN	1,676,860	1,714,305	1,753,655
2,4-DICHLOROPHENOL	45	63	77
2,4,5-TRICHLOROPHENOL	169	180	186
2,4,6-TRICHLOROPHENOL	3,717	4,440	5,227
2,6-DICHLOROPHENOL	5	5	5
2,6-DICHLOROSYRINGALDEHYDE	32	32	34
3,4,5-TRICHLOROCATECHOL	0	30	113
3,4,5-TRICHLOROGUAIACOL	0	159	349
3,4,6-TRICHLOROCATECHOL	52	54	65
3,4,6-TRICHLOROGUAIACOL	66	67	71
4-CHLOROCATECHOL	0	1	4
4-CHLOROPHENOL	0	1	1
4,5-DICHLOROCATECHOL	0	12	31
4,5,6-TRICHLOROGUAIACOL	0	483	701
5,6-DICHLOROVANILLIN	0	31	50
6-CHLOROVANILLIN	0	0	16
CHLOROFORM	0	69	70
METHYLENE CHLORIDE	2	3	2
PENTACHLOROPHENOL	188	75	207
TETRACHLOROCATECHOL	0	82	263
TETRACHLOROGUAIACOL	1,236	1,364	1,455
TRICHLOROSYRINGOL	0	35	35
TOTAL	2,042,785	2,082,841	2,123,725
ADSORBABLE ORGANIC HALIDES (AOX)	1,380,674	9,928,106	12,495,141

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TABLE B-2

POLLUTANT REMOVALS - POUND EQUIVALENTS
DISSOLVING SULFITE SUBCATEGORY - ALL FACILITIES
10^-5 TOXIC WEIGHTING METHODOLOGY

CHEMICAL NAME	POLLUTANT REMOVALS (pound equivalents) OPTION 1	OPTION 2
2-BUTANONE (MEK)	0	0
2-PROPANONE (ACETONE)	0	0
2,3,4,6-TETRACHLOROPHENOL	0	193
2,3,7,8-TETRACHLORODIBENZOFURAN	30,095	39,688
2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN	348,940	927,881
2,4-DICHLOROPHENOL	41	74
2,4,5-TRICHLOROPHENOL	0	430
2,4,6-TRICHLOROPHENOL	3,367	4,547
2,6-DICHLOROPHENOL	0	12
2,6-DICHLOROSYRINGALDEHYDE	0	26
3,4,5-TRICHLOROCATECHOL	0	214
3,4,5-TRICHLOROGUAIACOL	0	257
3,4,6-TRICHLOROCATECHOL	0	101
3,4,6-TRICHLOROGUAIACOL	0	64
4-CHLOROCATECHOL	0	13
4-CHLOROPHENOL	0	4
4,5-DICHLOROCATECHOL	0	43
4,5,6-TRICHLOROGUAIACOL	0	629
5,6-DICHLOROVANILLIN	0	44
6-CHLOROVANILLIN	0	30
CHLOROFORM	677	893
METHYLENE CHLORIDE	0	1
PENTACHLOROPHENOL	1,545	1,891
TETRACHLOROCATECHOL	0	529
TETRACHLOROGUAIACOL	0	1,213
TRICHLOROSYRINGOL	0	36
TOTAL	384,664	978,814
ADSORBABLE ORGANIC HALIDES (AOX)	5,983,277	12,387,201

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TABLE B-3

POLLUTANT REMOVALS - POUND EQUIVALENTS
PAPERGRADE KRAFT SUBCATEGORY - ALL FACILITIES
10^-5 TOXIC WEIGHTING METHODOLOGY

CHEMICAL NAME	POLLUTANT REMOVALS (pound equivalents)				
	OPTION 1	OPTION 2	OPTION 3	OPTION 4	OPTION 5
2-BUTANONE (MEK)	20	23	26	24	24
2-PROPANONE (ACETONE)	584	291	1,869	411	1,022
2,3,4,6-TETRACHLOROPHENOL	802	1,951	980	2,126	2,108
2,3,7,8-TETRACHLORODIBENZOFURAN	4,285,289	4,433,841	4,451,571	4,447,362	4,451,945
2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN	52,742,741	57,923,017	58,643,733	59,417,952	59,480,879
2,4-DICHLOROPHENOL	1,986	2,001	2,409	2,761	2,761
2,4,5-TRICHLOROPHENOL	210,334	210,924	211,176	211,322	211,282
2,4,6-TRICHLOROPHENOL	23,286	51,967	68,099	83,993	84,427
2,6-DICHLOROPHENOL	153	169	177	169	182
2,6-DICHLOROSYRINGALDEHYDE	1	255	258	295	293
3,4,5-TRICHLOROCATECHOL	6,114	4,190	10,396	12,078	12,055
3,4,5-TRICHLOROGUAIACOL	79,254	65,293	89,942	93,260	93,235
3,4,6-TRICHLOROCATECHOL	546	633	682	892	880
3,4,6-TRICHLOROGUAIACOL	34	336	365	475	471
4-CHLOROCATECHOL	24,094	23,619	24,103	24,149	24,235
4-CHLOROPHENOL	28,795	28,762	28,796	28,809	28,808
4,5-DICHLOROCATECHOL	589	0	2,207	2,526	2,569
4,5,6-TRICHLOROGUAIACOL	27,531	23,215	33,191	37,438	37,170
5,6-DICHLOROVANILLIN	235	76	237	527	459
6-CHLOROVANILLIN	405	231	413	741	440
CHLOROFORM	12,389	11,297	12,997	13,034	13,035
METHYLENE CHLORIDE	41	46	51	45	54
PENTACHLOROPHENOL	48,112	49,069	47,663	49,357	49,409
TETRACHLOROCATECHOL	6,410	4,865	7,827	11,650	11,568
TETRACHLOROGUAIACOL	37,946	44,194	46,114	47,504	47,776
TRICHLOROSYRINGOL	876	0	1,305	1,305	0
TOTAL	57,538,566	62,880,266	63,686,587	64,490,203	64,557,088
ADSORBABLE ORGANIC HALIDES (AOX)	77,378,846	61,130,680	175,113,797	224,488,674	205,016,466

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TABLE B-4

POLLUTANT REMOVALS - POUND EQUIVALENTS
PAPERGRADE SULFITE SUBCATEGORY -ALL FACILITIES
10^-5 TOXIC WEIGHTING METHODOLOGY

CHEMICAL NAME	POLLUTANT REMOVALS (pound equivalents) OPTION 1	OPTION 2
2-BUTANONE (MEK)	0	0
2-PROPANONE (ACETONE)	0	0
2,3,4,6-TETRACHLOROPHENOL	0	196
2,3,7,8-TETRACHLORODIBENZOFURAN	112,176	120,332
2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN	469,461	835,621
2,4-DICHLOROPHENOL	22	49
2,4,5-TRICHLOROPHENOL	56	486
2,4,6-TRICHLOROPHENOL	7,593	8,267
2,6-DICHLOROPHENOL	0	12
2,6-DICHLOROSYRINGALDEHYDE	0	26
3,4,5-TRICHLOROCATECHOL	0	216
3,4,5-TRICHLOROGUAIACOL	0	260
3,4,6-TRICHLOROCATECHOL	0	102
3,4,6-TRICHLOROGUAIACOL	0	64
4-CHLOROCATECHOL	0	12
4-CHLOROPHENOL	0	3
4,5-DICHLOROCATECHOL	0	43
4,5,6-TRICHLOROGUAIACOL	0	631
5,6-DICHLOROVANILLIN	68	112
6-CHLOROVANILLIN	85	115
CHLOROFORM	134	248
METHYLENE CHLORIDE	3	5
PENTACHLOROPHENOL	746	1,070
TETRACHLOROCATECHOL	0	535
TETRACHLOROGUAIACOL	0	1,218
TRICHLOROSYRINGOL	0	37
TOTAL	590,343	969,662
ADSORBABLE ORGANIC HALIDES (AOX)	23,120,513	28,143,994

TABLE B-5

POLLUTANT REMOVALS - POUND EQUIVALENTS
DISSOLVING KRAFT SUBCATEGORY - DIRECT DISCHARGERS
10^-5 TOXIC WEIGHTING METHODOLOGY

CHEMICAL NAME	POLLUTANT REMOVALS (pound equivalents) OPTION 1	OPTION2	OPTION 3
2-BUTANONE (MEK)	0	0	0
2-PROPANONE (ACETONE)	0	99	0
2,3,4,6-TETRACHLOROPHENOL	202	148	209
2,3,7,8-TETRACHLORODIBENZOFURAN	360,211	361,102	360,896
2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN	1,676,860	1,714,305	1,753,655
2,4-DICHLOROPHENOL	45	63	77
2,4,5-TRICHLOROPHENOL	169	180	186
2,4,6-TRICHLOROPHENOL	3,717	4,440	5,227
2,6-DICHLOROPHENOL	5	5	5
2,6-DICHLOROSYRINGALDEHYDE	32	32	34
3,4,5-TRICHLOROCATECHOL	0	30	113
3,4,5-TRICHLOROGUAIACOL	0	159	349
3,4,6-TRICHLOROCATECHOL	52	54	65
3,4,6-TRICHLOROGUAIACOL	66	67	71
4-CHLOROCATECHOL	0	1	4
4-CHLOROPHENOL	0	1	1
4,5-DICHLOROCATECHOL	0	12	31
4,5,6-TRICHLOROGUAIACOL	0	483	701
5,6-DICHLOROVANILLIN	0	31	50
6-CHLOROVANILLIN	0	0	16
CHLOROFORM	0	69	70
METHYLENE CHLORIDE	2	3	2
PENTACHLOROPHENOL	188	75	207
TETRACHLOROCATECHOL	0	82	263
TETRACHLOROGUAIACOL	1,236	1,364	1,455
TRICHLOROSYRINGOL	0	35	35
TOTAL	2,042,785	2,082,841	2,123,725
ADSORBABLE ORGANIC HALIDES (AOX)	1,380,674	9,928,106	12,495,141

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TABLE B-6

POLLUTANT REMOVALS - POUND EQUIVALENTS
DISSOLVING SULFITE SUBCATEGORY - DIRECT DISCHARGERS
10^-5 TOXIC WEIGHTING METHODOLOGY

CHEMICAL NAME	POLLUTANT REMOVALS (pound equivalents) OPTION 1	OPTION 2
2-BUTANONE (MEK)	0	0
2-PROPANONE (ACETONE)	0	0
2,3,4,6-TETRACHLOROPHENOL	0	193
2,3,7,8-TETRACHLORODIBENZOFURAN	30,095	39,688
2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN	348,940	927,881
2,4-DICHLOROPHENOL	41	74
2,4,5-TRICHLOROPHENOL	0	430
2,4,6-TRICHLOROPHENOL	3,367	4,547
2,6-DICHLOROPHENOL	0	12
2,6-DICHLOROSYRINGALDEHYDE	0	26
3,4,5-TRICHLOROCATECHOL	0	214
3,4,5-TRICHLOROGUAIACOL	0	257
3,4,6-TRICHLOROCATECHOL	0	101
3,4,6-TRICHLOROGUAIACOL	0	64
4-CHLOROCATECHOL	0	13
4-CHLOROPHENOL	0	4
4,5-DICHLOROCATECHOL	0	43
4,5,6-TRICHLOROGUAIACOL	0	629
5,6-DICHLOROVANILLIN	0	44
6-CHLOROVANILLIN	0	30
CHLOROFORM	677	893
METHYLENE CHLORIDE	0	1
PENTACHLOROPHENOL	1,545	1,891
TETRACHLOROCATECHOL	0	529
TETRACHLOROGUAIACOL	0	1,213
TRICHLOROSYRINGOL	0	36
TOTAL	384,664	978,814
ADSORBABLE ORGANIC HALIDES (AOX)	5,983,277	12,387,201

TABLE B-7

POLLUTANT REMOVALS - POUND EQUIVALENTS
PAPERGRADE KRAFT SUBCATEGORY - DIRECT DISCHARGERS
10^-5 TOXIC WEIGHTING METHODOLOGY

CHEMICAL NAME	POLLUTANT REMOVALS (pound equivalents)				
	OPTION 1	OPTION 2	OPTION 3	OPTION 4	OPTION 5
2-BUTANONE (MEK)	19	22	25	23	23
2-PROPANONE (ACETONE)	510	266	1,671	366	891
2,3,4,6-TETRACHLOROPHENOL	692	1,738	850	1,898	1,882
2,3,7,8-TETRACHLORODIBENZOFURAN	3,730,659	3,869,123	3,885,477	3,881,587	3,885,823
2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN	44,378,795	49,228,275	49,905,500	50,626,430	50,685,024
2,4-DICHLOROPHENOL	1,863	1,877	2,256	2,584	2,584
2,4,5-TRICHLOROPHENOL	201,204	201,745	201,976	202,111	202,074
2,4,6-TRICHLOROPHENOL	22,798	49,336	64,402	79,196	79,598
2,6-DICHLOROPHENOL	142	157	164	157	169
2,6-DICHLOROSYRINGALDEHYDE	1	230	232	266	265
3,4,5-TRICHLOROCATECHOL	6,017	4,171	10,003	11,550	11,529
3,4,5-TRICHLOROGUAIACOL	74,106	61,078	84,108	87,198	87,174
3,4,6-TRICHLOROCATECHOL	497	576	621	814	803
3,4,6-TRICHLOROGUAIACOL	30	303	329	430	427
4-CHLOROCATECHOL	22,421	21,987	22,429	22,470	22,549
4-CHLOROPHENOL	28,793	28,762	28,795	28,807	28,806
4,5-DICHLOROCATECHOL	477	0	1,941	2,233	2,272
4,5,6-TRICHLOROGUAIACOL	27,145	23,005	32,407	36,341	36,092
5,6-DICHLOROVANILLIN	219	71	221	489	425
6-CHLOROVANILLIN	374	214	382	688	407
CHLOROFORM	10,917	9,941	11,463	11,497	11,498
METHYLENE CHLORIDE	40	45	49	43	52
PENTACHLOROPHENOL	47,647	48,518	47,240	48,784	48,832
TETRACHLOROCATECHOL	5,969	4,566	7,275	10,824	10,748
TETRACHLOROGUAIACOL	37,487	43,231	45,004	46,290	46,542
TRICHLOROSYRINGOL	855	0	1,245	1,245	0
TOTAL	48,599,678	53,599,234	54,356,066	55,104,321	55,166,488
ADSORBABLE ORGANIC HALIDES (AOX)	68,820,381	55,044,753	156,007,161	201,417,887	183,428,232

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TABLE B-8

POLLUTANT REMOVALS - POUND EQUIVALENTS
PAPERGRADE SULFITE SUBCATEGORY - DIRECT DISCHARGERS
10^-5 TOXIC WEIGHTING METHODOLOGY

CHEMICAL NAME	POLLUTANT REMOVALS (pound equivalents) OPTION 1	OPTION 2
2-BUTANONE (MEK)	0	0
2-PROPANONE (ACETONE)	0	0
2,3,4,6-TETRACHLOROPHENOL	0	182
2,3,7,8-TETRACHLORODIBENZOFURAN	95,763	103,145
2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN	469,461	803,812
2,4-DICHLOROPHENOL	22	48
2,4,5-TRICHLOROPHENOL	43	443
2,4,6-TRICHLOROPHENOL	7,573	8,201
2,6-DICHLOROPHENOL	0	11
2,6-DICHLOROSYRINGALDEHYDE	0	25
3,4,5-TRICHLOROCATECHOL	0	202
3,4,5-TRICHLOROGUAIACOL	0	242
3,4,6-TRICHLOROCATECHOL	0	95
3,4,6-TRICHLOROGUAIACOL	0	60
4-CHLOROCATECHOL	0	11
4-CHLOROPHENOL	0	3
4,5-DICHLOROCATECHOL	0	41
4,5,6-TRICHLOROGUAIACOL	0	588
5,6-DICHLOROVANILLIN	58	99
6-CHLOROVANILLIN	73	100
CHLOROFORM	117	224
METHYLENE CHLORIDE	2	4
PENTACHLOROPHENOL	728	1,028
TETRACHLOROCATECHOL	0	498
TETRACHLOROGUAIACOL	0	1,135
TRICHLOROSYRINGOL	0	34
TOTAL	573,841	920,232
ADSORBABLE ORGANIC HALIDES (AOX)	21,250,712	25,929,379

TABLE B-9

POLLUTANT REMOVALS - POUND EQUIVALENTS
PAPERGRADE KRAFT SUBCATEGORY - INDIRECT DISCHARGERS
10^-5 TOXIC WEIGHTING FACTOR METHODOLOGY

CHEMICAL NAME	POLLUTANT REMOVALS (pound equivalents)				
	OPTION 1	OPTION 2	OPTION 3	OPTION 4	OPTION 5
2-BUTANONE (MEK)	1	1	1	1	1
2-PROPANONE (ACETONE)	74	25	198	45	132
2,3,4,6-TETRACHLOROPHENOL	110	214	129	228	226
2,3,7,8-TETRACHLORODIBENZOFURAN	554,630	564,718	566,094	565,776	566,122
2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN	8,363,946	8,694,742	8,738,233	8,791,523	8,795,854
2,4-DICHLOROPHENOL	124	125	154	177	177
2,4,5-TRICHLOROPHENOL	9,130	9,179	9,199	9,211	9,208
2,4,6-TRICHLOROPHENOL	487	2,631	3,696	4,798	4,829
2,6-DICHLOROPHENOL	11	12	12	12	13
2,6-DICHLOROSYRINGALDEHYDE	0	26	26	29	29
3,4,5-TRICHLOROCATECHOL	97	19	392	528	526
3,4,5-TRICHLOROGUAIACOL	5,147	4,216	5,834	6,062	6,060
3,4,6-TRICHLOROCATECHOL	49	56	61	78	77
3,4,6-TRICHLOROGUAIACOL	4	34	36	45	45
4-CHLOROCATECHOL	1,673	1,632	1,674	1,678	1,685
4-CHLOROPHENOL	1	0	1	2	2
4,5-DICHLOROCATECHOL	112	0	266	293	297
4,5,6-TRICHLOROGUAIACOL	386	211	784	1,097	1,079
5,6-DICHLOROVANILLIN	15	5	15	38	34
6-CHLOROVANILLIN	31	16	31	53	33
CHLOROFORM	1,472	1,356	1,534	1,537	1,537
METHYLENE CHLORIDE	1	2	2	2	2
PENTACHLOROPHENOL	465	551	423	573	577
TETRACHLOROCATECHOL	442	299	552	826	820
TETRACHLOROGUAIACOL	459	963	1,110	1,214	1,234
TRICHLOROSYRINGOL	22	0	60	60	0
TOTAL	8,938,888	9,281,031	9,330,522	9,385,882	9,390,599
ADSORBABLE ORGANIC HALIDES (AOX)	8,558,465	6,085,927	19,106,636	23,070,787	21,588,234

TABLE B-10

POLLUTANT REMOVALS - POUND EQUIVALENTS
PAPERGRADE SULFITE SUBCATEGORY - INDIRECT DISCHARGERS
10^-5 TOXIC WEIGHTING FACTOR METHODOLOGY

CHEMICAL NAME	POLLUTANT REMOVALS (pound equivalents) OPTION 1	OPTION 2
2-BUTANONE (MEK)	0	0
2-PROPANONE (ACETONE)	0	0
2,3,4,6-TETRACHLOROPHENOL	0	13
2,3,7,8-TETRACHLORODIBENZOFURAN	16,414	17,187
2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN	0	31,809
2,4-DICHLOROPHENOL	0	1
2,4,5-TRICHLOROPHENOL	12	42
2,4,6-TRICHLOROPHENOL	19	65
2,6-DICHLOROPHENOL	0	1
2,6-DICHLOROSYRINGALDEHYDE	0	2
3,4,5-TRICHLOROCATECHOL	0	15
3,4,5-TRICHLOROGUAIACOL	0	18
3,4,6-TRICHLOROCATECHOL	0	7
3,4,6-TRICHLOROGUAIACOL	0	4
4-CHLOROCATECHOL	0	1
4-CHLOROPHENOL	0	0
4,5-DICHLOROCATECHOL	0	3
4,5,6-TRICHLOROGUAIACOL	0	43
5,6-DICHLOROVANILLIN	10	13
6-CHLOROVANILLIN	13	15
CHLOROFORM	16	24
METHYLENE CHLORIDE	0	1
PENTACHLOROPHENOL	18	42
TETRACHLOROCATECHOL	0	37
TETRACHLOROGUAIACOL	0	84
TRICHLOROSYRINGOL	0	3
TOTAL	16,503	49,430
ADSORBABLE ORGANIC HALIDES (AOX)	1,869,801	2,214,615

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APPENDIX C

INDUSTRY-WIDE REMOVALS IN POUNDS AND POUND EQUIVALENTS

TABLE C-4

TOTAL POUND EQUIVALENTS REMOVED AT SELECTED OPTION

Pollutant Name	All Mills	Direct Dischargers	Indirect Dischargers
2-BUTANONE (MEK)	25	24	1
2-PROPANONE (ACETONE)	510	465	45
2,3,4,6-TETRACHLOROPHENOL	2,469	2,228	241
2,3,7,8-TETRACHLORODIBENZOFURAN	4,968,486	4,385,523	582,963
2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN	62,895,646	54,072,314	8,823,332
2,4-DICHLOROPHENOL	2,915	2,736	178
2,4,5-TRICHLOROPHENOL	211,987	202,734	9,253
2,4,6-TRICHLOROPHENOL	100,066	95,203	4,863
2,6-DICHLOROPHENOL	186	173	13
2,6-DICHLOROSYRINGALDEHYDE	4,487	4,456	31
3,4,5-TRICHLOROCATECHOL	12,325	11,782	543
3,4,5-TRICHLOROGUAIACOL	93,679	87,599	6,080
3,4,6-TRICHLOROCATECHOL	1,048	963	85
3,4,6-TRICHLOROGUAIACOL	606	557	49
4-CHLOROCATECHOL	24,162	22,483	1,679
4-CHLOROPHENOL	28,813	28,810	2
4,5-DICHLOROCATECHOL	2,581	2,285	296
4,5,6-TRICHLOROGUAIACOL	38,552	37,412	1,140
5,6-DICHLOROVANILLIN	671	619	51
6-CHLOROVANILLIN	856	789	67
CHLOROFORM	14,028	12,466	1,562
METHYLENE CHLORIDE	52	50	2
PENTACHLOROPHENOL	52,047	51,432	615
TETRACHLOROCATECHOL	12,266	11,404	863
TETRACHLOROGUAIACOL	50,087	48,789	1,297
TRICHLOROSYRINGOL	1,377	1,315	62
TOTAL	**68,519,927**	**59,084,613**	**9,435,313**
ADSORBABLE ORGANIC HALIDES (AOX)	268,544,052	243,258,649	25,285,402

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